Ophthalmol Ther (2024) 13:367–384
https://doi.org/10.1007/s40123-023-00852-4

ORIGINAL RESEARCH

Epidemiology of Consumer-Product-Related Ocular Injuries in the Geriatric Population in the United States

Hassaam S. Choudhry · Aretha Zhu · Sadiq Shaikh · Haider Zaki · Samuel Masket · Simon K. Law

Received: September 30, 2023 / Accepted: November 2, 2023 / Published online: November 23, 2023

ABSTRACT

Introduction: The purpose of this study was to assess trends in consumer-product-related geriatric ocular injuries using National Electronic Injury Surveillance System (NEISS) data. Understanding the specific consumer products and settings coded in the NEISS dictionary that contribute to geriatric (≥ 65 years) ocular injuries, along with changing patterns during events like the COVID-19 pandemic, provides crucial insights for tailoring therapy and preventative strategies. This ultimately may reduce the burden of eye injuries on both older adults and healthcare systems.

Methods: This was a retrospective population-based cohort study. The NEISS database was used to study eye injuries in geriatric adults from 2010 to 2021. Patients were categorized by age groups (65–74, 75–84, 85–94, ≥ 95 years), and data on demographics, injury types, product categories, and COVID-19 impact were collected. Pearson's chi-squared test (with $p < 0.001$ taken to indicate significance) was used to assess differences in expected ratios between age groups.

Results: A total of 168,685 eye injury cases in adults aged 65 years and older were analyzed. Household items, tools, and gardening products accounted for over 75% of injuries. Most injuries occurred at home (65.3%). Contusions/abrasions (40.3%) and a foreign body (19.3%) were common diagnoses. Females had more household-item-related injuries, while males had more foreign body injuries. Regarding therapeutic disposition, 93.7% of all injuries were treated/examined and released, which showed a decreasing trend as age increased, while hospital admission/transfer rates increased with age. Compared to before COVID-19, the percentage of injuries during COVID-19 due to tools decreased (from 22.5% to 18.3%), while injuries due to gardening/lawn/landscaping/patio products increased (from 13.8% to 15.3%).

Conclusions: Our study characterizes geriatric ocular injuries and COVID-19 impact, highlighting common products and locations. Different age

This manuscript is based on work previously presented at: Association for Research in Vision and Ophthalmology Annual Meeting May 2023, New Orleans, LA, USA; American Society of Ophthalmic Trauma Annual Meeting June 2023, New York, NY, USA.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40123-023-00852-4.

H. S. Choudhry (✉) · A. Zhu · S. Shaikh · H. Zaki
Medical Science Building, New Jersey Medical School, 185 South Orange Avenue, Newark, NJ 07103, USA
e-mail: hsc53@njms.rutgers.edu

S. K. Law
UCLA Stein Eye Institute, 100 Stein Plaza, Los Angeles, CA 90095, USA

S. Masket
Advanced Vision Care, Los Angeles, USA

groups showed different injury patterns. Understanding these trends can aid injury prevention strategies for consumers and healthcare providers. Demographics and injury frequencies differed based on age and sex. Future research should further explore post-COVID-19 trends.

Keywords: Consumer products; Geriatrics; Ophthalmology; Epidemiology; Emergencies; Ocular trauma

Key Summary Points

Why carry out this study?

While acknowledging the limitations of analyzing retrospective data, which may not have been gathered with current research questions in mind, this population-based cohort study using National Electronic Injury Surveillance System (NEISS) data (with over 20 variables) analyzed 168,685 geriatric eye injury cases (aged $\geq$ 65 years) from 2010 to 2021 to identify trends in sources of eye injury for the at-risk elderly population.

To achieve an up-to-date understanding of the epidemiology of ocular trauma in geriatric populations, particularly in light of post-COVID-19 pandemic trends.

To investigate chronologic and demographic trends in consumer-product-related geriatric ocular injuries presenting to the emergency department.

What was learned from the study?

Analysis revealed that household items, tools, and gardening products were the leading causes of injuries (75%), with home settings accounting for most incidents (65.3%); contusions/abrasions (40.3%) and a foreign body (19.3%) were the most commonly diagnosed injuries, and all differences in percentages were statistically significant ($p < 0.001$); both significant gender-related differences in injury types and significant age-related increases in hospitalization rates were also noted ($p < 0.001$).

The identification of significant chronologic and demographic patterns, such as prevalent household items being the primary sources of geriatric ocular injuries, along with the observed shifts in injury patterns during the COVID-19 pandemic, including a statistically significant drop of nearly 10% in eye injuries occurring at home following the onset of COVID-19 compared to before, underscores the importance of targeted preventive measures to reduce such injuries among older adults.

INTRODUCTION

Ocular injuries are a significant contributor to visual impairment globally [1, 2]. According to the World Health Organization (WHO) in 2022, approximately 55 million eye injuries occur worldwide annually, and 23 million individuals with eye injuries experience resulting vision impairment [1]. In the United States, eye injury is an important contributor to the burden of vision impairment and blindness. Estimates published in 2020 by Swain et al. suggest that 24 million individuals in the United States have suffered at least one eye injury; 1.5 million of those individuals are visually impaired and 147,000 are partially blind or totally blind as a result of injury [3]. Visual impairment resulting from ocular injury can influence quality of life through socioeconomic and psychological impacts [4–6].

The epidemiology of ocular injury varies by age group [7]. For example, young males are prone to injury from acts of violence and athletics, while elderly patients are at increased risk of a fall-related ocular injury [6, 7]. In an analysis of the United States Eye Injury Registry (USEIR) database, age over 60 years and injury occurring during a fall are among several risk factors that were found to significantly increase the chance of an eye injury resulting in blindness [8]. Additionally, Choovuthayakorn et al. showed differences in epidemiological variation in sources of eye injuries between age groups:

adults were prone to get injured at the workplace, while children were more prone to get injured in the playground setting [9]. Hence, epidemiological research on eye injuries in geriatric patients may suggest therapies and prevention strategies that can reduce the burden of eye injuries in one of the most vulnerable populations.

From 1990 to 2017 alone, the proportion of people aged 65 years and older increased globally from 6.1% to 8.8% [10]. As the population of older adults in the US is growing rapidly, the consumer product market targeting this demographic has expanded proportionally, as have product safety concerns and consumer-product-related injuries among older adults. There is a paucity of literature assessing ocular injury from consumer products in elderly patients.

