



# The impact of coronavirus disease on ocular trauma: a review of 5065 cases from Kuwait

Ebrahem Alansari<sup>1</sup>, Nora Aldhefeery<sup>1</sup>, Sherein Hagra<sup>2</sup> and Nancy M Lotfy<sup>3</sup>

<sup>1</sup> Department of Ophthalmology, Farwaniya Hospital, Kuwait

<sup>2</sup> Department of Ophthalmology, Faculty of Medicine, Mansoura University, Mansoura, Egypt

<sup>3</sup> Department of Ophthalmology, Faculty of Medicine, Cairo University, Cairo, Egypt

## ABSTRACT

**Background:** Early reports during the lockdown associated with the coronavirus disease 2019 (COVID-19) pandemic indicated a shift in the trends of ocular injuries. This study examined the demographics and clinical characteristics of patients who presented with ocular trauma during the lockdown period in 2020, and compared them to those seen during the same months in the next year, after the lockdown had been lifted, at Farwaniya Hospital in Kuwait.

**Methods:** This retrospective hospital-based chart review was a comparative observational study that examined individuals who presented to the Ophthalmology Department's emergency room during two distinct periods: from March 22, 2020, the day quarantine measures were announced, until August 30, 2020, when the quarantine ended, and the same time frame in the following year. Demographic characteristics, diagnoses, mechanisms of ocular trauma, and the locations where the eye injuries had occurred were recorded. Local injuries were classified as either mechanical or non-mechanical. Mechanical injuries were further subdivided by their cause. Non-mechanical injuries encompassed those caused by burns or corrosive substances.

**Results:** The incidence of ocular trauma increased from 18.9% (1470 out of 7763 cases) during the lockdown to 21.5% (3595 out of 16748 cases) in the post-lockdown period. The mean age of the study population was slightly lower during the lockdown compared to the post-lockdown period, although this difference did not reach statistical significance ( $P > 0.05$ ). Ocular trauma among children  $< 18$  years was significantly higher during the lockdown period, accounting for 39.1% (575 of 1470 cases), compared to 36.0% (1293 of 3595 cases) in the post-lockdown period ( $P < 0.05$ ). During both periods, injuries predominantly occurred at home, but the percentage of injuries decreased significantly during the post-lockdown period ( $P < 0.05$ ). Workers were the most affected group, representing nearly 50% of cases during both periods. During the lockdown, 29.9% (439 cases) of ocular trauma cases involved work-related injuries, but this percentage increased significantly to 33.7% (1213 cases) post-lockdown ( $P < 0.05$ ). Mechanical injuries constituted the majority of cases in both periods, accounting for almost 95% of the incidents, with a significant difference between the two periods ( $P < 0.05$ ). Non-mechanical eye injuries did not differ between the two periods ( $P > 0.05$ ). Most ocular trauma cases involved the anterior segment of the eye, with superficial corneal and conjunctival injuries being predominant, accounting for  $> 50\%$  of cases during both periods.

**Conclusions:** The COVID-19 pandemic significantly impacted the trends in cases visiting ophthalmic emergency departments. After the lockdown, the incidence of ocular trauma increased. Ocular trauma among children was significantly higher during the lockdown period. The frequency of home-related ocular injuries was greater during the lockdown than in the post-lockdown phase. Work-related injuries showed a marked increase after the lockdown. Long-term, retrospective multicenter epidemiological studies in Kuwait could shed light on changes in the use of eye emergency department services during pre- and post-pandemic periods.

## KEYWORDS

trauma, injury, wounds, eye injury, coronavirus disease 2019 virus, quarantines, children

**Correspondences:** Nora Aldhefeery, Farwaniya Hospital, Al Farwaniyah Governorate, Ministry of Health, Kuwait. Email: [nora.aldeheery@gmail.com](mailto:nora.aldeheery@gmail.com). ORCID iD: <https://orcid.org/0009-0002-9020-8376>

**How to cite this article:** Alansari E, Aldhefeery N, Hagra S, Lotfy NM. The impact of coronavirus disease on ocular trauma: a review of 5065 cases from Kuwait. *Med Hypothesis Discov Innov Optom*. 2024 Winter; 5(4): 145-151. Doi: <https://doi.org/10.51329/mehdiptometry209>

Received: 05 January 2025; Accepted: 28 February 2025



Copyright © Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits copy and redistribute the material just in noncommercial usages, provided the original work is properly cited.



