

# Age and Consumer Product-Related Eye Injuries in the United States

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## ABSTRACT

**PURPOSE:** The purpose of this study was to describe the epidemiology of consumer product (CP) related eye injuries presenting to US emergency departments (EDs) stratified by age.

**METHODS:** The Consumer Product Safety Commission's National Electronic Injury Surveillance System (CPSC-NEISS) database was used to derive national, weighted estimates of nonfatal Emergency Department visits for eye injuries by patients' age, gender, diagnosis, injured body part, locale of incidence, and related CP.

**RESULTS:** The CPs causing the highest proportion of injury visits varied among the different age groups: chemicals in the very young (0-4 yr), household items in 5-9 year olds, sports products in 10-24 year olds, cutting and construction tools in 25-64 year olds, and chemicals in the elderly (65+). Patients aged 0-4 also represented the age interval with the highest rate of injury visits (92 visits per 10,000).

**CONCLUSION:** This study identified the CPs responsible for the most eye injury visits by age groups. Further research is needed on how to effectively change the behavior of individuals and their environment so that we can minimize preventable eye injuries from consumer products.

**KEYWORDS:** consumer products, eye injury, emergency department (ED)

## INTRODUCTION

Each year, more than 2.5 million eye injuries occur in the United States (US).<sup>1</sup> Consumer products (CPs) – defined as any articles produced or distributed for use by the public in or around a home, school or recreational area – are an important cause of eye injuries and contribute to more than 210,000 eye injury visits annually in the US.<sup>2</sup> However, the current characteristics of CP-related eye injuries are not well described in the US population. Specific age ranges,<sup>3-5</sup> a focus on a specific type of consumer product<sup>6-9</sup> or older data<sup>10,11</sup> have limited previous studies of CP-related eye injuries. More detailed information on CP-related eye injuries by age will assist in targeting high-risk products and implementing effective prevention strategies specific to appropriate age groups.

The purpose of this study was to describe the epidemiology of CP-related eye injuries presenting to US emergency departments (EDs), with a focus on identifying the highest injury-causing CP categories for different age ranges. Unlike previous studies that have used this database to examine eye injuries over all age ranges,<sup>10,11</sup> we used both the narrative and administrative data from each case record to describe and classify the CP-related eye injuries.

## MATERIAL AND METHODS

### Data source and population

The Providence VA Institutional Review Board exempted the protocol for this retrospective cohort study. The data source for this study was derived from the Consumer Product Safety Commissions' National Electronic Injury Surveillance System (CPSC-NEISS), a database created by the U.S. CPSC with the objectives of establishing product safety standards and identifying unsafe consumer products. The data are derived from a probability sample of 100 hospitals nationwide, which is representative of the estimated 5300 hospitals that include a minimum of six beds and a 24-hour emergency department in the United States and its territories. CPSC-NEISS data, through use of inverse probability weights, can be used to project national, weighted estimates of nonfatal injuries treated in US EDs. We reviewed data for all nonfatal eye injuries occurring in patients of all ages from 2002–2010.

CPSC data include information on patients' age, gender, diagnosis, injured body part, locale of incident, case disposition, and the CP causing the injury; each CP has a NEISS-specific code. Each case also includes a narrative component, which describes the injury. Data not provided in the NEISS include patient visual acuity, follow-up information, or comorbidities. For our study, all cases in which the injured body part was coded as "eyeball" met the criteria for analysis.

### Data analysis

We reviewed data for all non-fatal eye injuries in patients of all ages from 2002-2010. Proportions of eye-injury visits were calculated by age, gender, diagnosis, disposition, and locale of incidents. To calculate proportion of CP injuries by age group, we took a stratified random sample of 500 cases from each age group (see Table 3 for age-group breakdown),

and two authors (AC and JC), used the narrative data associated with each case to classify the cause of injury. Any discrepancies in coding were revisited for correction, and uncertain products were placed in an "Other" category. Groups were then constructed to categorize the CPs causing eye injuries (Table 1), and the proportion of injuries from each CP category was calculated for all the age groups.

## RESULTS

There were an estimated 119,800,205 CP-related injury visits to US EDs in patients ages 0 to 110 from 2002-2010; 1,903,269 involved the eye. Males comprised 69% of all eye-injury visits. Patients aged 0-4 were the five year age group with the highest percentage of ED-treated eye injuries (9.5%) (Table 1).

