Animal-inflicted ocular and adnexal injuries in children: A systematic review

Anne-Marie E. Yardley, FRANZCO, MOphth\textsuperscript{a,b,c,*}, Annette K. Hoskin, BSc(Optom), MBA\textsuperscript{b,c}, Kate Hanman, BOrth & OphthalSc\textsuperscript{a,b}, Sue L. Wan, MBBS, FRANZCO\textsuperscript{b,c}, David A. Mackey, MD, FRANZCO\textsuperscript{a,b}

\textsuperscript{a} Princess Margaret Hospital for Children, Perth, Western Australia, Australia
\textsuperscript{b} Lions Eye Institute, Perth, Western Australia, Australia
\textsuperscript{c} Centre for Ophthalmology and Visual Science, University of Western Australia, Perth, Western Australia, Australia

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1. Introduction

Children are naturally inquisitive about the world around them, and there are a variety of situations in which they may encounter animals. The dangers associated with animals may be underestimated and underreported. An American study published in 1985 found that approximately 50% of children suffer a dog bite during childhood.\textsuperscript{12} Eye injury from all causes is the leading reason for monocular blindness in children despite 90% of injuries being potentially preventable.\textsuperscript{96,113} To develop appropriate prevention strategies, we need a better understanding of why and how injuries happen. We review the literature to understand the nature and severity of animal-inflicted ocular and adnexal injury in the pediatric population.

2. Findings

Table 1 provides a summary of the distribution of identified articles by the type of animal involved. The largest number of articles related to insects, followed by domestic mammals.
postinjury best-corrected visual acuity (BCVA) was given, it was good, ranging from 6/6 to 6/7.5. Typical management involved topical steroids with additional antibiotics and cycloplegia in some, as well as mechanical removal of hairs where possible.\textsuperscript{14,34,35,49,86,100,102,117,119,126,128,135,160}

In contrast, Loxosceles-related injuries were bites and primarily involved the adnexa. Preseptal swelling associated with hemorrhage and necrosis was the most common presentation. In one case, the preseptal edema was so extensive the globe became compromised, with the patient requiring lateral canthotomy and cantholysis procedures.\textsuperscript{2,18,76,82,146} Postinjury BCVA was documented in one case and was good (6/6).\textsuperscript{2}

Table 1 – Distribution of articles by animal involved

<table>
<thead>
<tr>
<th>Article topic</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insects</td>
<td>80</td>
</tr>
<tr>
<td>Domestic mammals (cats and dogs)</td>
<td>27</td>
</tr>
<tr>
<td>Arachnids</td>
<td>19</td>
</tr>
<tr>
<td>Population-based study (specific animals involved not described)</td>
<td>13</td>
</tr>
<tr>
<td>Birds</td>
<td>12</td>
</tr>
<tr>
<td>Nondomestic mammals</td>
<td>10</td>
</tr>
<tr>
<td>Reptiles</td>
<td>3</td>
</tr>
</tbody>
</table>

2.1. Population-based studies

We identified 12 population-based pediatric eye injury studies with details about animal-related injuries. The majority were retrospective (92%). Two were concerned with open-globe,\textsuperscript{13,133} one with hospitalized, eye injuries,\textsuperscript{18} and the remainder with severe ocular trauma or undifferentiated eye injuries in children.\textsuperscript{38,40,57,80,90,96,108,124,144}

These 12 studies included 2,856 pediatric ocular and adnexal injuries, 98 (3.29%) of which were animal-inflicted (age range, 0–20 years). The proportion of injuries inflicted by animals in each study varied from 1.5% to 9.1%.\textsuperscript{13,38,40,57,80,90,96,108,124,133,144}

Of the 2 studies on open-globe injuries in children (age range, 0–16 years), 8 of 337 (2.4%) were caused by animals.\textsuperscript{13,133}

An Austrian study investigating the management of bite wounds described 898 animal-related bites suffered by children.\textsuperscript{75} Thirty-four of these bites were ocular and adnexal (3.8%), with the majority caused by dogs (94%).\textsuperscript{75}