## INTRODUCTION

The coronavirus disease 2019 (COVID-19), first reported in December 2019, spread to all parts of the world and was declared a pandemic by the World Health Organization in March 2020 [1]. To limit the spread of COVID-19, countries endorsed a range of unprecedented public health responses. These measures aimed to curtail the magnitude of the epidemic and to decrease the burden on the health-care system [2]. In Kuwait, several precautionary measures were taken to curb the spread of the virus, which included suspending congregational prayers at mosques, and incoming and outgoing flights, as well as suspending work in the public sector, including the government ministries, and completely transforming teaching at schools and universities to online teaching [3, 4]. A curfew was announced, at first partial and then total, and people throughout Kuwait were ordered to stay at home [3].

With enforcement of the lockdown rules, the wide-ranging changes might have altered ocular trauma presentation. Previous studies have found a greater incidence of ocular trauma occurring outdoors [5-8], whereas early reports during the COVID-19 lockdown suggested an increase in household injuries due to chemical exposures [9-11].

To standardize the description of shared eye injury information, an integrated classification system was crucial. The Birmingham Eye Trauma Terminology System was proposed in 1997 as a classification system for mechanical globe injuries [12, 13]. Later modifications were suggested by adding adnexal injuries as well as non-mechanical causes of ocular trauma to this system. These modifications led to the appearance of other classification systems [14-16].

This study describes the demographics and clinical characteristics of patients presenting with ocular trauma during the COVID-19 lockdown in 2020 and compared them with the same timeframe in the following year, in the post-lockdown period, in Kuwait.

## METHODS

This retrospective hospital-based chart review was a comparative observational study that included individuals presenting to the emergency room of the Ophthalmology Department at Farwaniya Hospital in Al Farwaniyah Governorate, Kuwait, during the COVID-19 pandemic lockdown and post-lockdown periods. The study protocol adhered to the principles of the Declaration of Helsinki and was reviewed and approved by the regional Medical Ethics Committee. Informed written consent was obtained from all participants included in the study.

We conducted a retrospective chart review of individuals with hospital records who presented to the emergency room in the Ophthalmology Department with various forms of ocular trauma. Data were collected from March 22, 2020, the day COVID-19 quarantine measures were announced, until August 30, 2020, when the lockdown was lifted [3]. These data were then compared to patients from the same timeframe in the following year, from March 22, 2021, to August 30, 2021. An ophthalmologist in the Emergency Department documented the diagnosis and cause of the ocular trauma in the clinical notes. We excluded any cases with incomplete records.

All individuals underwent thorough ocular examinations upon their presentation to the emergency room in the Ophthalmology Department, including testing for presence of relative afferent pupillary defect, measurement of visual acuity with a Snellen chart using an Auto Chart Projector CP 670 (Nidek Co., Ltd., Gamagori, Japan), a meticulous examination of the anterior and posterior segments using slit-lamp biomicroscopy (Haag-Streit Photo-Slit-Lamp BX 900; Haag-Streit, Koeniz, Switzerland), and intraocular pressure measurement, provided that globe perforation was not suspected, using a Goldmann applanation tonometer AT 900 (Haag-Streit).

The following data were obtained from patients' records: demographic characteristics (including age, sex, and occupation), presenting ocular diagnosis, mechanisms of ocular trauma, and the locations in which the injuries occurred (home, workplace, or street). We categorized individuals into two age groups (children [under 18 years] and adults [18 years and older]), as well as by sex (males and females). In reference to Shukla et al. [14], all cases were divided into two categories: local injuries (limited to the eyeball or adnexa) and associated injuries (involving head injuries or multiple injuries). Local injuries were further classified into mechanical or non-mechanical injuries [14], or categorized as other, if applicable. If the mechanism of injury was not specified, we recorded it as unknown. Mechanical injuries were subdivided based on the cause into those resulting from blunt objects, sharp objects, motor vehicles, falls, or violence. Non-mechanical injuries included those caused by burns or corrosive substances [17].

Statistical analysis was performed using IBM SPSS Statistics for Windows (version 30.0; IBM Corp., Armonk, NY, USA). The incidence of patients with ocular trauma was calculated. All variables were assessed for normality of data distribution using the Shapiro-Wilk test. Categorical variables are presented as frequencies (percentages) and were compared between the two time periods by using the chi-square test. Age is presented as the mean and standard deviation (SD), and was compared between the two time periods by using independent Student's *t*-test. The significance level for statistical tests was set at  $P < 0.05$ .

## RESULTS

In total, 7763 and 1 6748 patients presented to the emergency department during the lockdown and post-lockdown periods, respectively. Of these, 1470 and 3 595 patients were diagnosed with ocular trauma during the lockdown and post-lockdown period, respectively.