In Table 2, CPs are classified into 11 categories. Table 3 lists the frequency and proportion of eye injury visits in each CP category by age group; the CPs causing the highest incidence of injury in each age group are bolded. The majority of eye injury visits in patients aged 0-4 were caused by chemicals (37%). The CP categories responsible for the most eye injury visits in those aged 5-9 were household items (25%); for those aged 10-14, sports products (41%); for those aged 15-24, sports products (25%); for those 25-64, cutting tools and construction products (32%); and for those 65 and older, chemicals (23%).

Table 4 contains the diagnosis of eye injuries. Contusions and abrasions were the leading diagnoses of eye injuries (44%), followed by foreign body injuries (19%) and conjunctivitis (10%). Of the injuries recorded with a specific locale of injury, the most common locale was at home (79%), followed by at a place of recreation or sports (8.8%) and at school (5.9%). The recorded disposition of 97% of ED eye injury visits was "treated and released."

## DISCUSSION

This study describes CP-related eye injuries seen in US EDs from 2002 through 2010. The CPs causing the highest estimated number of eye injuries varied by age group and were in the categories of chemicals, cutting tools/construction, sports-related products, and household items.

In those aged 0-4 and 65+ years, chemicals were the leading cause of injury. The chemicals included cleaners, detergents, disinfectants, and various types of glue, soaps, and sprays. Chemical injuries in those aged 0-4 often involved cleaning products used and sprayed by siblings, others at home, or the patients themselves. Chemical injuries in those aged 65+ were often indirectly linked to the use of eye medication in the elderly, as patients often mistook a bottle of nail glue for their eye drop medication (See Figure 1). To minimize chemical injuries to infants and toddlers, the AAO recommends

**Table 1.** Estimated emergency department visits by age

Age	% of ED <sup>a</sup> Visits	National Estimates <sup>b</sup> n (95% CI)	Sample Size <sup>c</sup>
0-4	9.5%	181,367 (152,509-210,225)	7,178
5-9	8.1%	154,281 (130,106-178,456)	5,779
10-14	8.2%	155,744 (135,597-175,890)	5,574
15-24	17.1%	325,895 (281,984-369,806)	8,383
25-34	17.0%	322,722 (277,323-368,122)	7,367
35-44	16.4%	313,059 (265,835-360,282)	7,061
45-54	12.2%	231,329 (197,658-265,000)	5,211
55-64	6.7%	127,081 (107,023-147,140)	2,806
Over 65	4.8%	91,791 (74,546-109,036)	1,973
Total	100%	1,903,269 (1,648,723-2,157,815)	51,332

<sup>a</sup> Emergency Department

<sup>b</sup> Weighted frequencies projected by CPSC-NEISS

<sup>c</sup> Actual number of injuries reported by CPSC-NEISS

that chemical cleaners and sprays be securely placed out of reach of small children and be used minimally around them.<sup>12</sup> In the case of the elderly, to prevent confusion between eye drops/artificial tears and chemicals, bottle fonts could be enlarged so that the elderly can easily read labels despite pre-existing visual deterioration. Furthermore, since glue accounted for 8% of all chemical injuries in the elderly, an engineering strategy could involve glue bottle manufacturers changing the shape and/or feel of their glue bottles, as many elderly may not be able to read bottle labels prior to putting in eye drops due to preexisting visual deterioration.

Among those aged 5-9, household item products were the leading cause of eye injury. Some of these products include bags, boxes, paper, clothing, hair combs, clothes hangers, spoons, teapots, toys, and umbrellas. Since the injuries caused by these products were highly prevalent in children, injury rates could be lowered through better adult supervision and education on the proper use of these items. The AAO suggests avoiding toys such as darts, bows and arrows, and missile-firing toys, and being aware of common household items such as paper clips, bungee cords, wire coat hangers, rubber bands, and fishhooks, which can cause serious eye injuries. In addition, they suggest that parents provide adequate supervision when children handle potentially dangerous items, such as pencils, forks, and knives.<sup>12</sup>