Additionally, in light of recent events, literature from other countries have begun to assess how COVID-19 may have affected epidemiological trends in eye injuries; in Jordan, for example, the lockdowns may have led to an increased risk of trauma at home [11]. We are not aware of any investigation of consumer-product-associated ocular injury in the geriatric population with respect to the COVID-19 pandemic that impacted Americans' daily routines and lifestyle activities, thus potentially influencing the epidemiology of ocular injuries. For example, alcohol-based hand sanitizer use increased during the pandemic, which led to an increased prevalence of hand-sanitizer-associated chemical eye injury [12].

Our study's purpose was to use the National Electronic Injury Surveillance System (NEISS) to assess the current epidemiology of consumer-product-related ocular injuries in the geriatric population as well as to answer the question of whether the COVID-19 pandemic significantly impacted these trends.

METHODS

The NEISS is a statistically valid injury surveillance system based on a nationally representative probability sample of hospitals in the United States (US) and its territories. Its primary purpose is to collect data on consumer-product related injuries in the US. Each participating NEISS hospital reports patient information for every emergency department (ED) visit associated with a consumer product, and the data are publicly available [13]. It must be recognized that the NEISS database is specific to cases presented to a hospital ED. As such, patients who were seen in urgent care centers, clinics, or private practices are not included in the present analysis, and national estimates may underrepresent the total number of eye injuries related to consumer products.

The NEISS was queried for all cases coded as "eye injury" from January 1st, 2010 to December 31st, 2021 for all adults aged 65 years and older. Specific consumer product codes were categorized into broader groupings by two independent reviewers (S.S. and H.Z.); if there was a disagreement about the categorization, a third reviewer (H.C.) served as a tiebreaker. Resolution of a disagreement over product categorization was achieved through discussion until consensus was reached if one of the initial independent reviewers still felt strongly about a certain categorization; see Table S1 in the electronic supplementary material. Patient's age, sex at birth, race, diagnosis (type of ocular injury), environmental location in which the injury occurred, year of injury, consumer product category involved in the injury, and disposition were collected.

Patients were divided into four age groups: 65–74 (G1), 75–84 (G2), 85–94 (G3), and $\geq$ 95 years old (G4), and differences in patient demographics and frequencies of consumer-product-related ocular injuries were compared between age groups as well as between males and females. Additionally, the potential impact of COVID-19 on consumer-product-related ocular injuries in geriatric patients was assessed by comparing cases from January 1st, 2018 to December 31st, 2019 (pre-COVID cases) to cases from January 1st, 2020 to December 31st, 2021 (during-COVID cases).

Pearson's chi-squared analysis was performed to discern significance. IBM SPSS Statistics v.24 was used to run the statistical analysis. Specific consumer product codes constituting at least 1% of all patient cases included were identified as well. A p value of less than

0.001 was considered statistically significant. While the NEISS data are valuable in many ways, the retrospective nature of the analysis limits the ability to control for potential confounding variables. Nevertheless, the study looks to characterize significant trends rather than to delineate causal relationships between variables, where conclusions depend on the acknowledgement of confounding variables. All missing data in the NEISS are labeled "unknown" and were likewise labeled "unknown" in our tables.

This was a retrospective population cohort analysis from a publicly accessible de-identified HIPAA-compliant electronic database ensuring patient confidentiality, and, as such, institutional review board approval was not required.

RESULTS

168,685 patients 65 years old or older who experienced eye injuries were included in the analysis. The mean age was 72.8 ± 6.9 years. 62.6% of the patients were male, 55.6% of the patients identified as white, 6.3% identified as black/African American, 1.0% identified as Asian, 0.2% identified as American Indian/Alaska Native, and 0.1% identified as Native Hawaiian/Pacific Islander. Additionally, 34.6% of the patients did not specify a race, and 2.2% of patients identified as other. More than 75% of the ocular injuries involved household items/furnishing, tools, and gardening/lawn/landscaping/patio products. The most common location in which injuries occurred was at home (65.3%), which was consistent across all age groups. The most common diagnosis for ocular injury was abrasions (40.3%) followed by a foreign body (19.3%) for the entire cohort. The most likely disposition for the ocular injury was being treated/examined and then released (93.7%), followed by treated and admitted/hospitalized (4.0%).

Overall, household items/furnishing products accounted for the greatest proportion (37.5% total) of ocular injuries. The proportion of injuries in this category increased with age (32.6% in G1, 42.5% in G2, 62.7% in G3, and 75.1% in G4). On the other hand, the proportions of injuries associated with tools and gardening/lawn/landscaping/patio declined from G1 to G4 (from 25.3% to 5.8% and from 16.5% to 5.1%, respectively). Each of the other categories accounted for less than 6% of the total injuries (Table 1).

The majority (65.3%) of the injuries occurred in a home environment. The proportion of injuries occurring at home varied between age groups from 64.1% to 69.0% among G1, G2, and G3; however, it fell to 50.0% of injuries in G4 (age 95 or older). Injuries occurring in public rose with successive age groups (3.0% in G1, 4.3% in G2, 10.2% in G3, and 22.7% in G4), with 4.0% of the total injuries occurring in a public setting. Overall, a moderate portion of the reported injuries had an unknown or no reported location (27.1% total) (Table 1).

The majority of the injury diagnoses were contusions/abrasions (40.3%) and foreign body (19.3%). There was no obvious trend among the four age groups in the prevalence of contusions/abrasions (varies from 31.4% in G3 to 41.6% in G1). Regarding disposition, 93.7% of all injuries were treated/examined and released, with a decreasing trend as age increased (95.6% in G1, 92.0% in G2, 83.5% in G3, and 75.2% in G4). Hospital admission or transfer rate increased from 3.5% in G1 to 7.7% in G2, 14.2% in G3, and 24.8% in G4 (Table 2).