**Table 1. Comparison of socio-demographic characteristics of patients presenting with ocular trauma during the COVID-19 lockdown period versus the post-lockdown period**

Variable	Lockdown period (n = 1470)	Post-lockdown period (n = 3595)	P-value
Age (y), Mean $\pm$ SD	25.1 $\pm$ 17.20	26.6 $\pm$ 16.03	0.734
Male, n (%)	1022 (69.5)	2639 (73.4)	<b>0.005</b>
Female, n (%)	448 (30.5)	956 (26.6)	<b>0.005</b>
Children under 18 years, n (%)	575 (39.1)	1293 (36.0)	<b>0.035</b>
<b>Occupation, n (%)</b>			
Students	628 (42.7)	1447 (40.3)	0.109
Workers	727 (49.5)	1879 (52.3)	0.071
Child or retired	115 (7.8)	269 (7.5)	0.689

Abbreviations: COVID-19, coronavirus disease 2019; y, years; SD, standard deviation; n, number of participants; %, percentage. Note: P-values < 0.05 are shown in bold.

**Table 2. Comparison of mechanisms of ocular trauma, diagnosis, and location at which the injury occurred for patients presenting with ocular trauma during the COVID-19 lockdown period versus the post-lockdown period**

Variable	Lockdown period (n = 1470)	Post-lockdown period (n = 3595)	P-value
<b>Mechanisms of ocular trauma, n (%)</b>			
Mechanical	1388 (94.4)	3443 (95.8)	<b>0.035</b>
Blunt objects	1349 (97.2)	3378 (98.1)	
Sharp objects	29 (2.1)	41 (1.2)	
Motor vehicle	0 (0.0)	2 (0.1)	
Falls	1 (0.1)	5 (0.1)	
Violence	9 (0.6)	17 (0.5)	
Non-Mechanical (burns or corrosive substances)	42 (2.9)	92 (2.6)	0.548
Other or unknown	40 (2.7)	60 (1.7)	<b>0.016</b>
<b>Location at which the injury occurred, n (%)</b>			
Street	20 (1.4)	71 (2.0)	0.133
Workplace	439 (29.9)	1213 (33.7)	<b>0.006</b>
Home	1011 (68.8)	2311 (64.3)	<b>0.001</b>
<b>Diagnosis, n (%)</b>			
Foreign body on external eye	415 (28.2)	1228 (34.2)	< <b>0.001</b>
Superficial injury	835 (56.8)	1876 (52.2)	< <b>0.001</b>
Subconjunctival hemorrhage	42 (2.9)	150 (4.2)	<b>0.026</b>
Eyelid injury	24 (1.6)	37 (1.0)	0.074
Hyphema	4 (0.3)	2 (0.1)	0.063
Retinal edema	6 (0.4)	1 (0.03)	<b>0.003</b>
Orbital fracture	0 (0.0)	5 (0.1)	0.330
Penetrating wound	3 (0.2)	6 (0.2)	0.776
Other or unknown	141 (9.6)	290 (8.1)	0.077

Abbreviations: COVID-19, coronavirus disease 2019; n, number of participants; %, percentage. Note: P-values < 0.05 are shown in bold.

We found that the incidence of ocular trauma increased from 18.9% during the lockdown to 21.5% in the post-lockdown period. Demographic factors of the study participants are summarized in Table 1. The mean (SD) age of the study population was slightly lower during the lockdown period (25.1 [17.20] years) than during the post-lockdown period (26.6 [16.03] years), but this did not reach statistical significance ( $P > 0.05$ ) (Table 1). The incidence of ocular trauma among children was significantly higher ( $P < 0.05$ ) during the lockdown period (n = 575 of 1470, 39.1%) than during the post-lockdown period (n = 1293 of 3595, 36.0%) (Table 1).

Data on eye injuries are presented in Table 2. During both the lockdown and post-lockdown periods, ocular injuries occurred primarily at home (n = 1011, 68.8% in 2020 vs. n = 2311, 64.3% in 2021), with a significantly decreased percentage occurring at home during the post-lockdown period ( $P < 0.05$ ; Table 2). Workers were the predominant affected group (n = 727, 49.5% in 2020 vs. n = 1879, 52.3% in 2021) (Table 1). During the lockdown period, 29.9% (n = 439) of ocular trauma cases were work-related injuries, and this percentage increased significantly to 33.7% (n = 1213) during the post-lockdown period ( $P < 0.05$ ) (Table 2). Mechanical injuries represented the majority of cases during and after the lockdown period (n = 1388, 94.4% vs. n = 3443, 95.8%) and differed significantly between these two periods ( $P < 0.05$ ). Blunt objects were the most common cause of mechanical injuries (Table 1). The frequency of non-mechanical eye injuries during the lockdown period (n = 42, 2.9%) and post-lockdown period (n = 92, 2.6%) were not significantly different ( $P > 0.05$ ) (Table 2).