2.2. Arachnids

Nineteen case reports involving arachnid-inflicted pediatric ocular injuries were identified in children ranging aged 7–18 years (mean, 14.2 years). Tarantulas were implicated in 14 of these cases.\textsuperscript{14,31,34,67,71,88,100,102,117,119,126,128,135,160} Ten of 11 articles pertaining to pediatric eye and adnexal injuries caused by tarantulas were recorded. Three were retrospective articles, and 10 were case reports describing injuries in 15 children.\textsuperscript{9,19,25,35,49,86,100,132,136,148,152}

Two retrospective reviews from India of caterpillar hair–induced eye injury described the proportion of these occurring in children, ranging from 9.92%\textsuperscript{123} to 20.2%.\textsuperscript{132} The majority of injuries in the latter study were corneal abrasions.\textsuperscript{132} Another review from the United States described that of all caterpillar hair exposure-related presentations, 80% occurred in children and 0.4% involved the eye.\textsuperscript{86}

Ten case reports describing 15 patients were identified. Forty percent of these originated from the United Kingdom and Northern Ireland,\textsuperscript{9,19,25,106,132} 20% from India,\textsuperscript{9,134} 20% from Europe,\textsuperscript{9,152} with the remainder from Australia\textsuperscript{148} and the United States.\textsuperscript{25} The mean age of these children was 11.1 years (range 6 months to 16 years) and the majority of individuals were male (86.7%).

A number of different species were implicated, although the offending caterpillar was not always identified.\textsuperscript{148} The culprits were endemic to the study regions, with species-specific seasonal population peaks.\textsuperscript{19,35,49,86,132,134,152} Mechnism of injury included caterpillars\textsuperscript{9,106,136} or butterflies\textsuperscript{152} being thrown at the child, inadvertent ocular contact while playing with a caterpillar,\textsuperscript{25,148} or in some cases, no definite history of caterpillar contact or trauma.\textsuperscript{9,19,25,148}

Anterior ocular structures were involved in 73.3% of cases and included nodular conjunctivitis, keratitis, keratouveitis, and anterior uveitis. The visual outcomes in this group were excellent with all patients who had visual acuity recorded (10 of 11) attaining 6/6 vision.\textsuperscript{9,19,25,134,148,152}

Four cases had posterior segment involvement with varying degrees of vitritis and chorioretinitis. One of these cases required enucleation, whereas the others retained good vision with BCVA of 6/6 to 6/12.\textsuperscript{35,49,106,136} The case requiring enucleation was reported in 1955 and involved a chronically irritated eye with poor vision. Histology after removal showed setae scattered throughout the eye.\textsuperscript{25}

A spectrum of management approaches were used, ranging from observation, hair removal where possible,
topical management with antibiotics and steroids, and enucleation in the most extreme case.6,9,19,25,35,49,86,106,123,132,134,136,148,152

2.3.2. Bees
There were 9 cases of bee-sting ocular and adnexal injuries. A large majority (89%) were male children (mean age, 10.5 years; range 3–18 years).

One-third of the injuries were limited to the lids and cornea,7,139 and one-third involved keratouveitic changes.74,156,158 When recorded, BCVA in this portion of the cohort was good, with 80% of patients attaining 20/20 vision. In the remaining one-third of cases, there was 1 corneal injury associated with iris heterochromia and internal opthal-molmpia33 and 2 cases of bilateral optic neuropathy.17,99

These two optic neuropathy cases had similarities. One involved a sting to the brow, followed 2 weeks later by decreased vision in both eyes to count fingers or hand motions associated with bilateral optic disc swelling. The patient received intravenous methylprednisolone followed by oral steroids. At 3 months’ follow-up, he had recovered vision to 20/25–20/30.17 The other case sustained a facial sting with subsequent decreased vision (20/80) and bilateral optic disc swelling. After the patient received intravenous steroids, the swelling resolved and vision improved to 20/15 with restoration of color vision.17 The underlying mechanism for bee-sting optic neuritis is focal demyelination secondary to an acute allergic reaction to the bee venom.17

2.3.3. Fly larvae
2.3.3.1. External opthal-momyiasis. External opthal-momyiasis results from the larval form of various flies being deposited in tissues outside the globe. Of the 31 articles identified regarding external ophthalmomyiasis, 30 were case reports discussing 37 children. The one retrospective review identified concerning external ophthalmomyiasis, 30 were case discussions of 31 articles.