Regarding sex at birth and ocular injury, within the G1 and G2 age groups, males suffered the majority of the injuries (66.1% and 58.5%, respectively), while in the G3 and G4 age groups, females were more commonly injured (54.8% and 58.9%, respectively). As reported in the summary of ocular injuries given above, household items/furnishing, tools, and gardening/lawn/landscaping/patio were the top three product categories involved in ocular injuries in both male and female patients. However, 58.7% of the ocular injuries that occurred in female patients involved the product category of household item/furnishing. The locations in which the injuries occurred were similar for male and female patients (64.1% vs 67.4% occurred at home, respectively). Female patients had a greater proportion of contusions/abrasions (42.6% vs 38.9%, respectively) and fewer foreign-body ocular

Table 1 Product categories and locations of consumer-product-related ocular injuries in geriatric patients by age cohort

Variable	Age groups				Total	*p* value
	65–74 (*n* = 113,408)	75–84 (*n* = 43,180)	85–94 (*n* = 10,896)	95 + (*n* = 1381)		
Category of product						
Household items/furnishing	42,441 (32.6%)	21,649 (42.5%)	8266 (62.7%)	1197 (75.1%)	73,553 (37.5%)	$p < 1e{-}15$
Tools	32,947 (25.3%)	9140 (18.0%)	1071 (8.1%)	92 (5.8%)	43,250 (22.1%)	
Gardening/lawn/landscaping/patio	21,487 (16.5%)	8109 (15.9%)	1551 (11.8%)	81 (5.1%)	31,228 (15.9%)	
Sports recreation	7370 (5.7%)	2530 (5.0%)	325 (2.5%)	0 (0.0%)	10,225 (5.2%)	
Other	5490 (4.2%)	2474 (4.9%)	181 (1.4%)	136 (8.5%)	8281 (4.2%)	
Cooking/kitchen items	4423 (3.4%)	1050 (2.1%)	478 (3.6%)	0 (0.0%)	5951 (3.0%)	
Electronics/tech	2946 (2.3%)	1591 (3.1%)	122 (0.9%)	71 (4.5%)	4730 (2.4%)	
Medical equipment/drugs	3250 (2.5%)	621 (1.2%)	337 (2.6%)	0 (0.0%)	4208 (2.1%)	
Non-cooking/personal appliances	2758 (2.1%)	700 (1.4%)	172 (1.3%)	0 (0.0%)	3630 (1.9%)	
Cosmetics/personal care	2031 (1.6%)	913 (1.8%)	279 (2.1%)	17 (1.1%)	3240 (1.7%)	
Apparel	1825 (1.4%)	735 (1.4%)	290 (2.2%)	0 (0.0%)	2850 (1.5%)	
Powered vehicles	1191 (0.9%)	919 (1.8%)	93 (0.7%)	0 (0.0%)	2203 (1.1%)	
Non-sports recreation	1241 (1.0%)	243 (0.5%)	16 (0.1%)	0 (0.0%)	1500 (0.8%)	
Office items	834 (0.6%)	232 (0.5%)	0 (0.0%)	0 (0.0%)	1066 (0.5%)	
Location						

Table 1 continued

Variable	Age groups				Total	*p* value
	65–74 (*n* = 113,408)	75–84 (*n* = 43,180)	85–94 (*n* = 10,896)	95 + (*n* = 1381)		
Home	72,639 (64.1%)	29,799 (69.0%)	7182 (65.9%)	691 (50.0%)	110,311 (65.3%)	$p < 1e{-}15$
Unknown	32,537 (28.7%)	10,183 (23.6%)	2581 (23.7%)	377 (27.3%)	45,678 (27.1%)	
Public	3423 (3.0%)	1858 (4.3%)	1116 (10.2%)	313 (22.7%)	6710 (4.0%)	
Sports	4056 (3.6%)	1047 (2.4%)	0 (0.0%)	0 (0.0%)	5103 (3.0%)	
Street	419 (0.4%)	293 (0.7%)	17 (0.2%)	0 (0.0%)	729 (0.4%)	
Farm	178 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	178 (0.1%)	
Mobile	83 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	83 (0.0%)	
School	73 (0.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	73 (0.0%)	

injuries (8.3% vs 25.9%, respectively) than male patients. Dispositions were similar for the two groups (Table 3).

The total number of ED visits due to consumer-product-related ocular injury in the geriatric population from 2010 to 2021 are presented in Fig. 1. Total male and female visits decreased in 2010–2012 such that they were similar to the level they were at in 2002. It is possible that this drop is more attributable to the decrease in male ED visits, as the number of female ED visits stayed relatively constant, as visualized in Fig. 1.

Table 4 summarizes the trends in ocular injuries before COVID-19 (2018–2019) and during COVID-19 (2020–2021). Household items/furnishing was the most common category of products that caused injury in the geriatric population in both time periods (39.4% and 40.8%, respectively). The percentage of injuries due to tools decreased from 22.5% to 18.3%, while injuries due to gardening/lawn/landscaping/patio products or sports recreation increased from 13.8% to 15.3% and from 4.5% to 6.1%, respectively. The percentage of injuries diagnosed as abrasions decreased from 41.2% to 35.6%, while the percentage of injuries diagnosed as a foreign body increased from 14.7% to 18.5%. Chemical burn injuries decreased from 7.8% to 5.3% following the onset of the pandemic. Furthermore, the percentage of injuries occurring at home decreased from 71.4% to 62.7%, while injuries occurring in public spaces or in sports-related facilities increased from 4.8% to 5.3% and from 2.8% to 3.3%, respectively.

Specific NEISS product codes contributing to at least 1% of all eye injury cases in the total cohort are presented in Table S2 in the electronic supplementary material. The number one cause of injury was related to lawn mowers (5.14%). This was followed by workshop grinders, buffers or polishers (5.06%), and pruning or trimming equipment (4.34%). Floors or flooring materials, non-cosmetic bleaches, and lawn trimmers or edgers also each contributed to over 3% of all cases in the total cohort.

Table 2 Diagnosis and disposition of consumer-product-related ocular injuries in geriatric patients by age cohort