Most of the ocular trauma injuries involved the anterior segment of the eye, with superficial injuries of the cornea and conjunctiva being predominant ( $n = 835$ , 56.8% during lockdown vs.  $n = 1876$ , 52.2% post-lockdown). The percentage of foreign bodies on the external eye showed an increase from 28.2% during lockdown to 34.2% post-lockdown. No case of motor vehicle-associated or orbital fracture occurred during lockdown, but during the post-lockdown period, two and five cases sustained these injuries, respectively (Table 2).

## DISCUSSION

This retrospective hospital-based comparative observational study found that the incidence of ocular trauma increased from 18.9% during the COVID-19 lockdown period to 21.5% in the same time frame during the following year, after lockdown had been lifted. Although the individuals affected during the lockdown period were slightly younger, this difference did not reach statistical significance. During both periods, ocular injuries predominantly occurred at home, although the percentage showed a significant decrease after lockdown had been lifted. The incidence of ocular trauma during the lockdown period was significantly higher (39.1% vs. 36.0%) among individuals aged under 18 years. Additionally, the frequency of work-related injuries increased significantly during the post-lockdown period. Mechanical injuries were the most common type of injury during both periods, with a slight but significant increase after the lockdown (94.4% vs. 95.8%). Blunt objects were the leading cause of injuries during both periods, accounting for over 95% of cases. However, the frequency of non-mechanical eye injuries remained comparable between the two time periods.

Ocular trauma is one of the major causes of preventable vision loss worldwide [18]. A meta-analysis found that the overall incidence of ocular trauma during the COVID-19 pandemic decreased to 67.7% of that in the pre-pandemic period [19]. The regulations imposed during the COVID-19 pandemic had a significant effect on the trends for emergency Ophthalmic Department visits worldwide. A study conducted in India found that the post-lockdown phase demonstrated a 41% increase in the number of cases as compared with the lockdown period [20]. Halawa et al. [21] found a significantly lower estimated incidence of eye injuries during the first year of the pandemic (2020) compared to the years 2011–2019 in the United States [21]. The German Ophthalmological Society reported a 7.3% decline in urgent cases of perforating eyeball injuries during the pandemic from March 15 to April 15, 2020 [22]. A nationwide, population-based, cross-sectional study utilizing data from the Korean National Health Insurance analyzed trends in ocular trauma during the COVID-19 pandemic. The findings indicated a decrease in the incidence of hyphema, orbital blow-out fractures, and primary closure of the cornea or sclera in 2020 as compared to that in the years 2011–2019 [23]. Here, we found that the incidence of ocular trauma increased from 18.9% during the lockdown to 21.5% in the post-lockdown period.

Liew et al. [24] conducted a comparison of patients presenting with ocular trauma during the early COVID-19 period, from March 18, 2020, to September 17, 2020, with a similar period from the year before the pandemic. Consistent with the current study, a higher proportion of patients in both periods were male (76.82%,  $n = 348$  of 453), and closed globe injuries were predominant ( $n = 436$ , 96.24%), with rates of 96.84% in the pre-COVID-19 period ( $n = 245$ ) compared to 95.50% during the early COVID-19 period ( $n = 191$ ). However, the most common location for trauma occurrence was the workplace (38.19%,  $n = 173$  of 453) [24]. During the early COVID-19 period, males accounted for 81.00% (162 of 200) of ocular injury cases, compared to 73.52% (162 of 253) in the pre-COVID-19 era. The values for these variables were comparable between the two periods. The study did not find a significant difference in the distribution of patients across different age groups between the two periods [24]. In our study, the percentage of ocular injuries that happened at home was significantly higher during the lockdown period ( $n = 1011$ , 68.8% during the quarantine period vs.  $n = 2311$ , 64.3% in the following year), which was similar to the findings of a cohort study from Philadelphia, in which patients presenting during the stay-at-home order were more likely to have an injury occur at home [25]. Additionally, during the post-lockdown period, the percentage of work-related injuries increased, which is expected and has been previously reported [26].