The clinical manifestations of external ophthalmomyiasis fell into 3 groups: lid myiasis (48.6%),24,27,39,46,62,79,101,114,116,120,129,139,158 ocular surface myiasis (45.9%),5,15,22,39,44,65,66,84,104,115,130,138,145,150,166 and orbital infestation (25.4%).41,129

The mean age for the overall cohort was 9.1 years (range, 12 days to 17 years). The lid myiasis group tended to be younger compared with the ocular surface and orbital groups (mean age, 5.7, 12.2, and 12.5 years, respectively). There was a male preponderance across all groups, with the overall male-to-female ratio being 3:2. Vision, when measured, was universally good, ranging from 6/5 to 6/6. Both patients in the orbital infestation group had diagnoses of retinoblastoma,129 with 1 developing an infestation in a chronically exposed hydroxyapatite implant.41

The culprit larva was identified in 83.3% of lid myiasis cases, 67.4% of ocular surface cases, and in 1 of the 2 orbital cases. Dermatobia hominis was the most common larva to cause lid myiasis (8 of 14 cases)46,114,120,122,158 followed by Cuterebra larva (3 of 14 cases)62,79,116. There were also single lid myiasis cases of Chrysomya bezziana and Musca fly.130 The orbital case was caused by an infestation of Cochliomyia hominivorax.41

The United States24,44,46,66,79,114,116,122 and India15,65,84,101,104,115,129,130,150 were the most common geographical locations for these reports, with 29% of articles originating from each of these countries.

2.3.3.2. Internal opthal-momyiasis. Internal opthal-momyiasis refers to larval invasion of the globe by certain types of flies.112 Eighteen cases of pediatric internal opthalmomyiasis were described in 15 articles. The mean age of these patients was 9.9 years (range, 3–16 years) with a male-to-female ratio of 3.5:1. One case was a mixed case of anterior and posterior internal ophthalmomyiasis,112 whereas the remainder solely involved posterior structures. The majority of the cases originated in the United States (53%),36,43,48,87,94,112,131,170 followed by Europe (27%).61,81,141,142

Sixteen of the 18 cases had visual outcomes documented: 31% had excellent outcomes (6/6–6/7.5),58,94,110,131,141,142,18.75% reasonable outcomes (6/12–6/18),102,112, and the remaining 50% had poor outcomes with 25% having perception of light vision, 6% having NPL vision, and 18.75% undergoing enucleation.43,58,61,81,87,142

The larva responsible was identified in 75% of cases, with the reindeer warble fly (Oedemagena tarandi) being the most common (75% of identified cases).61,81,141,142 Other larva reported included Oestrus ovis, Hypoderma bovis, Hypoderma lineatum,43 Cuterebra,36 and Hypoderma tarandi.87

2.3.4. Miscellaneous insects
One prospective Nepalese study found that 3% of pediatric ocular trauma in children is caused by insects.1 Table 2 gives the details of 10 case reports concerning 17 cases of ocular and adnexal injury in children caused by insects not already discussed.

2.4. Reptiles
Three cases (1 male and 2 female, mean age of 10 years) of snake-related pediatric ocular and adnexal injuries were identified. Two of these concerned bites from vipers and one a topical exposure to Diamondback rattler snake venom.154

The child who had a topical exposure to venom made a full recovery after immediate irrigation,154 as did the child who suffered a viper bite to his medial canthus. Although there were ecchymosis, hemorrhage, and chemosis initially, he received timely antivenom. After 3 days, his platelet count improved, and he recovered.64 Unfortunately, the other case involving a viper resulted in a poor outcome. The eye required enucleation after the patient presented with severe facial swelling and proptosis and was systemically unwell.70

2.5. Birds
Of the 12 articles describing birds causing eye and adnexal injuries, 3 were retrospective reviews,45,103,157 and the remainder case series and reports.15,28,59,61,68,85,91,93,127 Three-quarters involved roosters and chickens.11,28,59,63,85,93,103,157
The 3 retrospective studies included a total of 281 ocular injuries in children aged 15 years and younger. Four of these injuries were caused by chickens and roosters (1.42%).50,110,137

The case series and reports detailed 14 cases of bird-inflicted ocular trauma, all of which were open-globe injuries. The mean age of the patients was 6.3 years, and more than half were male. Three of the cases were complicated by endophthalmitis.50,110,137