Variable	Age groups				Total	*p* value
	65–74 (*n* = 113,408)	75–84 (*n* = 43,180)	85–94 (*n* = 10,896)	95 + (*n* = 1381)		
Diagnosis						
Contusions, abrasions	47,147 (41.6%)	16,962 (39.3%)	3420 (31.4%)	442 (32.0%)	67,971 (40.3%)	$p < 1e{-}15$
Foreign body	24,009 (21.2%)	6810 (15.8%)	1506 (13.8%)	279 (20.2%)	32,604 (19.3%)	
Other	19,311 (17.0%)	9466 (21.9%)	3349 (30.7%)	434 (31.4%)	32,560 (19.3%)	
Dermatitis/conjunctivitis	9217 (8.1%)	3316 (7.7%)	503 (4.6%)	0 (0.0%)	13,036 (7.7%)	
Burn, chemical	7640 (6.7%)	3256 (7.5%)	673 (6.2%)	63 (4.5%)	11,632 (6.9%)	
Hemorrhage	1857 (1.6%)	978 (2.3%)	478 (4.4%)	81 (5.9%)	3394 (2.0%)	
Laceration	1413 (1.2%)	917 (2.1%)	206 (1.9%)	47 (3.4%)	2583 (1.5%)	
Radiation	1417 (1.2%)	321 (0.7%)	16 (0.1%)	0 (0.0%)	1754 (1.0%)	
Hematoma	460 (0.4%)	599 (1.4%)	535 (4.9%)	17 (1.2%)	1611 (1.0%)	
Puncture	443 (0.4%)	196 (0.5%)	126 (1.2%)	18 (1.3%)	783 (0.5%)	
Burn, thermal	237 (0.2%)	84 (0.2%)	0 (0.0%)	0 (0.0%)	321 (0.2%)	
Burn, scald	242 (0.2%)	32 (0.1%)	0 (0.0%)	0 (0.0%)	274 (0.2%)	
Strain, sprain	16 (0.0%)	68 (0.2%)	84 (0.8%)	0 (0.0%)	168 (0.1%)	
Nerve damage	0 (0.0%)	98 (0.2%)	0 (0.0%)	0 (0.0%)	98 (0.1%)	
Burn, electrical	0 (0.0%)	78 (0.2%)	0 (0.0%)	0 (0.0%)	78 (0.0%)	
Disposition						
Treated/examined and released	108,363 (95.6%)	39,729 (92.0%)	9102 (83.5%)	1038 (75.2%)	158,232 (93.7%)	$p < 1e{-}15$
Treated and admitted/hospitalized	2972 (2.6%)	2385 (5.5%)	1238 (11.4%)	205 (14.9%)	6800 (4.0%)	
Treated and transferred	1039 (0.9%)	930 (2.2%)	307 (2.8%)	137 (9.9%)	2413 (1.4%)	
Left without being seen	831 (0.7%)	64 (0.1%)	74 (0.7%)	0 (0.0%)	969 (0.6%)	
Held for observation	203 (0.2%)	71 (0.2%)	175 (1.6%)	0 (0.0%)	449 (0.3%)	

Table 3 Comparison of the epidemiology of consumer-product-related ocular injuries in male vs female geriatric patients

Variable	Sex at birth		Total	*p* value
	Male (*n* = 105,733)	Female (*n* = 63,132)		
Category of product				
Household items/furnishing	29,641 (24.5%)	43,912 (58.7%)	73,553 (37.5%)	$p < 1e{-}15$
Tools	39,002 (32.2%)	4249 (5.7%)	43,251 (22.1%)	
Gardening/lawn/landscaping/patio	23,547 (19.4%)	7682 (10.3%)	31,229 (15.9%)	
Sports recreation	6804 (5.6%)	3421 (4.6%)	10,225 (5.2%)	
Other	5217 (4.3%)	3064 (4.1%)	8281 (4.2%)	
Cooking/kitchen items	2707 (2.2%)	3243 (4.3%)	5950 (3.0%)	
Electronics/tech	3266 (2.7%)	1464 (2.0%)	4730 (2.4%)	
Medical equipment/drugs	3014 (2.5%)	1195 (1.6%)	4209 (2.1%)	
Non-cooking/personal appliances	2657 (2.2%)	972 (1.3%)	3629 (1.9%)	
Cosmetics/personal care	709 (0.6%)	2531 (3.4%)	3240 (1.7%)	
Apparel	1414 (1.2%)	1438 (1.9%)	2852 (1.5%)	
Powered vehicles	1891 (1.6%)	313 (0.4%)	2204 (1.1%)	
Non-sports recreation	754 (0.6%)	746 (1.0%)	1500 (0.8%)	
Office items	515 (0.4%)	550 (0.7%)	1065 (0.5%)	
Race				
White	61,697 (58.4%)	32,155 (50.9%)	93,852 (55.6%)	$p < 1e{-}15$
Not specified	35,051 (33.2%)	23,327 (37.0%)	58,378 (34.6%)	
Black/African American	5730 (5.4%)	4966 (7.9%)	10,696 (6.3%)	
Other	2391 (2.3%)	1261 (2.0%)	3652 (2.2%)	
Asian	572 (0.5%)	1159 (1.8%)	1731 (1.0%)	
American Indian/Alaska Native	189 (0.2%)	176 (0.3%)	365 (0.2%)	
Native Hawaiian/Pacific Islander	104 (0.1%)	86 (0.1%)	190 (0.1%)	

Table 3 continued

Variable	Sex at birth		Total	*p* value
	Male (*n* = 105,733)	Female (*n* = 63,132)		
Diagnosis				
Contusions, abrasions	41,089 (38.9%)	26,882 (42.6%)	67,971 (40.3%)	$p < 1e{-}15$
Foreign body	27,381 (25.9%)	5224 (8.3%)	32,605 (19.3%)	
Other	17,348 (16.4%)	15,211 (24.1%)	32,559 (19.3%)	
Dermatitis/conjunctivitis	7564 (7.2%)	5471 (8.7%)	13,035 (7.7%)	
Burn, chemical	5758 (5.4%)	5874 (9.3%)	11,632 (6.9%)	
Hemorrhage	2001 (1.9%)	1393 (2.2%)	3394 (2.0%)	
Laceration	1469 (1.4%)	1113 (1.8%)	2582 (1.5%)	
Radiation	1739 (1.6%)	15 (0.0%)	1754 (1.0%)	
Hematoma	680 (0.6%)	930 (1.5%)	1610 (1.0%)	
Puncture	445 (0.4%)	337 (0.5%)	782 (0.5%)	
Burns, thermal	0 (0.0%)	321 (0.5%)	321 (0.2%)	
Burn, scald	99 (0.1%)	175 (0.3%)	274 (0.2%)	
Strain, sprain	0 (0.0%)	168 (0.3%)	168 (0.1%)	
Nerve damage	81 (0.1%)	17 (0.0%)	98 (0.1%)	
Burn, electrical	78 (0.1%)	0 (0.0%)	78 (0.0%)	

Table 3 continued

Variable	Sex at birth		Total	*p* value
	Male (*n* = 105,733)	Female (*n* = 63,132)		
Disposition				
Treated/examined and released	100,390 (94.9%)	57,843 (91.6%)	158,233 (93.7%)	$p < 0.001$
Treated and admitted/hospitalized	3545 (3.4%)	3256 (5.2%)	6801 (4.0%)	
Treated and transferred	970 (0.9%)	1443 (2.3%)	2413 (1.4%)	
Left without being seen	595 (0.6%)	375 (0.6%)	970 (0.6%)	
Held for observation	234 (0.2%)	214 (0.3%)	448 (0.3%)	
Location				
Home	67,754 (64.1%)	42,557 (67.4%)	110,311 (65.3%)	$p < 1e{-}15$
Unknown	31,142 (29.5%)	14,537 (23.0%)	45,679 (27.1%)	
Public	2498 (2.4%)	4212 (6.7%)	6710 (4.0%)	
Sports	3645 (3.4%)	1457 (2.3%)	5102 (3.0%)	
Street	444 (0.4%)	285 (0.5%)	729 (0.4%)	
Farm	178 (0.2%)	0 (0.0%)	178 (0.1%)	
Mobile	0 (0.0%)	83 (0.1%)	83 (0.0%)	
School	73 (0.1%)	0 (0.0%)	73 (0.0%)	
Age range (years)				
65–74	75,004 (70.9%)	38,405 (60.8%)	113,409 (67.2%)	$p < 1e{-}15$
75–84	25,242 (23.9%)	17,937 (28.4%)	43,179 (25.6%)	
85–94	4920 (4.7%)	5976 (9.5%)	10,896 (6.5%)	
95 +	568 (0.5%)	813 (1.3%)	1381 (0.8%)	
Year				