Among those aged 10-24, sports-related products were the

Table 2. Consumer product categories

Category	Included Consumer Products
Chemical	acetic acid solution, algaecide concentrate, air freshener, battery acid, bleach, cedar stain, chlorine, cleaner, degreaser, deodorant, detergent, disinfectant, Febreze, furniture polish, gasoline, glue, hair coloring dye, kerosene, nail polish, Oxyclean, paint, paint thinner, pepper spray, perfume, shampoo, shower cleaner, smoke, soap, stain remover, sunscreen, wasp spray
Furniture	bathtub, bed, bedrail, blinds, chair, clothes rack, couch, door, doorknob, drawer, dresser, floor, lamp, light fixture, mattress, nightstand, refrigerator, rugs, shelf, sofa, stairs, table, tub faucet, TV, TV stand, wall, window shade, wood chest
Cutting Tools & Construction	attic insulation, chain swing, cutter, drill, pipe, plaster, plastic decking, power grinder, sandblasting, saw, table saw, tent poles, tractor, trailer, welding tools, wood cutter
Gardening	gardening-tool related injury, hose, leaf blower, mower, mulch, plant stick, pressure washer, rake, sprinkler, trimmer, weed-wacker, wheelbarrow, wood saw (for branches)
Household Items <sup>1</sup>	basket, bed sheet, beer bottle, belt, book, broom, bucket, bungee cord, can, cardboard, carpet, CD, chopsticks, Christmas tree lights, cigarette, clothes, clothes line, clothesline, cork, crayon, cup, divider, drinking glass, eraser, flashlight, folder, fork, glass bottle, glass bowl, glass vase, hanger, jacket, key, knife, laundry basket, magazine, mailbox, metal rod, pan, paper, paper clip, pen, pencil, pillow, ribbon, rug, ruler, scissors, shower cap, spoon, staple, stapler, straw, tape, teapot, toothpick, towel, zipper
Toys	airsoft gun, balloon, eye patch, jigsaw puzzle, rubber dart, rubber snake, suction cup gun, toy arrow, toy unspecified
Appliances	air conditioner, antenna, ceiling fan blade, cellphone, computer, cord, curling iron, electric cord, electric toothbrush, fan, grill fan, hair curler, hair dryer, hot water heater, iron, key board, light bulb, radiator, radio antenna, sewing machine needle, slot machine, computer, telephone receiver, TV, vacuum
Household tools <sup>2</sup>	cord, hammer, ladder, nail, nail kit, nail gun, plier, rod, rope, screw, screwdriver, steel wool, stereo wire, tool box, tweezers, wrench, zipper
Sports-related products	air pistol, arrow, baseball, basketball, bike, exercise band, fishing pole, football, golf ball, golf club, gun, hockey, paintball, racquet, rifle, sinker, soccer ball, soccer net, soft gun, swimming, tennis ball, trampoline, treadmill, water polo
Glasses	Glasses, sunglasses, glass bottle, window
Other	4 wheel AV, 4-wheeler, amusement ride, artificial Christmas tree, ashes, bottle rocket, charcoal, clothes tag, compound bow, dog food, dust, exercise weights, fence, fence wire, filter, fire extinguisher, firecrackers, firework, fishing rod, foot, glitter, go-cart, graduation cap, laser beam, monkey bar, no narrative information, sandbox, scooter, slide, snowball, sparkle from Christmas decoration, sparkler, tennis court, toenail, trashcan lid, unknown, walker, window lock, yard sign

leading cause of eye injury. These products included baseballs, basketballs, air pistols, bikes, fishing poles, footballs, golf balls, clubs, paintballs, soft guns, tennis balls, among others. Those aged 10-14 had an especially high incidence of sports product-related injury; 41% of their eye injuries were due to sports products. Previous literature has shown that eye injury rates (# eye injuries/# participants) from sports were highest among participants of airsoft and paintball, basketball, football, and baseball.<sup>13</sup> Consistent with these findings, our study also revealed that sports injuries were mostly a result of being struck by a ball or high velocity projectiles from guns. According to the Eye Injury Snapshot conducted by the AAO and American Society of Ocular Trauma, more than 78% of people were not wearing eyewear at the time of sports injury, and of those reported to be wearing eyewear, only 5.3% were wearing safety or sports glasses.<sup>14</sup> Encouraging people (especially children beginning their sports careers) to habitually wear protective eyewear may help eliminate many of these sports product-related injuries. Such directives may most effectively come from parental enforcement: parents of children who are involved with paintball or BB gun battles should require their children to wear

face masks prior to commencing gun battles and should prevent children from accessing these guns when they are not involved in an organized game (e.g., in the home setting). An enforcement strategy could be for paintball battle hosts mandating all participants to wear full-face masks prior to entering the battlefield.