Seven of the cases were caused by roosters or chickens. These patients had a mean age of 3.4 years and had poor visual outcomes with vision, for 5 of the 7 patients who had a vision recorded, ranging from 5/60 to NLP.11,28,59,63,85,93,127

One case series detailed 5 injuries caused by the Australian magpie (Cracticus tibicen).68 This bird is a member of the Artamidae family, unlike the European magpie which is part of the Corvidae. The behaviour of these magpies differs, with the Australian bird notorious for being territorial and aggressive during its breeding season and swooping on unsuspecting victims. The children who suffered injuries in the magpie case series had a male-to-female ratio of 3:2 with a mean age of 8 years. The visual outcomes in this group were better than the chicken and roosters subgroup with BCVA ranging from 6/4.5–6/18.68

The other birds represented in the literature include cases involving a cormorant and a heron. This group did poorly; one patient was left with NPL vision, and one patient required enucleation.91,127

### 2.6. Domestic mammals

#### 2.6.1. Cats

Cat scratches are responsible for 0.4% of eye injuries presenting to emergency departments in Brazil.26 From 2 retrospective reviews, the percentage of open-globe injuries in children caused by cats ranged from 1.2%153 to 2.8%.151

Open globe injuries were suffered by all of the 6 children presented in the 4 case series and reports.30,50,140,161 Two developed cataracts, and one sustained an adnexal injury in the form of a lid injury.30,140 The age range was from 3 to 11 years (mean age, 7.3 years) with the majority being female (67%). Visual outcomes were documented in 5 of the 6 cases and ranged widely from full visual recovery to requiring evisceration. Fifty percent of the cases were complicated by intraocular Pasteurella multocida contamination.50,140,161

#### 2.6.2. Dogs

##### 2.6.2.1. Eye injuries caused by dogs

Of children’s eye injuries presenting to hospital or requiring admission, three retrospective studies identified that 2.25% (range 0.2–3%) were inflicted by dogs.8,26,60,109

Two retrospective studies identified that dogs were responsible for causing between 1.4%153 to 3%4 of open-globe injuries in children. One case report also described a dog-inflicted open-globe injury; the 11-year-old girl involved had been handling her caretaker’s new dog when she was attacked. She sustained a corneoscleral laceration and multiple facial lacerations. Her visual outcome was excellent with a recorded BCVA of 6/5.78

Of the 3 studies reviewing 407 pediatric dog bite injuries in all anatomic regions, 9% were found to involve the eye or periorbital tissues (range 5.8%–20%).16,21,51 It is reported that there is a predilection for the face, head, and neck as a zone for biting by dogs in children, with 82% of injuries involving this region requiring hospitalization of the patient.73

Two studies confined their anatomic parameters to bites affecting the face, head, and neck region. In these studies, approximately 20% of bites involved the eye or periorbital region.69,105

##### 2.6.2.2. Periocular injury caused by dogs

Six articles in which the main topic was periocular dog-inflicted injury in children were identified.23,55,56,92,164 Among the 46 children presented in 4 case series, there were high rates of canalicular injury (50%–88.9%). The mean age of children in these studies was fairly young, ranging from 4.8 years to 6.6 years.23,55,56,92,164

The two case reports identified different, but interesting, clinical scenarios. The first described a case of canine-tooth syndrome in a 5-year-old girl after multiple bites to her mid-face by her neighbor’s German shepherd. The right orbit was involved, with superior and inferior lid lacerations and lower canaliculus involvement as well as a severed superior oblique globe attachment posterior to the trochlea. The muscle had prolapsed through the lid wound and was excised. She has recovered well, with minimal residual lid position or motility disturbance and no diplopia.92

The second concerned a 2-year-old girl who had sustained a vertical full-thickness upper lid laceration. This was completely hidden at initial presentation because of swelling, thus highlighting the high level of suspicion needed when a dog bite causes injury.72

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**Table 2—Additional insect-inflicted pediatric ocular and adnexal injury**

