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ORIGINAL RESEARCH

Epidemiology of older adult patients with ocular and periocular injuries and risk factors for severe injuries: a multicenter, observational study

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Abstract

In an aging society, the annual frequency of older adult patients with ocular and periocular injuries has consistently increased. We aimed to identify the epidemiological characteristics and factors associated with severe ocular and periocular injuries in older adult patients. This retrospective, multicenter study was conducted using the regional eye injury registry of four tertiary teaching hospitals at a single metropolitan city in the Republic of Korea from August 2016 to December 2020. We enrolled adult patients aged ≥65 years and classified them as having severe or mild eye injuries. Next, we compared the epidemiological characteristics of the two study groups and determined the risk factors associated with severe eye injury through logistic regression analyses. Of the 1185 older adult patients, 279 (23.5%) had severe eye injuries. Males comprised most (823, 69.5%) of the study population. The most common location wherein the injury occurred was the street/highway for men and the home for women. Fall was the most common causative activity; however, farm work or mowing predominated as reasons for men and home activity for women. Multivariable logistic regression analysis revealed that male sex (adjusted odds ratio (aOR): 1.91, 95% confidence interval (95% CI): 1.34–2.77), 70–74 years (aOR: 1.49, 95% CI: 1.05–2.11), hammering/nailing (aOR: 5.84, 95% CI: 1.71–21.75), and mowing (aOR: 2.51, 95% CI: 1.04–6.60) acted as risk factors for severe eye injury. In conclusion, older adult patients with ocular and periocular injuries occurred more commonly among men, and the most common causative activity of injury was a fall. Severe eye injury tended to occur in men aged 70–74 years while performing hammering/nailing and mowing activities.

Keywords

Aged; Eye injuries; Epidemiology; Risk factors; Visual acuity

1. Introduction

In the United States, ocular and periocular injuries are the cause for 3.15 per 1000 population emergency department (ED) visits annually [1] with 1.4% of the patients being hospitalized with primary ocular and periocular injuries [2]. Ocular injury is a common cause of visual loss, accounting for 5%–20% of all cases of blindness and vision impairment in the United States [3]. In an aging society, the annual frequency of ED-treated older adult patients with ocular and periocular injuries has consistently increased [4]. Verbeek *et al.* [5] found that visual impairment in older adults can affect daily functioning, social participation and cognitive state, and is associated with lower quality of life, more depressive symptoms and higher mortality rates. However, most ocular and periocular injuries are preventable, unlike most age-related diseases that cause vision loss. Therefore, epidemiologic studies of older adults with ocular and periocular injuries may provide the data needed for improving public health.

Epidemiological studies of older adults with ocular and periocular injuries reflect the unique characteristics of countries or communities considered. In the United States, 11.5% of all older adult patients with ocular trauma were fall-related and likely to result in hospitalization (odds ratio (OR): 22.8; 95% confidence interval (95% CI): 15.6–33.9) and globe rupture (OR: 14.1; 95% CI: 6.5–30.6) compared to non-fall-related injuries, suggesting that falls are an important mechanism of eye injury associated with worsened outcomes in older adults [4]. A study of older adult patients with ocular and periocular injuries at an urban, single, level 1 trauma center reported that the proportion of women with ocular injuries was more than that of men, occurring mostly at homes and nursing homes [6]. Meanwhile, males were twice as more to experience eye injury than females in Nigeria, a developing country. Among males, farm-related injuries were the most common, whereas assault-related injuries at home were the most common for females.

Sex-related differences regarding activities and locations of injury were observed in this regard [7]. Characteristics and risk factors of ocular and periocular injuries may vary based on individual, environmental and cultural factors. Identifying factors contributing to ocular and periocular injuries can help establish preventive strategies against eye injury and improve system-based policy development.

This study aimed to identify epidemiological characteristics of older adult patients with ocular and periocular injuries and factors associated with severe injuries at the Daegu Metropolitan City in the Republic of Korea.

2. Materials and methods

2.1 Study design and setting

This retrospective, multicenter, observational study considered older adult patients with ocular trauma visiting one of the four academic teaching hospitals in the Daegu Metropolitan City between August 2016 and December 2020. As of the year 2020, the Daegu metropolitan area encompassed 883.6 km^2, supporting a population of 2,410,700. Among this population, 394,279 adults were of age >65 years (15.9%) [8]. All four academic teaching hospitals in Daegu participated, and all had ophthalmology departments and EDs capable of providing eye injury care at all hours.