Table 3 continued

Variable	Sex at birth		Total	*p* value
	Male (*n* = 105,733)	Female (*n* = 63,132)		
2010	7005 (6.6%)	4174 (6.6%)	11,179 (6.6%)	$p < 0.001$
2011	7330 (6.9%)	4518 (7.2%)	11,848 (7.0%)	
2012	7611 (7.2%)	3912 (6.2%)	11,523 (6.8%)	
2013	9740 (9.2%)	4072 (6.5%)	13,812 (8.2%)	
2014	7548 (7.1%)	5856 (9.3%)	13,404 (7.9%)	
2015	8847 (8.4%)	5317 (8.4%)	14,164 (8.4%)	
2016	11,213 (10.6%)	6316 (10.0%)	17,529 (10.4%)	
2017	11,080 (10.5%)	5579 (8.8%)	16,659 (9.9%)	
2018	9361 (8.9%)	6120 (9.7%)	15,481 (9.2%)	
2019	8819 (8.3%)	5945 (9.4%)	14,764 (8.7%)	
2020	7043 (6.7%)	5419 (8.6%)	12,462 (7.4%)	
2021	10,136 (9.6%)	5902 (9.3%)	16,038 (9.5%)	

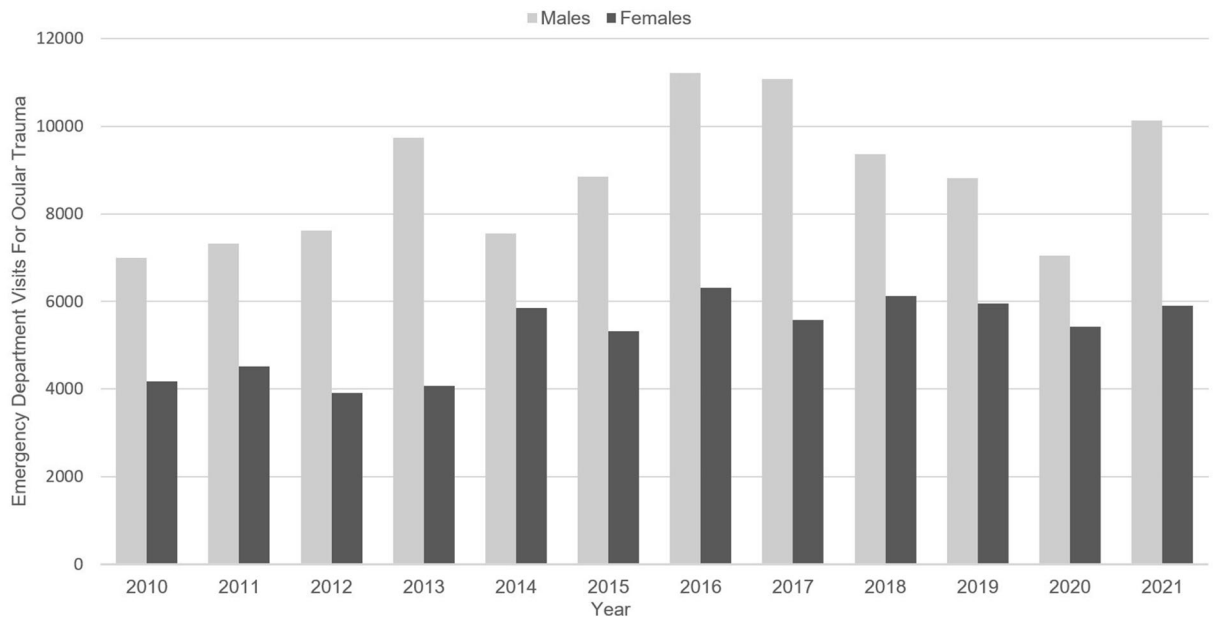

Fig. 1 Trends in visits to the ED for ocular injury in the geriatric population from 2010 to 2021

DISCUSSION

In this study, we sought to characterize the epidemiology of consumer-product-related ocular injury in the geriatric population and assess the impact of COVID-19 on these patterns. In consumer-product-related ocular injury in the US, household item/furnishing products, tools, and gardening/lawn/landscaping/patio products accounted for more than 75% of the injuries, and the majority (65.3%) of the injuries occurred in the home environment.

Older patients may experience a significantly lowered quality of life due to visual impairment [14], and ocular injury is a significant cause of visual impairment in the elderly [15]. Previous studies have suggested that elderly patients make up a unique ocular injury population that is likely to have poor visual outcomes [15–17]. Consumer-product-related ocular injury in the geriatric population is thus a public health concern. Research on this topic can inform consumers, manufacturers, healthcare providers, and public health legislators in injury prevention efforts. On a more day-to-day basis, tips to prevent eye injuries in older adults have been listed on the American Academy of Ophthalmology's website for public education. These interventions include simple actions in one's own home, such as ensuring stair railings are secure, cushioning sharp furniture corners, and improving lighting (https://www.aao.org/eye-health/tips-prevention/seniors-eye-health-tips). We sought to characterize epidemiologic patterns of consumer-product-related ocular injury in the geriatric population and assess the impact of COVID-19 on these patterns.

As people age, they are more prone to different types of injuries and various causes of injury. Our findings revealed that a range of products were associated with ocular injuries in the geriatric population, consistent with previous studies [18]. Products from tool and gardening/lawn/landscaping/patio categories were among the most represented in our study overall, a pattern which is consistent with other studies of ocular trauma [16, 19]. We found that the proportion of eye injuries related to household item/furnishing products increased with age, while injuries related to tools and gardening/lawn/landscaping/patio products declined with age.