<table>
<thead>
<tr>
<th>Insect (number cases)</th>
<th>Age (year)</th>
<th>Sex</th>
<th>Nature of injury</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurella multocida</td>
<td>4</td>
<td>M</td>
<td>Foreign body</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Fire ants (1) ¹</td>
<td>2</td>
<td>M</td>
<td>Bilateral keratitis</td>
<td>Corneal scarring; no VA recorded</td>
</tr>
<tr>
<td>Giant millipede (7) ²</td>
<td>Mean: 3.8</td>
<td>Not known</td>
<td>Periorbital burns; keratitis (1 case)</td>
<td>Depigmentation skin no VA recorded</td>
</tr>
<tr>
<td>Leech (3)</td>
<td>Mean: 4.7</td>
<td>1M 2F</td>
<td>Conjunctival/corneal injury (hemorrhage/epithelial defect)</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Megacopta (1)</td>
<td>2</td>
<td>F</td>
<td>Insect superior fornix</td>
<td>Not recorded</td>
</tr>
<tr>
<td>Tick (3)</td>
<td>Mean: 3</td>
<td>1M 2F</td>
<td>Conjunctival injury</td>
<td>Not recorded</td>
</tr>
<tr>
<td>Stick insect (1)</td>
<td>8</td>
<td>M</td>
<td>Conjunctival/corneal injury from venom</td>
<td>BCVA 20/20</td>
</tr>
</tbody>
</table>

BCVA, best-corrected visual acuity; F, female; M, male; VA, visual acuity.
Two articles concerned primarily with canalicular injury included information about dog bites. One demonstrated that, when dogs are responsible for periocular wounds, there is a propensity for canalicular injury. Forty-five percent of the 68 canalicular injuries in that study occurred in children less than 10 years old.121 The other study showed 24 of 71 canalicular injuries in children younger than 15 years were caused by dogs. The same article described that the majority of dog-inflicted canalicular injuries occur in children (77%; 24/31 cases).83

Two case series of dog bites causing facial fractures in children included information about orbital fractures. In the first, there were 3 orbital fractures out of the total 6 cases of orbital fractures in a cohort ranging in age from 4 to 7 years.135 In the second, there were 5 orbital fractures out of the 17 facial fractures in a cohort ranging from 6 months to 10 years.162 In both of these series, all patients who sustained an orbital fracture had an associated lid injury.155,162 Aside from these case series, mention was also made in other studies of dog-inflicted orbital fractures with 2 documented in the study by Brogan and colleagues,21 one in the study by Horswell and Chahine,69 and one in the study by Wladis and Dewan.164

### 2.7. Nondomestic mammals

Three retrospective reviews47,52,54 and 7 case series and reports involving 8 children were identified in this group.29,73,107,143,149,167,169 Horses were involved in 3 of these 10 articles.47,52,73 One American study reported that horses were responsible for 2 out of 84 eye injuries requiring hospital admission in children (2.4%).52

An Australian study described 22 patients with neuroophthalmic sequelae of horse-related head trauma, 7 of whom were pediatric. All 7 were female, with a mean age of 12.1 years (range, 4–17 years). The mechanism of injury for 86% was falling from a horse. The neuroophthalmic sequelae included traumatic optic neuropathy (25%), cranial nerve palsy (37.5%), and orbital fracture (37.5%).47

A further case report of a 17-year-old girl sustaining a comminuted inferomedial orbital fracture from a horse-related incident was also identified. In that case, both cosmetic and functional outcomes were good.71

### Table 3 – Nondomestic mammal-inflicted pediatric ocular and adnexal injury

<table>
<thead>
<tr>
<th>Country</th>
<th>Animal</th>
<th>Age</th>
<th>Sex</th>
<th>Injury</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>India²⁹</td>
<td>Buffalo</td>
<td>5.5 years</td>
<td>M</td>
<td>Intraocular foreign body (buffalo tail hair)</td>
<td>BCVA 6/9</td>
</tr>
<tr>
<td>USA¹⁰⁷</td>
<td>Rat</td>
<td>7 weeks</td>
<td>M</td>
<td>Open-globe injury and adnexal injury (lid laceration)</td>
<td>Phthisical eye</td>
</tr>
<tr>
<td>UK¹⁰⁷</td>
<td>Rat</td>
<td>3 months</td>
<td>M</td>
<td>Adnexal injury (extensive loss upper and lower lids requiring reconstruction)</td>
<td>Dense amblyopia</td>
</tr>
<tr>
<td>Saudi Arabia¹⁴³</td>
<td>Desert fox</td>
<td>1.5 years</td>
<td>F</td>
<td>Adnexal injury (Lid laceration)</td>
<td>Full recovery</td>
</tr>
<tr>
<td>Saudi Arabia¹⁴³</td>
<td>Desert fox</td>
<td>7 years</td>
<td>F</td>
<td>Adnexal injury (Lid laceration)</td>
<td>Death</td>
</tr>
<tr>
<td>India¹⁴⁹</td>
<td>Asiatic black bear</td>
<td>8 years</td>
<td>M</td>
<td>Bilateral open-globe injury and adnexal injury (facial fractures and extensive lacerations)</td>
<td>Bilateral evisceration</td>
</tr>
<tr>
<td>Singapore¹⁶⁹</td>
<td>Monkey</td>
<td>1 day</td>
<td>M</td>
<td>Adnexal injury (upper lid avulsion and laceration)</td>
<td>Ptosis—gradual improvement</td>
</tr>
</tbody>
</table>