2.2 Study population

We included patients with ocular and periocular injuries aged ≥65 years who visited the ED or ophthalmology outpatient department during the study period. Ocular and periocular injuries were defined as eyeball injuries, adnexa injuries, eyelid lacerations and orbital wall fractures. Severe ocular and periocular injuries were defined as those meeting at least one of the following criteria: (1) open-globe injury; (2) required emergency surgery or admission; (3) ocular trauma-related complications; and (4) decreased final visual acuity (VA) versus presenting VA [9].

2.3 Data variables

The Daegu Eye Injury Registry used in this study was initially developed as a temporary reporting form based on previous studies and the World Eye Injury Registry. It was finally revised and completed by the Regional Eye Injury Committee consisting of ophthalmologists, emergency medicine physicians, preventive medicine physicians and biostatisticians [9]. Eye injury data were collected using standardized registry forms by research coordinators and investigators who regularly provided feedback regarding the quality control process to ensure data completeness and consistency *via* the quality management center [10].

We employed the following registry variables: demographics (age and sex), route and mode of a hospital visit, involved eye, the use of protective eyewear, alcohol use, time of injury, place of injury, type of injury, causative activity, initial and final VA, clinical diagnosis and ED disposition. Patients were categorized by age as follows: 65–69, 70–74, 75–79 and ≥80 years. The use of protective eyewear was defined as the use of any type of eyewear with the objective of preventing injury, except glasses with corrective lenses and sunglasses. The type of injuries was classified by using the Birmingham Eye Trauma Terminology System [11]. Presenting and final VA was measured as the best-corrected VA of the injured eye and classified as one of the following five categories: no light perception (NLP), light perception (LP) to hand motion (HM), finger count (FC) to 19/200, 20/200 to 20/50, and ≥20/40, similar to the visual acuity classification in Ocular Trauma Score [12]. Visual acuity was presented as a fraction, and the numerator indicates the distance (in feet) from the chart the subject can read the line, and the denominator indicates the distance at which a normal eye can read the line. 20/20 means normal vision, and the larger the denominator number is, the poorer vision is. Clinical diagnosis was categorized with reference to the International Classification of Disease 10th edition and included exclusively diagnostic codes for trauma.

2.4 Statistical analysis

Data were analyzed using R software version 4.0.5 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are presented as the median and interquartile range (25th and 75th percentiles), and the Mann-Whitney U-test was employed to assess non-normally distributed data. Categorical variables are presented as frequencies and percentages and were compared by Pearson's Chi-square test or Fisher's exact tests, as deemed appropriate.

Univariable and multivariable logistic regression analyses were employed to determine the risk factors for severe injuries. The multivariable logistic regression analysis was adjusted for sex, age, the use of protective eyewear, alcohol consumption and type of causative activity to substantiate important risk factors. Logistic regression analysis results were presented as ORs with 95% CIs. Statistical significance was set at $p < 0.05$.

3. Results

3.1 Demographic and general characteristics

Among 11,247 patients enrolled in the Daegu Eye Injury Registry during the study period, 1185 (10.5%) patients aged ≥65 years were considered. Among these, 279 (23.5%) had severe ocular and periocular injuries. A flow diagram of the study is shown in Fig. 1. Among patients with severe ocular and periocular injuries, 88 had open-globe injuries, 198 were admitted or underwent emergency surgery, 20 reported complications after injury, and 78 experienced decreased VA versus presenting VA. Some of these aforementioned categories were found to overlap.

The demographic and baseline characteristics of the study population are summarized in Table 1. A total of 823 cases (69.5%) were male, and the proportion of males with severe injuries (80.6%) was higher than that of those with mild injuries (66.0%) ($p < 0.001$). Most patients fell in the age group of 65–69 years (552, 46.6%), followed by 70–74 years (283, 23.9%), and 75–79 years (210, 17.7%). Most patients visited the hospital *via* the ED (96.5%), with mild ocular and periocular injuries accounting for a higher proportion of direct visits ver-