Although the proportion of injuries that occurred in the home environment did not significantly vary with patient age for patients aged 65 to 94 years old, patients who were

Table 4 Epidemiology of ED visits from consumer-product-related ocular injuries in geriatric patients before COVID-19 (2018–2019) and during COVID-19 (2020–2021)

Variable	Time period		Total	*p* value
	2018–2019 (*n* = 30,246)	2020–2021 (*n* = 28,500)		
Category of product				
Household items/furnishing	14,295 (39.4%)	14,154 (40.8%)	28,449 (40.1%)	$p < 0.001$
Tools	8169 (22.5%)	6334 (18.3%)	14,503 (20.4%)	
Gardening/ lawn/landscaping/patio	5020 (13.8%)	5319 (15.3%)	10,339 (14.6%)	
Sports recreation	1626 (4.5%)	2121 (6.1%)	3747 (5.3%)	
Other	1741 (4.8%)	1342 (3.9%)	3083 (4.3%)	
Cooking/kitchen items	1261 (3.5%)	975 (2.8%)	2236 (3.1%)	
Electronics/tech	1113 (3.1%)	926 (2.7%)	2039 (2.9%)	
Medical equipment/drugs	362 (1.0%)	1069 (3.1%)	1431 (2.0%)	
Cosmetics/personal care	576 (1.6%)	559 (1.6%)	1135 (1.6%)	
Non-cooking/personal appliances	439 (1.2%)	685 (2.0%)	1124 (1.6%)	
Apparel	516 (1.4%)	503 (1.5%)	1019 (1.4%)	
Powered vehicles	396 (1.1%)	316 (0.9%)	712 (1.0%)	
Office items	425 (1.2%)	181 (0.5%)	606 (0.9%)	
Non-sports recreation	367 (1.0%)	202 (0.6%)	569 (0.8%)	
Sex at birth				
Male	18,181 (60.1%)	17,179 (60.3%)	35,360 (60.2%)	$p < 0.676$
Female	12,066 (39.9%)	11,321 (39.7%)	23,387 (39.8%)	
Race				
White	15,412 (51.0%)	15,201 (53.3%)	30,613 (52.1%)	$p < 0.001$
Not specified	11,167 (36.9%)	10,283 (36.1%)	21,450 (36.5%)	
Black/African American	2798 (9.2%)	2127 (7.5%)	4925 (8.4%)	
Other	387 (1.3%)	373 (1.3%)	760 (1.3%)	
Asian	285 (0.9%)	410 (1.4%)	695 (1.2%)	
American Indian/Alaska Native	111 (0.4%)	89 (0.3%)	200 (0.3%)	
Native Hawaiian/Pacific Islander	86 (0.3%)	16 (0.1%)	102 (0.2%)	
Diagnosis				

Table 4 continued

Variable	Time period		Total	*p* value
	2018–2019 (*n* = 30,246)	2020–2021 (*n* = 28,500)		
Contusions, abrasions	12,466 (41.2%)	10,142 (35.6%)	22,608 (38.5%)	$p < 0.001$
Other	6688 (22.1%)	6984 (24.5%)	13,672 (23.3%)	
Foreign body	4455 (14.7%)	5283 (18.5%)	9738 (16.6%)	
Burn, chemical	2346 (7.8%)	1503 (5.3%)	3849 (6.6%)	
Dermatitis/conjunctivitis	2158 (7.1%)	1612 (5.7%)	3770 (6.4%)	
Hemorrhage	564 (1.9%)	1705 (6.0%)	2269 (3.9%)	
Laceration	414 (1.4%)	506 (1.8%)	920 (1.6%)	
Hematoma	261 (0.9%)	492 (1.7%)	753 (1.3%)	
Radiation	542 (1.8%)	95 (0.3%)	637 (1.1%)	
Puncture	152 (0.5%)	128 (0.5%)	280 (0.5%)	
Nerve damage	81 (0.3%)	17 (0.1%)	98 (0.2%)	
Strain, sprain	84 (0.3%)	0 (0.0%)	84 (0.1%)	
Burn, thermal	35 (0.1%)	15 (0.1%)	50 (0.1%)	
Burn, scald	0 (0.0%)	16 (0.1%)	16 (0.0%)	
Disposition				
Treated/examined and released	28,017 (92.6%)	26,312 (92.3%)	54,329 (92.5%)	$p < 0.001$
Treated and admitted/hospitalized	1257 (4.2%)	1450 (5.1%)	2707 (4.6%)	
Treated and transferred	565 (1.9%)	421 (1.5%)	986 (1.7%)	
Left without being seen	273 (0.9%)	192 (0.7%)	465 (0.8%)	
Held for observation	134 (0.4%)	125 (0.4%)	259 (0.4%)	
Location				
Home	21,591 (71.4%)	17,856 (62.7%)	39,447 (67.1%)	$p < 0.001$
Unknown	6200 (20.5%)	8159 (28.6%)	14,359 (24.4%)	
Public	1457 (4.8%)	1525 (5.3%)	2982 (5.1%)	
Sports	846 (2.8%)	944 (3.3%)	1790 (3.0%)	
Street	152 (0.5%)	16 (0.1%)	168 (0.3%)	
Age range (years)				
65–74	18,741 (62.0%)	18,553 (65.1%)	37,294 (63.5%)	$p < 0.001$
75–84	9515 (31.5%)	7749 (27.2%)	17,264 (29.4%)	
85–94	1474 (4.9%)	1852 (6.5%)	3326 (5.7%)	
95 +	516 (1.7%)	345 (1.2%)	861 (1.5%)	

95 years old or older had a higher proportion of injuries that occurred in public (22.7%). This may be because those 95 years old and older are more likely to be in a facility and thus are possibly less likely to experience an injury in the home environment. We also found that although the majority (59.6%) of ocular injuries were contusions/abrasions or arose from foreign bodies, and a large majority (93.7%) of the injured patients were treated/examined and released, hospital admission or transfer was more likely in older patients. Although patterns of consumer-product-related ocular injuries in the pre-COVID period and during the COVID period were similar, fewer patients presented to an ED with ocular injuries during the first year of the pandemic.

Our study showed variations in consumer-product-related ocular injury across age groups. The younger geriatric age groups were more likely to experience ocular injury from construction tools and landscaping items, which are among the most common products associated with eye injury overall [16]. The younger geriatric age groups were also more likely to experience ocular injury with sports-related products. This may be explained by younger patients performing more physical activity and physical work/labor requiring tools due to better fitness and coordination [20]. The age group distribution may also be influenced by other factors, such as sex at birth; for example, a study by Kamboj et al. found that the ratio of females to males reporting ocular exposure to cleaning products increased with age [21]. Our study also found that patients in the youngest age group of the study (65–74 years old) made up a significantly greater proportion of consumer-product-related ocular injuries during COVID-19. It is unclear why this subgroup demonstrated this trend. Perhaps the incidence of ocular injury increased among this subgroup, or perhaps the prevalence remained the same but the likelihood of them going to the ED increased.