Chauhan et al. [27] reported a significant increase in the proportion of children aged 3 years and younger who were diagnosed with ocular injuries related to chemical burns. This figure rose from 23.34% during the pre-pandemic period to 31.63% during the pandemic. Notably, 71.75% of these injuries were attributed to cleaning products [27]. Martin et al. [28] conducted a retrospective chart review of children < 18 years and found a 46% reduction in pediatric ocular emergencies during the pandemic. This decrease was observed between March 17 and June 7, 2020, as compared to the same period in the previous year, from March 18 to June 9, 2019. The most common reason for visits to the eye-related emergency department was traumatic injury, with a significant reduction in the number of patients during the COVID-19 period [28]. Cavuoto et al. [29] conducted a retrospective chart review of children  $\leq 18$  years who presented to an ophthalmology emergency department at a single institution, from March 1 to August 31, 2020. Of 10 738 emergency patients treated during the pandemic, 6% (643) were children. Among these, 156 (24%) experienced ocular trauma [29]. In our study, the proportion of children < 18 years with ocular trauma was higher during the lockdown period, with 575 cases (39.1%) than in the following year with 1293 cases (36.0%). This may have been due to confinement of children to a smaller space during the lockdown period.

Pellegrini et al. [17] conducted a retrospective review of patient charts from an ophthalmological emergency department. They compared data from two time periods: March 10, 2020 (the day quarantine measures were implemented in the city), to April 10, 2020, against the same period in the previous year (from March 10, 2019, to April 10, 2019). During the pre-COVID-19 period, 354 eye injuries occurred, which accounted for 15.6% of all patients presenting to the emergency department [17].

In contrast, during the COVID-19 period, the number of eye injuries decreased to 112, accounting for 19.9% of all patients [17]. Notably, the proportion of children and adolescents with eye injuries decreased from 14.7% to 8.0%, while the percentage of males with eye injuries increased from 66.7% to 75.0% [17]. When they examined the mechanisms of injury, the greatest decrease was noted in injuries from falls and sports activities, with rates dropping from 6.5% to 0.9% and from 5.9% to 2.7%, respectively. However, injuries occurring during home activities and those involving plants showed the greatest increase, rising from 12.4% to 17.0% and from 8.5% to 10.7%, respectively [17]. Additionally, the percentage of minor injuries with a low risk of vision loss increased from 93.2% to 94.6%, while major injuries that required monitoring decreased from 6.8% to 5.4% [17]. The most common diagnosis was a foreign body on the external eye, with 142 cases (40.1%) in the pre-COVID-19 period and 56 cases (50.0%) during COVID-19. This was followed by superficial corneal or conjunctival injuries, which accounted for 97 cases (27.4%) pre-COVID-19 and 39 cases (34.8%) during the pandemic [17]. In the present study, both diagnoses remained the most frequent among the ocular injuries: superficial corneal or conjunctival injuries made up more than half of all cases in both periods, followed by a foreign body on the external eye, with 415 cases (28.2%) during COVID-19, compared to 1228 cases (34.2%) recorded after the pandemic. We found that the number of ocular trauma cases increased in the post-lockdown period. Mechanical injuries were the predominant mechanism of ocular trauma among our patients in both periods, which was similar to the findings of a study from China [30]. The percentage of chemical ocular injuries was higher during the lockdown period ( $n = 42$ , 2.9%), and corresponded with that reported in India (2.9%) [20].

Schulz et al. [31] conducted a retrospective review of electronic medical records for 318 patients who underwent evaluation and repair for open-globe injuries between March 2017 and March 2021. Their findings revealed a predominance of male patients, which comprised 77.4% of the total. Furthermore, a significant decrease in motor vehicle-associated open-globe injuries occurred during the COVID-19 pandemic [31]. In our study, we found two cases of motor vehicle-associated ocular injuries in the post-COVID-19 period, compared to none during the quarantine period. Males outnumbered females in both of these timeframes. The mean age of the individuals in our study sample was lower than that of the participants in similar studies conducted in the United States [25], China [32], and India [20]. This discrepancy in age distribution may be attributed to the relatively youthful demographics of the Kuwaiti population.

The current study contributed to existing reports indicating that the incidence of ocular trauma changed during the COVID-19 lockdown. However, since our research was conducted at a single hospital in Kuwait, sampling bias may have been present. Additionally, the study did not include data from the pre-lockdown period (pre-COVID-19) for comparison, which implies that the results should be interpreted with caution. To address these limitations, further long-term, multicenter retrospective epidemiological studies in Kuwait are necessary to provide a more reliable understanding of the extent of ocular injuries and to guide policy-making.