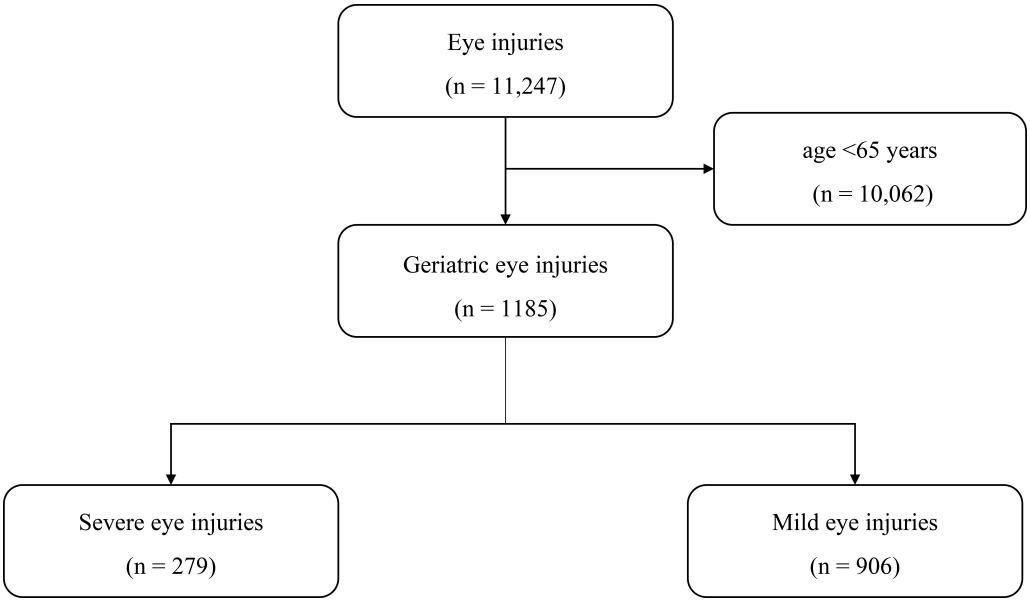

FIGURE 1. A flow diagram of the study.

sus severe ocular and periocular injuries (79.6% versus 53.0%, respectively, $p < 0.001$). Only 1.4% of the patients used protective eyewear, with no significant between-group difference observed ($p = 0.180$). Most ocular and periocular injuries (77.1%) occurred during the daytime. The most common type of injury was closed-globe (753 patients, 63.5%), followed by others (344, 29.0%) and open-globe (88, 7.4%). The most common site of injury was the home (330, 27.8%), followed by streets/highways (219, 18.5%) and farm/forest (198, 16.7%). Mild ocular and periocular injuries most frequently occurred at the patient's homes (30.8%); however, streets/highways (23.7%) were the most common location for severe ocular and periocular injuries. Most patients were discharged from the ED (964, 81.4%) and 198 (16.7%) were hospitalized.

3.2 Distribution of VA

The most common presenting VA was ≥20/40 (539, 45.5%), followed by 20/100–20/50 (263, 22.2%), FC 19/100 (117, 9.9%), LP-HM (82, 6.9%) and NLP (14, 1.2%). Presenting VA was unknown in 170 patients (14.3 %). The most common final VA was ≥20/40 (231 cases, 19.5%), followed by 20/100–20/50 (108, 9.1%), FC 19/100 (60, 5.1%), LP-HM (28, 2.4%) and NLP (6, 0.5%). Final VA was not measured in 752 patients (63.5%).

3.3 Distribution of older adult patients with ocular and periocular injuries diagnoses

The most frequent diagnosis was cornea/conjunctival abrasion (320 cases, 27.0%), followed by orbital wall fracture (186, 15.7%), subconjunctival hemorrhage (86, 7.3%), hyphemia (70 5.9%), and conjunctival laceration (61, 5.1%). Fig. 2 presents a summary of the distribution of the diagnoses.

3.4 Age and sex distributions stratified by causative activities based on age and sex

Table 2 shows the activities most associated with injury based on age and sex. The most common causative activity among both male (110, 13.4%) and female (93, 25.7%) patients was falls. After falls, farm work (101, 12.3%), other mechanisms of injury (101, 12.3%), and mowing (102, 11.9%) were the most common reasons for males. Home activity (82, 22.7%), other mechanisms of injury (70, 19.3%), and farm work (31, 9.4%) were the most commonly reported reasons for females. Other mechanisms of injury were the most common causative activity among those aged 65–69 years (78 cases, 14.1%), with falls being the most common one among other age groups. The proportion of falls as an injury mechanism was found to increase with age (7.2%, 15.2%, 29.5% and 41.4%, respectively).

3.5 Proportions of severe and mild ocular and periocular injuries based on causative activity

Severe and mild ocular and periocular injuries distributions, as well as the proportion of severe ocular and periocular injuries due to various causative activities, are shown in Fig. 3. Among causative activities considered, hammering/nailing (61.1%) was most likely to cause severe ocular and periocular injuries, followed by mowing (44.1%) and traffic accidents (37.6%). Regarding severe injuries frequency, falls were the most common reason (46 cases), followed by mowing (45 cases).

3.6 Risk factors for severe ocular and periocular injuries

Table 3 shows factors associated with a severe ocular and periocular injuries in univariable and multivariable logistic regression analyses. In multivariable analysis, male sex (adjusted OR (aOR): 1.91; 95% CI: 1.34–2.77), 70–74 years (versus 65–69 years old, aOR: 1.49; 95% CI: 1.05–2.11),

TABLE 1. Demographic and baseline characteristics of the study population.