BCVA, best-corrected visual acuity; F, female; M, male.

### Discussion

#### 3.1. Assessment of quality and bias

The vast majority of articles identified for inclusion in this review were case studies and series. Any estimates of prevalence presented are based on studies other than these to reduce inaccuracy. Because of the predominance of case studies, there may be publication bias in terms of the types of animals identified and injury outcomes. There may also be geographically based bias, with the studies in the literature not providing an accurate representation of global animal-inflicted pediatric ocular and adnexal injury, particularly in terms of those injuries occurring in developing countries. In addition, articles that were excluded based on unavailability or non-English language may have altered our findings. The effect of this bias on findings regarding severe injuries is likely to be minimal; however, it may have resulted in an element of underestimation of the number of animal-inflicted eye and adnexal injuries in the global pediatric population.

#### 3.2. What does this mean for the future? What can we change?

One of the aims of studying the nature and severity of injuries is to identify potential methods of injury prevention. Children and animals will always interact with each other, but there are ways to make those interactions safer. Education plays a key role in this approach. The general public needs to be aware that some animals can inflict devastating eye and adnexal injuries. Raising public awareness about any of these injury types should help prevention to some extent or at least facilitate more timely intervention. Several studies discussed the need for education of child-appropriate animal interaction and need for better animal controls to limit the incidence of animal-related ocular injury.32,34,42,53,71

Our review found that male children are more at risk of all types of animal-inflicted ocular and adnexal injury, with two
exceptions. Girls are more at risk from cats and horses. This specific information is invaluable in terms of targeting education and other prevention strategies.

3.3. Dog bite interventions

In terms of dog bites, different strategies have been used to reduce their incidence. In the United States, a reduction of dog bites in children younger than 14 years by 47% from 1994 to 2003 was achieved by interventions introduced by the Centers for Disease Control in association with the American Veterinary Medical Association Task Force on Canine Aggression and Human-Canine Interventions.53 Strategies included education of children about appropriate behavior with dogs, licensing of dog ownership, and banning of "dangerous" breeds.53

A Cochrane collaboration review of the education of children and adolescents for the prevention of dog bite injuries included two randomized controlled trials.32 Both studies were Australian; the first investigated a program aimed at primary school age children. One group was exposed to a lesson from a dog handler about the dangers associated with dogs and how best to approach them, whereas the other group received no intervention. The children were then video-recorded interacting with a dog 7–10 days after this intervention without their knowledge and their behavior was coded by the authors. The intervention group demonstrated increased precautionary behavior around dogs.32

The second study involved kindergarten age children and had 4 groups: a control group that received no intervention, a group of children who were read a story about the dangers of dogs, a third group of children whose parents received an information brochure, and a fourth group of children who were read the story and whose parents were given information. Four weeks after this, the children were shown a series of photos of dogs in different positions. The children in the 2 groups that had been read the story demonstrated increased knowledge and caution regarding dogs, whereas parental information was not associated with any behavioral changes in the children.163

Programs such as these appear to improve children’s knowledge and attitude toward dogs; however, the length of the effect is unknown, and these studies did not directly measure the effect the interventions had on dog bite rates but assessed surrogate outcomes.32,42,163

There are many obstacles to measuring outcomes in this situation. The incidence of reported injuries is low and dependent on accurate reporting systems. Also because of this low incidence, the population numbers and follow-up times needed to measure intervention effectiveness accurately are very large and long, respectively.