## CONCLUSIONS

The COVID-19 pandemic had a significant effect on the trends in ophthalmic emergency department visits. The incidence of ocular trauma increased from 18.9% during the lockdown to 21.4% in the post-lockdown period. Ocular trauma among children was significantly higher during the lockdown period. The incidence of ocular injuries at home was higher during the lockdown period than during the post-lockdown period. Work-related injuries showed a significant increase during the post-lockdown period. Long-term multicenter epidemiological studies in Kuwait may be needed to determine changes in the use of ophthalmic emergency department services as compared with the pandemic period. By uncovering shifting patterns in their utilization, these studies promise not only to enrich our understanding of eye health trends, but also to enhance the quality of care for patients throughout the country.

## ETHICAL DECLARATIONS

**Ethical approval:** The study protocol adhered to the principles of the Declaration of Helsinki and was reviewed and approved by the Ethics Committee at the institute level. Informed written consent was obtained from all participants included in the study.

**Conflict of interests:** None.

## FUNDING

None.

## ACKNOWLEDGMENTS

None.

## REFERENCES

1. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. *Acta Biomed.* 2020 Mar 19;91(1):157-160. doi: 10.23750/abm.v91i1.9397. PMID: 32191675; PMCID: PMC7569573.
2. Wilder-Smith A, Chiew CJ, Lee VJ. Can we contain the COVID-19 outbreak with the same measures as for SARS? *Lancet Infect Dis.* 2020 May;20(5):e102-e107. doi: 10.1016/S1473-3099(20)30129-8. Epub 2020 Mar 5. PMID: 32145768; PMCID: PMC7102636.