	Total (n = 1185)		Severe injury (n = 279)		Mild injury (n = 906)		*p*-value
	N	%	N	%	N	%	
Sex							
Male	823	69.5	225	80.6	598	66.0	<0.001
Female	362	30.5	54	19.4	308	34.0	
Age							
65–69	552	46.6	119	42.7	433	47.8	0.095
70–74	283	23.9	82	29.4	201	22.2	
75–79	210	17.7	45	16.1	165	18.2	
≥80	140	11.8	33	11.8	107	11.8	
Route of hospital visit							
ED	1144	96.5	262	93.9	882	97.4	0.010
OPD	41	3.5	17	6.1	24	2.6	
Mode of hospital visit							
Direct	869	73.3	148	53.0	721	79.6	<0.001
Transferred	316	26.7	131	47.0	185	20.4	
Eye involved							
Single	1099	92.7	270	96.8	829	91.5	0.005
Both	86	7.3	9	3.2	77	8.5	
Use of protective eyewear							
Yes	17	1.4	6	2.2	11	1.2	0.180
No	1138	96.0	263	94.3	875	96.6	
Unknown	30	2.5	10	3.6	20	2.2	
Alcohol use							
Yes	64	5.4	13	4.7	51	5.6	0.808
No	1085	91.6	257	92.1	828	91.4	
Unknown	36	3.0	9	3.2	27	3.0	
Time of injury							
Daytime (06:00–17:59)	914	77.1	228	81.7	686	75.7	0.057
Nighttime (18:00–05:59)	238	19.7	41	14.7	192	21.2	
Unknown	38	3.2	10	3.6	28	3.1	
Type of injury							
Open-globe injury	88	7.4	88	31.5			<0.001
Rupture	54	4.6	54	19.4			
Lacerations	34	2.9	34	12.2			
Penetrating	8	0.7	8	2.9			
IOFB	22	1.9	22	7.9			
Perforating	4	0.3	4	1.4			
Closed-globe injury	753	63.5	162	58.1	591	65.2	
Contusion	557	47.0	118	42.3	439	48.5	
Lamellar lacerations	196	16.5	44	15.8	152	16.8	
Other injuries	344	29.0	29	10.4	315	34.8	

TABLE 1. Continued.

	Total (n = 1185)		Severe injury (n = 279)		Mild injury (n = 906)		*p*-value
	N	%	N	%	N	%	
Place of injury							
Home	330	27.8	51	18.3	279	30.8	
Factory	141	11.9	36	12.9	105	11.6	
Farm/forest	198	16.7	41	14.7	157	17.3	
School	1	0.1	0	0.0	1	0.1	
Outdoor	178	15.0	59	21.1	119	13.1	0.001
Commercial facility	41	3.5	8	2.9	33	3.6	
Street/highway	219	18.5	66	23.7	153	16.9	
Sports and athletics area	8	0.7	1	0.4	7	0.8	
Others	22	1.9	5	1.8	17	1.9	
Unknown	47	4.0	12	4.3	35	3.9	
ED disposition							
Discharge	964	81.4	72	25.8	892	98.5	
Admission	198	16.7	198	71.0	0	0.0	<0.001
Transfer	23	1.9	9	3.2	14	1.5	

ED: emergency department; OPD: ophthalmology department; IOFB: intraocular foreign body.