3.4. Other interventions

Other animal groups also have modifiable injury risk factors. Addressing these could decrease exposures and reduce injury severity. Some groups of animals do not lend themselves to these strategies and are therefore more reliant on increased awareness and education to improve outcomes after injuries have occurred.

Tarantulas are an example where there is potential to alter exposure. There are recommendations in the literature about wearing gloves and eye protection during handling, especially when the spider is a new addition to a household.34,71 Access to appropriate information at the point of sale and training of sales assistants to provide education would seem an obvious intervention to make buyers aware of the hazards of handling tarantulas and how to avoid them.

In Australia, magpie attacks commonly occur during nesting season when territoriality increases. Raising public awareness of the potential for magpie-inflicted eye and adnexal injuries and the need to provide protection for children’s eyes at this time of year seems worthwhile. Whether such protection is as simple as recommending that children wear helmets with visors while cycling remains to be seen.

In terms of other modifiable risk factors for bird-related injuries, improved awareness and understanding should improve supervision, decrease potential exposure situations, and ultimately prevent injury.

Prevention is much better than cure,132 and so applying the approach mentioned previously to other animal groups, particularly caterpillars, cats, and horses should improve injury rates.

Educating parents, caregivers, and medical personnel about the potential dangers associated with animals, the types of injuries they can cause, and appropriate and timely management approaches should improve outcomes. For example, knowing when caterpillar numbers are at their peak locally, along with the awareness that caterpillar exposure in children can cause significant ocular issues, would decrease time to presentation and lower the threshold for referral from an emergency department setting to an ophthalmologist, thereby expediting diagnosis and minimizing suffering and visual loss for the patient.

The natural hosts of fly larvae are animals such as sheep, cattle, horses, and reindeer58; exposure to these animals therefore puts an individual at risk of ophthalmomyiasis. For people living in rural areas, it may not be possible to alter exposure, so raising awareness of ophthalmomyiasis through appropriate education in these populations may aid timely diagnosis and improve outcomes.

4. Conclusions

Children interact with animals in a wide range of environments. The nature and severity of ocular and adnexal injuries inflicted on the pediatric population by animals is extremely varied. There are obvious geographical differences in some exposures, for example, magpie injuries have only been documented in Australia,68 whereas Loxosceles spider injuries have occurred predominantly in Turkey.2,18,82,146

Overall, less than 5% of eye injuries in children are caused by animals,13,38,40,57,80,90,96,108,118,124,133,144 eye injuries caused by insects, predominantly ophthalmomyiasis, are the most widely reported. Dogs are the animals most likely to cause adnexal injuries in children, with a predilection for canalicular injury. Birds and nondomestic mammals are responsible for the most severe injuries.
A better understanding of the nature and severity of animal-inflicted pediatric ocular and adnexal injury will help develop effective prevention strategies to reduce their incidence in the future.

5. Methods of literature search

A systematic search of MEDLINE, PubMed, and EMBASE databases was performed to identify relevant studies. Search terms used included “eye injury” and “children” or “pediatric/pediatric” and “animal” as well as specific animals known to be implicated in eye injuries including “insect,” “mammal,” “reptile,” “cat,” “bird,” “dog,” and “horse.” Non-English articles were excluded. No year limits were imposed.

Methodology and reporting followed MOOSE guidelines. Articles containing detailed information concerning the nature and severity of animal-inflicted ocular and adnexal injuries in the pediatric population (20 years and younger) were included. Eligible article types included case series and reports and epidemiologic and hospital-based studies (both retrospective and prospective).

Articles were retrieved based on titles and abstracts. These were then independently assessed by 2 authors relative to the research question. If the article was deemed suitable, the full-text was then screened to assess whether it met the inclusion criteria. Reference lists of included studies were then searched for any additional eligible studies. Figure 1 provides diagrammatic representation of this process.

The following details were extracted from included articles: author, year of publication, and country of origin. The details extracted regarding the injuries included: animal causing injury, age and number of children involved, the type of injury, and visual outcome where available. Risk of bias was minimized through 2 authors independently assessing articles for eligibility and extracting data individually.

A narrative synthesis was used for all case reports and series. Prevalence data from population studies were combined where appropriate.

6. Disclosures

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