Household/furnishing items and cosmetics/personal care products were more common in females. Females may be more likely than males to use these products. Previous epidemiologic studies have shown that women are more likely to experience adverse ocular effects in response to cosmetics/personal care products such as nail glue [22]. Kamboj et al. reported that 60% of ocular injuries due to cosmetics and personal care products that were referred to the United States Poison Control Centers occurred in women [23]. Another study performed by Kamboj et al. found that women accounted for 67% of reported ocular exposures to household cleaning products [21]. This trend may also explain the prevalence of chemical burn injury among females, as it is a potential sequela of household cleaning product use. Meanwhile, men were more likely to experience ocular injuries caused by products related to tools and activities requiring labor, such as construction and landscaping, consistent with previous studies [16]. Men were also more likely to experience ocular injury from products related to sports, similar to the result of an investigation by Patel et al., who reported that 83.5% of sports-related eye injuries occurred in males [24].

Our study also assessed the slight variation in epidemiologic patterns that occurred during COVID-19 as compared to before COVID-19; the pandemic impacted the daily routines of many Americans. Lockdown measures increased the time spent indoors [25], and social distancing measures impacted the popularity of different leisure activities [26]. Our study found that, in response to COVID-19, the ED saw fewer geriatric ocular injuries which occurred at home, despite Americans typically spending more time indoors and at home in response to stay-at-home mandates and curfew orders [27]. There may have been more hesitation of patients to seek care and go to the emergency department or hospital, where they could be exposed to infectious disease. In addition, our study found that sports-associated ocular injuries increased in response to COVID-19. This is consistent with data showing that during the pandemic, more leisure time was spent on activities that could allow social distancing [26], such as sports [28].

Although Americans spent more time using electronics/technology during COVID-19 [28], interestingly, our study found a decreased occurrence of electronics-associated ocular injury. Perhaps the ocular injuries caused by

products in this category like CDs and telephones were less likely to be severe or emergent and thus less likely to warrant a visit to the ED. Our study shows that fewer geriatric patients came to the ED with contusions/abrasions and strains/sprains, which may be considered less emergent compared to injuries such as laceration and hemorrhage. Medical-equipment-related exposures also significantly increased, which may be explained by the increased use of medical devices used to diagnose, prevent, and/or treat COVID-19, such as masks and nasal swabs [29, 30].

There are several limitations of this study to note. The NEISS database only includes ocular injuries treated in an ED; thus, this sample does not include patients who presented to urgent care centers or outpatient offices [13]. Another limitation of the NEISS database is the possibility of documentation and/or miscoding errors among different physicians and hospitals, alongside simply missing entries. The missing entries are recorded as "unknown," in line with the coding in NEISS itself, and it is important to acknowledge that such missing data may potentially skew results. In addition, due to the retrospective nature of the research, there may be confounding variables and risk factors that contribute to the prevalence of ocular injury which are not represented in our study [31]. Socioeconomic status, access to healthcare, and geographic location may all influence the results but cannot be controlled for, given they are not recorded in the data to prevent the identification of patient cases. Existing variables may be broad (for instance, "Home" is a location), but we are limited by how the data are coded in NEISS. Further, the data do not include the mechanism of injury. For example, a fall onto furniture can be classified as an ocular injury associated with an household item, which is different from accidental poking of the eye with an umbrella [32].

CONCLUSIONS

In conclusion, our study uncovered recent trends in the epidemiology of ocular injury in geriatric adults reporting to the ED. Understanding these patterns can inform consumers and ophthalmic care providers when developing strategies to minimize consumer-product-associated ocular injuries. In our investigation, we find significant differences in the demographics and frequencies of consumer-product-related eye injuries among the elderly adult US population stratified by factors such as age and sex at birth. Future work should continue to analyze trends in consumer-product-associated ocular injuries experienced by geriatric patients post-COVID-19.

Authorship. Hassaam S. Choudhry, Aretha Zhu, Sadiq Shaikh, Haider Zaki, Samuel Masket, and Simon K. Law agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy/integrity of any part of the work are appropriately investigated and resolved, and they have given their approval for this version to be published.

Author Contribution. Hassaam S. Choudhry, Aretha Zhu, Sadiq Shaikh, Haider Zaki, Samuel Masket, and Simon K. Law made substantial contributions to the study design, analysis of data, drafting of the article, revising it critically, and the final approval of the version to be submitted.

Funding. This work is supported by an unrestricted grant from Research to Prevent Blindness, Inc. to the Department of Ophthalmology at UCLA. No funding or sponsorship was received for the publication of this article.

Data Availability. The datasets used and analyzed during the present study are available from the National Electronic Injury Surveillance System (NEISS) repository, https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx.

Declarations

Conflict of Interest. Samuel Masket has the following commercial relationships: consultant/contractor: CAPSULaser, Ocular Therapeutix; recipient: Haag-Streit; patent: Morcher GmbH; personal financial Interest: Mask-it Eye Patch. Hassaam S. Choudhry, Aretha Zhu, Sadiq Shaikh, Haider Zaki, and Simon K. Law have

nothing to disclose regarding the content of this article.

Ethical Approval. This was a retrospective population cohort analysis from a publicly accessible de-identified HIPAA-compliant electronic database ensuring patient confidentiality, and, as such, institutional review board approval was not required.

REFERENCES

1. Négrel AD, Thylefors B. The global impact of eye injuries. Ophthalmic Epidemiol. 1998;5(3):143–69. https://doi.org/10.1076/opep.5.3.143.8364.

2. Resnikoff S, Pascolini D, Etya'ale D, et al. Global data on visual impairment in the year 2002. Bull World Health Organ. 2004;82(11):844–51.

3. Swain T, McGwin G Jr. The prevalence of eye injury in the United States, estimates from a meta-analysis. Ophthalmic Epidemiol. 2020;27(3):186–93. https://doi.org/10.1080/09286586.2019.1704794.

4. Karaman S, Ozkan B, Gok M, et al. Effect of eye trauma on mental health and quality of life in children and adolescents. Int Ophthalmol. 2017;37(3):539–44. https://doi.org/10.1007/s10792-016-0301-9.

5. Islam SMR, Kadir SMU. Ocular morbidity from trauma: a 1-year. J Am Coll Surg. 2021. https://doi.org/10.1016/j.jamcollsurg.2021.08.356.