Among those aged 25-64, the cutting tools/construction products were the leading cause of eye injury. These products include drills, cutters, power grinders, saws, insulation, plaster, welding tools, among other construction products. Ocular injuries from these products were often due to high-velocity projectiles of metal, dust, concrete, and wood. The Vision Council recommends the use of protective eyewear while working in situations with higher risk of injury, such as auto repair, construction, electric work, and welding.<sup>15</sup> Some interventions that may encourage the use of eye protection may include use of media: for instance, the media can encourage 25-64 year olds to use eyewear when working with construction and cutting tools by promoting protective eyewear while marketing certain machine tools (e.g., We know that people in this age range often shop online or scavenge online reviews, so online product sites or

**Table 3.** Consumer product-related eye injuries by age group (in %)\*

	0-4 yrs	5-9 yrs	10-14 yrs	15-24	25-44 yrs	45-64 yrs	>65 yrs
Chemical	<b>37.1</b> (30.8, 43.3)	15.1 (10.3, 19.9)	15.5 (11.0, 20.0)	16.4 (12.4, 20.4)	16.6 (13.9, 19.4)	20.4 (17.4, 23.3)	<b>23.6</b> (19.2, 28.0)
Furniture	11.3 (7.5, 15.1)	10.2 (6.2, 14.3)	4.1 (1.7, 6.6)	4.3 (2.1, 6.4)	3.7 (2.4, 5.1)	2.8 (1.8, 3.9)	11.0 (7.9, 14.1)
Cutting tools/ construction	1.8 (0.0, 3.6)	1.3 (-0.2, 2.9)	1.9 (0.3, 3.6)	25.0 (20.1, 29.9)	<b>34.7</b> (31.2, 38.3)	<b>31.1</b> (27.7, 34.5)	23.4 (18.9, 27.9)
Gardening	1.6 (0.0, 3.3)	2.2 (0.3, 4.1)	1.5 (-0.1, 3.2)	2.3 (0.6, 4.0)	5.4 (3.7, 7.1)	10.6 (8.3, 12.9)	12.9 (9.5, 16.3)
Household items	22.8 (17.8, 27.9)	<b>25.3</b> (19.8, 30.7)	16.4 (12.1, 20.7)	13.0 (9.3, 16.7)	13.7 (11.2, 16.2)	15.0 (12.4, 17.6)	9.2 (6.3, 12.1)
Toys	11.3 (7.2, 15.4)	11.4 (7.2, 15.5)	7.4 (4.2, 10.6)	1.4 (0.2, 2.6)	1.0 (0.3, 1.6)	0.3 (0.0, 0.6)	0.1 (-0.1, 0.3)
Appliances	2.2 (0.5, 3.9)	0.9 (-0.3, 2.2)	0.7 (-0.2, 2.6)	2.2 (0.8, 3.5)	3.1 (1.8, 4.4)	3.8 (2.4, 5.2)	6.1 (3.5, 8.6)
Household tools	1.6 (0.0, 3.1)	2.6 (0.5, 4.6)	4.0 (1.5, 6.6)	3.9 (1.9, 6.0)	4.6 (3.0, 6.1)	2.8 (1.6, 4.0)	0.9 (-0.1, 2.0)
Sports-related product	2.3 (0.6, 4.1)	20.7 (15.5, 25.9)	<b>40.8</b> (34.7, 46.8)	<b>25.4</b> (20.7, 30.0)	8.4 (6.4, 10.4)	4.7 (3.1, 6.2)	1.5 (0.2, 2.8)
Glasses	0.7 (0.3, 1.7)	1.0 (-0.1, 2.2)	0.4 (-0.1, 1.0)	1.5 (0.2, 2.8)	2.7 (1.5, 3.9)	2.0 (1.0, 3.0)	2.3 (0.8, 3.9)
Miscellaneous	7.4 (4.1, 10.7)	9.3 (5.5, 13.1)	7.2 (4.0, 10.4)	4.6 (2.3, 6.9)	6.1 (4.3, 7.9)	6.5 (4.8, 8.3)	8.9 (6.0, 11.8)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

\* 95% confidence intervals are listed below each percent. The consumer product categories causing the highest percent of injury in each age group are bolded.

**Table 4.** Estimated emergency department visits by diagnosis

Diagnosis	% of ED <sup>a</sup> Visits	National Estimates <sup>b</sup> n (95% CI)	Sample Size <sup>c</sup>
Contusion/abrasion	44%	829,752 (715,569-943,935)	23,317
Foreign body	19%	357,546 (297,797-417,296)	7,989
Dermatitis/conjunctivitis	10%	192,591 (156,773-228,410)	4,949
Burns	6%	121,313 (98,625-144,000)	2,596
Chemical burn	4%	84,381 (68,136-100,626)	2,444
Hemorrhage	2%	45,231 (36,136-54,325)	1,461
Laceration/puncture	2%	39,908 (33,072-46,745)	1,340
Hematoma	.6%	11,727 (9,041-14,412)	285
Strain/sprain	.03%	616 (258-974)	16 <sup>d</sup>
Nerve damage	.01%	323 (-22.9-669)	14 <sup>d</sup>
Other/unknown	12%	219,881 (180,097-259,666)	6,921
Total	100%	1,903,269 (1,648,723-2,157,815)	51,332

<sup>a</sup> Emergency Department

<sup>b</sup> Weighted frequencies projected by CPSC-NEISS

<sup>c</sup> Actual number of injuries reported by CPSC-NEISS

<sup>d</sup> Numbers <20 are considered unstable by CPSC-NEISS

videos might show a demonstrator wearing eye protection while using the advertised power drill or metal grinder).