3. Tyshenko MG, Oraby T, Longenecker J, Vainio H, Gasana J, Alali WQ, AlSeaidan M, ElSaadany S, Al-Zoughool M. Analysis of intervention effectiveness using early outbreak transmission dynamics to guide future pandemic management and decision-making in Kuwait. *Infect Dis Model*. 2021;6:693-705. doi: 10.1016/j.idm.2021.04.003. Epub 2021 Apr 19. PMID: 33898885; PMCID: PMC8054527.
4. Aldhyani THH, Alkahtani H. A Bidirectional Long Short-Term Memory Model Algorithm for Predicting COVID-19 in Gulf Countries. *Life (Basel)*. 2021 Oct 21;11(11):1118. doi: 10.3390/life11111118. PMID: 34832994; PMCID: PMC8625101.
5. Low L, Hodson J, Morris D, Desai P, MacEwen C. Socioeconomic deprivation and serious ocular trauma in Scotland: a national prospective study. *Br J Ophthalmol*. 2017 Oct;101(10):1395-1398. doi: 10.1136/bjophthalmol-2016-309875. Epub 2017 Mar 8. PMID: 28274942; PMCID: PMC5629949.
6. Ramirez DA, Porco TC, Lietman TM, Keenan JD. Ocular Injury in United States Emergency Departments: Seasonality and Annual Trends Estimated from a Nationally Representative Dataset. *Am J Ophthalmol*. 2018 Jul;191:149-155. doi: 10.1016/j.ajo.2018.04.020. Epub 2018 May 9. PMID: 29750945; PMCID: PMC6014923.
7. Matsa E, Shi J, Wheeler KK, McCarthy T, McGregor ML, Leonard JC. Trends in US Emergency Department Visits for Pediatric Acute Ocular Injury. *JAMA Ophthalmol*. 2018 Aug 1;136(8):895-903. doi: 10.1001/jamaophthalmol.2018.2062. Erratum in: *JAMA Ophthalmol*. 2018 Aug 1;136(8):959. doi: 10.1001/jamaophthalmol.2018.2944. PMID: 29879287; PMCID: PMC6142941.
8. Kanoff JM, Turalba AV, Andreoli MT, Andreoli CM. Characteristics and outcomes of work-related open globe injuries. *Am J Ophthalmol*. 2010 Aug;150(2):265-269.e2. doi: 10.1016/j.ajo.2010.02.015. Epub 2010 Jun 3. PMID: 20522411.
9. Chang A, Schnall AH, Law R, Bronstein AC, Marraffa JM, Spiller HA, Hays HL, Funk AR, Mercurio-Zappala M, Calello DP, Aleguas A, Borys DJ, Boehmer T, Svendsen E. Cleaning and Disinfectant Chemical Exposures and Temporal Associations with COVID-19 - National Poison Data System, United States, January 1, 2020-March 31, 2020. *MMWR Morb Mortal Wkly Rep*. 2020 Apr 24;69(16):496-498. doi: 10.15585/mmwr.mm6916e1. PMID: 32324720; PMCID: PMC7188411.
10. Le Roux G, Sinno-Tellier S, Puskarczyk E, Labadie M, von Fabek K, Pélissier F, Nisse P, Paret N; French PCC Research Group; Descatha A, Vodovar D. Poisoning during the COVID-19 outbreak and lockdown: retrospective analysis of exposures reported to French poison control centres. *Clin Toxicol (Phila)*. 2021 Sep;59(9):832-839. doi: 10.1080/15563650.2021.1874402. Epub 2021 Feb 12. PMID: 33576261.
11. Raffee L, Daradkeh HM, Alawneh K, Al-Fwadleh AI, Darweesh M, Hammad NH, Almasarweh SA. Impact of COVID-19 lockdown on the incidence and patterns of toxic exposures and poisoning in Jordan: a retrospective descriptive study. *BMJ Open*. 2021 Dec 9;11(12):e053028. doi: 10.1136/bmjopen-2021-053028. PMID: 34887279; PMCID: PMC8662587.
12. Kuhn F, Morris R, Witherspoon CD, Mester V. The Birmingham Eye Trauma Terminology system (BETT). *J Fr Ophtalmol*. 2004 Feb;27(2):206-10. doi: 10.1016/s0181-5512(04)96122-0. PMID: 15029055.
13. Kuhn F, Morris R. A quarter of a century of the Birmingham Eye Trauma Terminology (BETT) system. *Graefes Arch Clin Exp Ophthalmol*. 2021 Oct;259(10):2867-2868. doi: 10.1007/s00417-021-05407-6. Epub 2021 Sep 6. PMID: 34487225.
14. Shukla B, Agrawal R, Shukla D, Seen S. Systematic analysis of ocular trauma by a new proposed ocular trauma classification. *Indian J Ophthalmol*. 2017 Aug;65(8):719-722. doi: 10.4103/ijo.IJO\_241\_17. PMID: 28820158; PMCID: PMC5598183.
15. Xiao JH, Zhang MN, Li SY, Jiang CH, Jiang H, Zhang Y, Qiu HY. A new classification for epidemiological study of mechanical eye injuries. *Chin J Traumatol*. 2014;17(1):35-7. PMID: 24506921.
16. Shah M, Shah S, Agrawal R, Patel K. Validation of a modified Birmingham eye trauma terminology classification for mechanical eye injuries. *Trauma*. 2018 Jul;20(3):217-20. doi: 10.1177/1460408617715488.
17. Pellegrini M, Roda M, Di Geronimo N, Lupardi E, Giannaccare G, Schiavi C. Changing trends of ocular trauma in the time of COVID-19 pandemic. *Eye (Lond)*. 2020 Jul;34(7):1248-1250. doi: 10.1038/s41433-020-0933-x. Epub 2020 May 6. PMID: 32376977; PMCID: PMC7202459.
18. Congdon NG, Friedman DS, Lietman T. Important causes of visual impairment in the world today. *JAMA*. 2003 Oct 15;290(15):2057-60. doi: 10.1001/jama.290.15.2057. PMID: 14559961.
19. Liang H, Zhang M, Chen M, Lin TPH, Lai M, Chen H. Ocular Trauma During COVID-19 Pandemic: A Systematic Review and Meta-analysis. *Asia Pac J Ophthalmol (Phila)*. 2022 Sep 1;11(5):481-487. doi: 10.1097/APO.0000000000000539. PMID: 36094376.
20. Pande R, Mohod SS, V P, Shanbhag S, Kumar NS. Impact of the COVID-19-induced lockdown on the incidence of ocular trauma presenting to a tertiary care hospital. *BMJ Open Ophthalmol*. 2022 Mar 18;7(1):e000861. doi: 10.1136/bmjophth-2021-000861. PMID: 35342820; PMCID: PMC8935004.
21. Halawa OA, Friedman DS, Roldan AM, Zebardast N. Changing trends in ocular trauma during the COVID-19 pandemic in the USA. *Br J Ophthalmol*. 2023 Feb;107(2):295-298. doi: 10.1136/bjophthalmol-2021-319627. Epub 2021 Aug 20. PMID: 34417186.
22. Hattenbach LO, Heinz P, Feltgen N, Hoerauf H, Kohnen T, Priglinger S, Bachmann W, Rieks J, Eter N, Reinhard T. Impact of the SARS-CoV-2 pandemic on ophthalmic care in Germany. *Ophthalmologe*. 2021 Jul;118(Suppl 2):166-175. doi: 10.1007/s00347-021-01411-7. Epub 2021 Jun 4. PMID: 34086070; PMCID: PMC8176275.
23. Whang WJ, Kwon JW. Yearly trends in the incidence of ocular traumas and the effects of COVID-19 pandemic: a nationwide population-based study of Korean data. *Ann Transl Med*. 2023 Mar 31;11(6):241. doi: 10.21037/atm-22-2458. Epub 2023 Mar 6. PMID: 37082683; PMCID: PMC10113071.
24. Liew TK, Yong GY, Zainal Abidin Z, Asnir ZZ. Ocular Trauma Trends during COVID-19 Pandemic. *Malays J Med Sci*. 2023 Jun;30(3):135-142. doi: 10.21315/mjms2023.30.3.12. Epub 2023 Jun 27. PMID: 37425384; PMCID: PMC10325137.
25. Wu C, Patel SN, Jenkins TL, Obeid A, Ho AC, Yonekawa Y. Ocular trauma during COVID-19 stay-at-home orders: a comparative cohort study. *Curr Opin Ophthalmol*. 2020 Sep;31(5):423-426. doi: 10.1097/ICU.0000000000000687. PMID: 32740065.
26. Agrawal D, Parchand S, Agrawal D, Chatterjee S, Gangwe A, Mishra M, Sahu A. Impact of COVID-19 pandemic and national lockdown on ocular trauma at a tertiary eye care institute. *Indian J Ophthalmol*. 2021 Mar;69(3):709-713. doi: 10.4103/ijo.IJO\_3200\_20. PMID: 33595506; PMCID: PMC7942066.