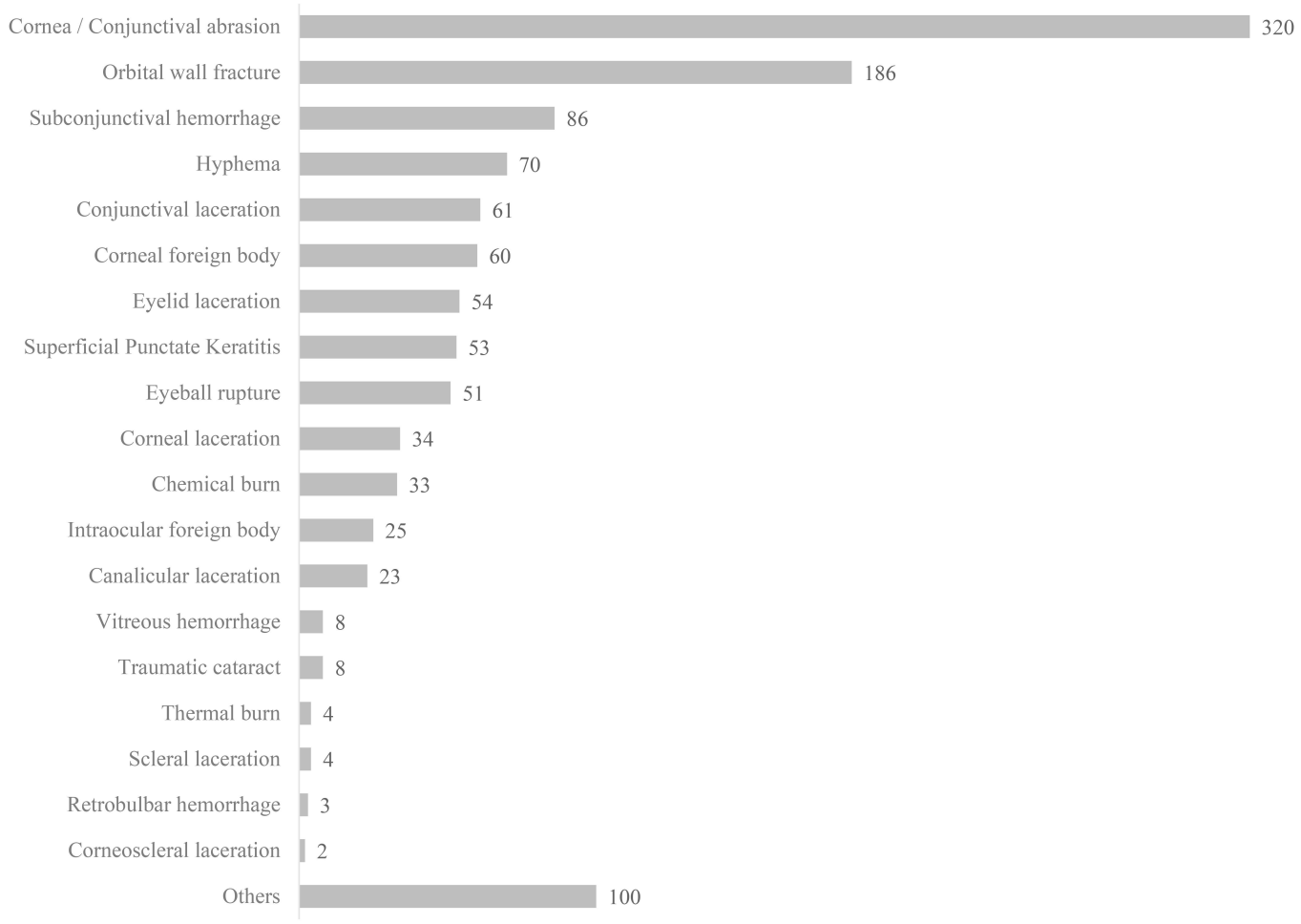

FIGURE 2. Diagnosis of geriatric patients with ocular and periocular injuries.

TABLE 2. Sex and age group distributions associated with causative activities.

	Total		Sex				Age							
			M		F		65–69		70–74		75–79		≥80	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Assault	43	3.6	30	3.6	13	3.6	22	4.0	10	3.5	6	2.9	5	3.6
Chemical handling work	14	1.2	13	1.6	1	0.3	9	1.6	3	1.1	1	0.5	1	0.7
Traffic accident	93	7.8	65	7.9	28	7.7	31	5.6	28	9.9	17	8.1	17	12.1
Fall	203	17.1	110	13.4	93	25.7	40	7.2	43	15.2	62	29.5	58	41.4
Farm work	135	11.4	101	12.3	34	9.4	70	12.7	33	11.7	15	7.1	17	12.1
Grinding/cutting metal	60	5.1	57	6.9	3	0.8	39	7.1	14	4.9	6	2.9	1	0.7
Hammering/nailing	18	1.5	17	2.1	1	0.3	15	2.7	2	0.7	1	0.5	0	0.0
Home activity	132	11.1	50	6.1	82	22.7	63	11.4	31	11.0	28	13.3	10	7.1
Other mechanism of injury	171	14.4	101	12.3	70	19.3	78	14.1	43	15.2	31	14.8	19	13.6
Mowing	102	8.6	98	11.9	4	1.1	55	10.0	29	10.2	15	7.1	3	2.1
Planning/sawing	27	2.3	25	3.0	2	0.6	15	2.7	4	1.4	6	2.9	2	1.4
Sports/hiking	27	2.3	19	2.3	8	2.2	16	2.9	3	1.1	6	2.9	2	1.4
Tree trimming/pruning	55	4.6	42	5.1	13	3.6	28	5.1	18	6.4	7	3.3	2	1.4
Welding	34	2.9	34	4.1	0	0.0	26	4.7	6	2.1	1	0.5	1	0.7
Other work-related activity	71	6.0	61	7.4	10	2.8	45	8.2	16	5.7	8	3.8	2	1.4

M: male; F: female.