6. Aghadoost D. Ocular trauma: an overview. Arch Trauma Res. 2014;3(2): e21639. https://doi.org/10.5812/atr.21639.

7. Go CC, Chien L, Lahaie Luna GM, Briceño CA. Epidemiology of product-related ocular injuries in the United States From 2001 to 2020. J Emerg Med. 2022;63(4):489–97. https://doi.org/10.1016/j.jemermed.2022.04.019.

8. Kuhn F, Morris R, Witherspoon CD, Mann L. Epidemiology of blinding trauma in the United States eye injury registry. Ophthalmic Epidemiol. 2006;13(3):209–16. https://doi.org/10.1080/09286580600665886.

9. Choovuthayakorn J, Worakriangkrai V, Patikulsila D, et al. Epidemiology of eye injuries resulting in hospitalization, a referral hospital-based study. Clin Ophthalmol. 2020;14:1–6. https://doi.org/10.2147/OPTH.S234035.

10. Cheng X, Yang Y, Schwebel DC, et al. Population ageing and mortality during 1990–2017: a global decomposition analysis. PLoS Med. 2020;17(6): e1003138. https://doi.org/10.1371/journal.pmed.1003138.

11. Alqudah AA, Al Dwairi RA, Alqudah NM, Abumurad SK. COVID-19 lockdown and eye injury: a case series from Jordan. Int Med Case Rep J. 2020;13: 493–501. https://doi.org/10.2147/IMCRJ.S274284.

12. Akbas E, Korkmaz I, Palamar M, Barut SO. Shifting trends in demographic features of chemical eye injuries during COVID-19 pandemic. Int Ophthalmol. 2022;42(7):2127–32. https://doi.org/10.1007/s10792-022-02211-x.

13. US Consumer Product Safety Commission. National Electronic Injury Surveillance System (NEISS), March 4, 2021. Bethesda: US Consumer Product Safety Commission; 2021.

14. Brown RL, Barrett AE. Visual impairment and quality of life among older adults: an examination of explanations for the relationship. J Gerontol B Psychol Sci Soc Sci. 2011;66(3):364–73. https://doi.org/10.1093/geronb/gbr015.

15. Andreoli MT, Andreoli CM. Geriatric traumatic open globe injuries. Ophthalmology. 2011;118(1): 156–9. https://doi.org/10.1016/j.ophtha.2010.04.034.

16. Chen AJ, Kim JG, Linakis JG, Mello MJ, Greenberg PB. Eye injuries in the elderly from consumer products in the United States: 2001–2007. Graefes

Arch Clin Exp Ophthalmol. 2013;251(3):645–51. https://doi.org/10.1007/s00417-012-2004-x.

17. Kuhn F, Morris R, Witherspoon D, Mann L. Ocular trauma in patients 60 years of age and over. Invest Ophthalmol Vis Sci. 2008;49(13):4057–4057.

18. Kim JG, Linakis JG, Mello MJ, Armstrong GW, Greenberg PB. Eye injuries in elderly adults presenting to U.S. emergency departments. J Am Geriatr Soc. 2013;61(3):470–2. https://doi.org/10.1111/jgs.12137.

19. Chen AJ, Chan JJ, Linakis JG, Mello MJ, Greenberg PB. Age and consumer product-related eye injuries in the United States. R I Med J. 2014;97(1):44–8.

20. Leinert J, Griffin R, Blackburn J, McGwin G Jr. The epidemiology of lawn trimmer injuries in the United States: 2000–2009. J Safety Res. 2012;43(2):137–9. https://doi.org/10.1016/j.jsr.2012.03.001.

21. Kamboj A, Spiller HA, Casavant MJ, Kistamgari S, Chounthirath T, Smith GA. Household cleaning product-related ocular exposures reported to the United States poison control centres. Eye (Lond). 2020;34(9):1631–9. https://doi.org/10.1038/s41433-019-0691-9.

22. Forrester MB. Characteristics of ocular nail glue exposures reported to the National Electronic Injury Surveillance System during 2000–2019. Clin Toxicol (Phila). 2021;59(7):633–8. https://doi.org/10.1080/15563650.2020.1834115.

23. Kamboj A, Spiller HA, Casavant MJ, Chounthirath T, Smith GA. Ocular exposures reported to United States poison control centers. Ophthalmic Epidemiol. 2019;26(2):84–94. https://doi.org/10.1080/09286586.2018.1521982.

24. Patel PA, Patel PN, Ahmed H. Epidemiologic trends in ophthalmic trauma related to major sports: an NEISS study. Ophthalmic Epidemiol. 2023. https://doi.org/10.1080/09286586.2023.2173246.

25. Chiesa V, Antony G, Wismar M, Rechel B. COVID-19 pandemic: health impact of staying at home, social distancing and "lockdown" measures-a systematic review of systematic reviews. J Public Health (Oxf). 2021;43(3):e462–81. https://doi.org/10.1093/pubmed/fdab102.

26. Panarese P, Azzarita V. The impact of the COVID-19 pandemic on lifestyle: how young people have adapted their leisure and routine during lockdown in Italy. Young. 2021;29(4_Suppl):S35–64. https://doi.org/10.1177/11033088211031389.

27. Moreland A, Herlihy C, Tynan MA, et al. Timing of state and territorial COVID-19 stay-at-home orders and changes in population movement—United States, March 1–May 31, 2020. MMWR Morb Mortal Wkly Rep. 2020;69(35):1198–203. https://doi.org/10.15585/mmwr.mm6935a2.

28. Bureau of Labor Statistics. Time spent in leisure and sports activities increased by 32 minutes per day in 2020. TED: The Economics Daily 1 Oct 2021

29. Fazekas B, Fazekas B, Darraj E, Jayakumar D. Preseptal cellulitis and infraorbital abscess as a complication of a routine COVID-19 swab. BMJ Case Rep. 2021;14(5):e241963. https://doi.org/10.1136/bcr-2021-241963.

30. Ramani S, Anusha A, Sundaresh DD, Shetty S. Collateral damage: corneal injury due to mask use during the COVID-19 pandemic—a case series. Indian J Ophthalmol. 2022;70(1):306–7. https://doi.org/10.4103/ijo.IJO_1861_21.

31. Moreira SHN, Kasahara N. Patterns of ocular trauma among the elderly in a South-American urban area and the association between eye traumas with sleep disorders. J Emerg Trauma Shock. 2017;10(3):111–5. https://doi.org/10.4103/jets.Jets_90_16.

32. Halawa O, Mitchell W, Zebardast N. Fall-related eye injury among older adults in the United States. Am J Ophthalmol. 2021;229:82–9. https://doi.org/10.1016/j.ajo.2021.03.063.