27. Chauhan MZ, Ali AA, Healy J, Elhusseiny AM, Phillips PH, Sallam AB, Uwaydat SH. The impact of the COVID-19 pandemic on ocular trauma in American infants and toddlers. *J AAPOS*. 2024 Apr;28(2):103864. doi: [10.1016/j.jaapos.2024.103864](https://doi.org/10.1016/j.jaapos.2024.103864). Epub 2024 Mar 6. PMID: [38458597](https://pubmed.ncbi.nlm.nih.gov/38458597/).
28. Martin GC, Boulanger E, Maalej R, Partouche S, Dentel A, Grosselin M, Ettayeb R, Chapron T, Caputo G, Vignal-Clermont C. Specificities of pediatric ocular emergencies before and during the COVID-19 era: A retrospective comparative study in an eye-related emergency department in Paris. *Arch Pediatr*. 2023 Aug;30(6):396-400. doi: [10.1016/j.arcped.2023.06.002](https://doi.org/10.1016/j.arcped.2023.06.002). Epub 2023 Jun 12. PMID: [37394362](https://pubmed.ncbi.nlm.nih.gov/37394362/); PMCID: [PMC10258578](https://pubmed.ncbi.nlm.nih.gov/PMC10258578/).
29. Cavuoto KM, Vanner EA, Osigian CJ. Trends in pediatric ocular trauma presenting to an ophthalmology-specific emergency department during the COVID-19 pandemic. *J AAPOS*. 2021 Jun;25(3):170-172. doi: [10.1016/j.jaapos.2021.01.004](https://doi.org/10.1016/j.jaapos.2021.01.004). Epub 2021 Apr 29. PMID: [33932568](https://pubmed.ncbi.nlm.nih.gov/33932568/).
30. Xu YM, Du LP, Huo YD, An GQ, Jin XM, Zhou PY. COVID-19 pandemic impact on ocular trauma in a tertiary hospital. *Int J Ophthalmol*. 2023 Jan 18;16(1):16-21. doi: [10.18240/ijo.2023.01.03](https://doi.org/10.18240/ijo.2023.01.03). PMID: [36659937](https://pubmed.ncbi.nlm.nih.gov/36659937/); PMCID: [PMC9815970](https://pubmed.ncbi.nlm.nih.gov/PMC9815970/).
31. Schulz M, Thomas PJ, Legocki AT, Bonnell A, Chee Y, Feng S, Chen P, Bojikian KD. Impact of socioeconomic status on open globe injuries during the COVID-19 pandemic. *Int Ophthalmol*. 2024 Aug 12;44(1):346. doi: [10.1007/s10792-024-03257-9](https://doi.org/10.1007/s10792-024-03257-9). PMID: [39134831](https://pubmed.ncbi.nlm.nih.gov/39134831/).
32. Zhang YX, Feng K, Liao MY, Yan H. Comparison of ocular trauma between normalized and the COVID-19 epidemic periods in China: a multi-center cross-sectional study. *Int J Ophthalmol*. 2023 Jan 18;16(1):10-15. doi: [10.18240/ijo.2023.01.02](https://doi.org/10.18240/ijo.2023.01.02). PMID: [36659951](https://pubmed.ncbi.nlm.nih.gov/36659951/); PMCID: [PMC9815975](https://pubmed.ncbi.nlm.nih.gov/PMC9815975/).