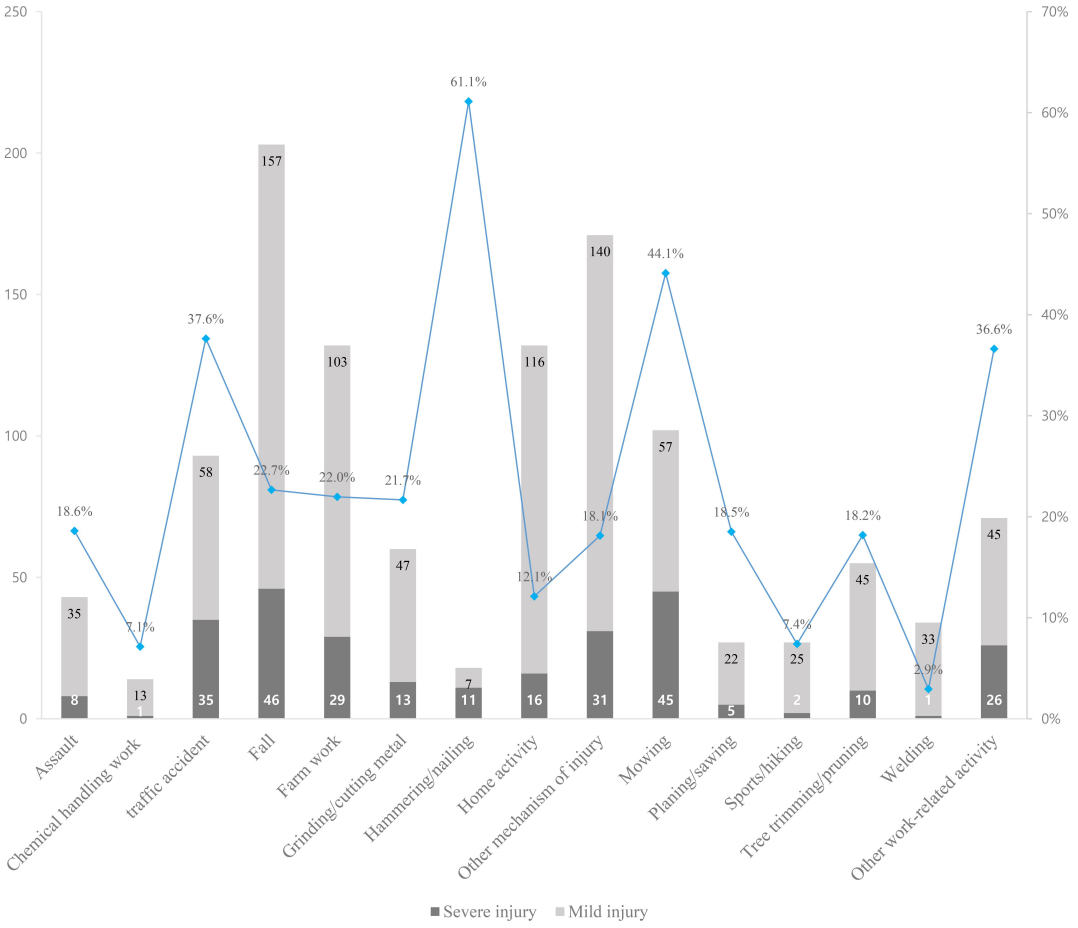

FIGURE 3. Distribution of severe and mild ocular and periocular injuries and the proportion of severe injuries by injury-causing activity.

TABLE 3. Univariable and multivariable logistic regression analyses of the risk factors for severe injuries.

	Univariable			Multivariable		
	Crude OR	95% CI	*p*-value	Adjusted OR	95% CI	*p*-value
Sex						
Female	1.00			1.00		
Male	2.15	1.56–3.00	<0.001	1.91	1.34–2.77	<0.001
Age						
65–69	1.00			1.00		
70–74	1.48	1.07–2.06	0.018	1.49	1.05–2.11	0.026
75–79	0.99	0.67–1.46	0.969	1.07	0.70–1.61	0.767
≥80	1.12	0.71–1.73	0.607	1.28	0.77–2.07	0.329
Alcohol use						
No	1.00			1.00		
Unknown	1.07	0.47–2.23	0.855	0.79	0.33–1.75	0.585
Yes	0.82	0.42–1.49	0.537	0.74	0.36–1.44	0.390
Protective eyewear						
No	1.00			1.00		
Unknown	1.66	0.74–3.52	0.196	1.40	0.58–3.24	0.443
Yes	1.81	0.62–4.82	0.245	2.21	0.67–6.99	0.178
Causative activity						
Assault	1.00			1.00		
Farm work	1.20	0.52–3.02	0.686	0.10	0.42–2.63	0.989
Chemical handling work	0.16	0.02–2.11	0.326	0.23	0.01–1.51	0.193
traffic injury	2.64	1.14–6.70	0.030	2.34	0.98–6.06	0.065
Fall	1.28	0.58–3.14	0.560	1.28	0.57–3.20	0.568
Grinding/cutting metal	1.21	0.46–3.35	0.704	0.86	0.31–2.50	0.773
Hammering/nailing	6.87	2.10–24.63	0.002	5.84	1.71–21.75	0.006
Home activity	0.60	0.24–1.60	0.287	0.65	0.25–1.78	0.385
Other injury of mechanism	0.97	0.42–2.43	0.942	0.92	0.39–2.37	0.859
Mowing	3.45	1.52–8.67	0.005	2.51	1.04–6.60	0.048
Planning/sawing	0.99	0.27–3.38	0.993	0.81	0.22–5.62	0.135
Sports/hiking	0.35	0.05–1.54	0.207	0.33	0.05–1.48	0.187
Tree trimming/pruning	0.97	0.35–2.79	0.957	0.80	0.28–2.39	0.687
Welding	0.13	0.01–0.78	0.957	0.09	0.00–0.56	0.030
Other work-related activity	2.53	1.05–6.59	0.045	2.07	0.82–5.62	0.135

OR: odds ratio; CI: confidence interval.

hammering/nailing (versus assault, aOR: 5.84; 95% CI: 1.71–21.75), and mowing (versus assault, aOR: 2.51; 95% CI: 1.04–6.60) were significantly positively associated with ocular and periocular injuries, whereas welding (versus assault, aOR: 0.09; 95% CI: 0.00–0.56) was significantly negatively associated with ocular and periocular injuries.

4. Discussion

To the best of our knowledge, this is the first study to determine epidemiological characteristics of older adult patients with ocular and periocular injuries and factors associated with severe ocular and periocular injuries using a citywide registry in the Republic of Korea. Similar to previous studies, the results of the present study showed that injury incidence in males was 2.3-times higher than that in females [2, 7, 13–15]. The male predominance may be related to their increased participation in outdoor activities [16], and a similar pattern was observed due to the overwhelming frequency of male participation in farm work, mowing and grinding/cutting metal in our study. The male sex was determined as an independent risk factor for severe injuries, even after adjusting for causative activities. Those aged 70–75 years were more likely than those of other age groups to experience severe ocular and periocular injuries.

Although we could not precisely explain these findings, males and those aged 70–75 years were most likely to experience a powerful impact capable of vision-threatening ocular and periocular injuries requiring hospitalization, independent of causative activity.

This study's findings revealed that the most common causative activity for ocular and periocular injuries in older adults fell, as they accounted for 17.1% of all ocular and periocular injuries. In the United States, 11.5% of ED-treated ocular and periocular injuries were fall-related, the majority of which occurred at patients' homes [4]. Generally, falls have been reported as the most common injury mechanism of older adult patients with ocular and periocular injuries [6, 15, 17–19]. Our study also revealed a similar trend, with a 40% rate of injury from a fall, especially among those aged >80 years. Falls were also highly associated with open-globe injuries. In Turkey, falls caused only 4% of open-globe injuries among non-older adult patients, but 65% among older adult patients, indicating that falls are the main mechanism of open-globe injury in older adults [14]. Age-related poor balance and mobility associated with deteriorated VA have been known to be one of the risk factors for falls [20]. Most falls in older adults occur at home [17]; however, some studies have shown that older adults living in nursing homes or long-term care facilities are at greater risk of falls than community-dwelling elderly because they are frailer in nature [21]. This suggests the importance of developing strategies for limiting environmental hazards in residential areas where falls are common. The Centers for Disease Control and Prevention has suggested some fall-prevention strategies including the use of non-slip mats, adequate lighting and railings on both sides of staircases [22]. Although not all fall-prevention interventions have been successful so far, some multifactorial interventions are expected to reduce fall occurrence and recurrence risk [23, 24].

Notably, this study's findings demonstrated that mowing is associated with severe ocular and periocular injuries. Although incidences of serious ocular and periocular injuries from mowing and falls seem similar, open-globe injuries related to mowing are twice as common as those related to falls. Hammering and nailing are also recognized as risk factors for severe ocular and periocular injuries; however, only 18 injuries have been reported so far, which is much fewer than those associated with mowing (n = 102). The unique culture of the Republic of Korea explains the reason for the high frequency of mowing activities. The fifteenth day of the eighth lunar month is Chuseok, a traditional Korean holiday that is referred to as Korean Thanksgiving Day. It is customary to cut the grass around ancestral graves for days to weeks before Chuseok. Since most graves are located in the mountains, lawn trimmers are preferred over lawnmowers. Lawn trimmers lack extensive shielding, increasing the probability of ejected debris hitting the operators, which together possibly increases the incidence of ocular and periocular injuries [25]. A single center-based ocular injury study conducted in the Republic of Korea has revealed that most open-globe injuries are associated with weed-cutting on Korean Thanksgiving Day in the autumn season, which conforms to our current findings [26]. This study did not consider seasonal ocular injury variation. However, the frequency of ocular and periocular injuries associated with farm work and mowing likely increases during the summer (busy season) and autumn (Chuseok) seasons. Before farming or mowing activities increases, especially before Korean Thanksgiving Day, publicity campaigns highlighting the importance of protective eyewear and warning against ocular and periocular injuries should be strengthened.

Residential houses have been reported as the most common location for older adults with ocular and periocular injuries by most studies, except those on older adults engaged in agriculture [6, 7, 13, 16, 17]. This could be because older adults spend a large proportion of their time at home and are less engaged in outside activities relative to younger adults. The second most common likely location is the streets/highways, followed by farms. Since participating hospitals were academic teaching hospitals capable of providing optimal treatment for major trauma, the transfer of traffic accident patients with ocular and periocular injuries for definite treatment may have contributed to the results.

To establish a preventive strategy for ocular and periocular injuries in older adult patients, the characteristics of older adult patients with ocular and periocular injuries should be understood. The causes of ocular and periocular injuries in younger and older adults differ. In the younger adult group, assault-, work-, sport- and outdoor activity-related to ocular and periocular injuries were more dominant, whereas, in the older adult group, home-related injuries were more common [27, 28]. Furthermore, injury characteristics in our study slightly differed among the older adult age group. The home activity- and fall-related injury rates were high among those aged ≥75 years, while outdoor activity-related rates of injury tended to increase in those aged <75 years. In addition, cultural considerations were deemed necessary for understanding the characteristics of ocular and periocular injuries in our region. Although preventive intervention was not considered in this study, a target group wherein an intervention is expected to be highly effective should be identified and a patient-specific prevention program should be ideated in the future.

This study has some limitations. First, the patients hospitalized from the ED were classified as those with severe ocular and periocular injuries, despite the fact that other injuries may have affected hospitalization. Some patients who did not undergo ophthalmologic surgery following hospital admission had poor VA or complained of initial visual disturbance, but some of them might have been hospitalized for major injuries to other parts of the body. However, we could not confirm this because the Daegu Eye Injury Registry does not contain diagnostic codes for trauma other than ocular and periocular injuries. Second, individual comorbidities or medications of patients may have affected the clinical outcomes and risk of complication after injury. No information on comorbidities or medications was collected from the Daegu Eye Injury Registry. Third, only tertiary hospitals participated in this study and hence this study does not represent all older adult patients with ocular and periocular injuries occurring in our city, because those who visited private ophthalmic clinics or secondary hospitals were excluded from the study. However, most patients with severe ocular and periocular injuries generally require hospitalization or treatment at tertiary hospitals. Fourth, final

VA was not measured in 752 patients (63.5%), which is more than four times the number of patients whose presenting VA has not been measured. Among them, 665 (88.4%) were discharged from the ED, and most of them (652, 98.0%) did not undergo ophthalmology outpatient follow-up testing. Therefore, we believe that the higher proportion of unmeasured final VA compared to the presenting VA can be attributed to not having an outpatient visit following the completion of treatment. Some of the patients with severe injuries might have been underestimated due to the non-measurement of the final VA, but this factor would not have significantly affected the results.

5. Conclusions

Older adult patients with ocular and periocular injuries occur most frequently in males and at home. The most frequent mechanism of injury was identified as falls. The risk factors for severe ocular and periocular injuries were the male sex, age of 70–75 years, and the activities of hammering/nailing and mowing. However, the mechanism and place of eye injury differed based on the sex and age group, with a particularly high association between mowing and severe ocular and periocular injuries, which can be easily prevented with protective eyewear. A prevention strategy for older adult patients with ocular and periocular injuries should contain patient-specific intervention programs for maximum effectiveness.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

CL and JYA—conceptualization; CL, JYA and SM—data curation; JYA and WKL—formal analysis; JYA and HWR—methodology; JYA, SM, HJ, WYN, JHK and SHL—investigation; CL and JYA—writing-original draft; CL, JYA, HWR, SM, HJ, WYN, JHK and SHL—writing-review & editing.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was reviewed and approved by the Korea Disease Control and Prevention Agency and Institutional Review Board (IRB) of Kyungpook National University Hospital (IRB No. 2016-05-005), which waived consent. This study was conducted in accordance with the principles of the Declaration of Helsinki.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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