The study has several limitations. First, the NEISS database does not provide patient data on visual acuity, use of protective eyewear, or follow-up care, which prevented us from distinguishing the more severe ocular injuries from the minor ones. Second, only eye injuries treated in EDs were included; therefore, the total number of eye injuries may be underestimated and may be more likely to include the more severe cases (Severe injuries would more likely induce a patient to present to the ED). Third, narrative data were used to identify the CP causing each injury, which may have led to interpretation error. To minimize this error, any uncertain product was put in an "Other" category. Finally, due to small sample sizes within certain subgroups, we were unable to form statistically stable national estimates for some variables of interest. However, because of the large volume and variety of cases seen in EDs, the study most likely represents an accurate description of CP-related eye injuries across all age groups in the United States.

**Figure 1.** Nail glue vs. eye drops: which is which\*?



\*The leftmost item is nail glue, and the middle and right items are lubricant eye drops.

## CONCLUSIONS

In conclusion, this study delineates the highest-risk CP categories by age group: chemicals in the very young (0-4 yr), household items in 5-9 year olds, sports products in 10-24 year olds, cutting and construction tools in 25-64 year olds, and chemicals in the elderly (65+). Characterizing this link between age and cause of CP-related eye injuries will assist in devising more effective interventions regarding the use of protective eyewear while working with higher risk CPs, whether they be through targeting young adults through internet media or minimizing elderly chemical injuries through encouraging glue bottle manufacturers to create more distinctive bottle designs to minimize confusion between chemicals and eye drops. Further research is needed on how to best change the behavior of individuals and their environment so that we can minimize preventable eye injuries from consumer products.

## References

- American Academy of Ophthalmology and American Society of Ocular Trauma, United States Eye Injury Registry summary report, 1998-2002. Available at: <http://www.aao.org/newsroom/guide/upload/Eye-InjuriesBkgrnderLongVersFinal-1.pdf>. Accessed June 17, 2013.
- United States Consumer Product Safety Commission (2010). National Electronic Injury Surveillance System (NEISS) coding manual. Consumer Product Safety Commission, Washington, DC.
- Pollard KA, Xiang H, Smith GA. Pediatric eye injuries treated in US emergency departments, 1990-2009. *Clin Pediatr*. 2012;51(4):374-81.
- 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
- Moren Cross J, Griffin R, Owsley C, McGwin G Jr. Pediatric eye injuries related to consumer products in the United States, 1997-2006. *J AAPOS*. 2008;12(6):626-8.
- 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.
- Seidman CJ, Linakis JG, Mello MJ, Greenberg PB. Aerosol container-related eye injuries in the United States: 1997-2009. *Am J Ophthalmol*. 2011;151(6):1041-1046.e1.
- Conn JM, Anest JL, Gilchrist J, Ryan GW. Injuries from paintball game related activities in the United States, 1997-2001. *Inj Prev*. 2004;10(3):139-43.
- McGwin G Jr, Hall TA, Xie A, Owsley C. Gun-related eye injury in the United States, 1993-2002. *Ophthalmic Epidemiol*. 2006;13(1):15-21.
- Sastry SM, Copeland RA Jr, Mezghebe HM, Siram SM, Spencer M, Cowan CL Jr. Consumer product-related ocular trauma. *J Natl Med Assoc*. 1995;87(5):349-52.
- McGwin G Jr, Hall TA, Seale J, Xie A, Owsley C. Consumer product-related eye injury in the United States, 1998-2002. *J Safety Res*. 2006;37(5):501-6.
- American Academy of Ophthalmology (2007). Eye Safety. Available at: <http://development.aao.org/eyecare/treatment/eye-safety.cfm>. Accessed June 1, 2012
- Kim T, Nunes AP, Mello MJ, Greenberg PB. Incidence of sports-related eye injuries in the United States: 2001-2009. *Graefes Arch Clin Exp Ophthalmol*. 2011;249:1743-4.
- American Academy of Ophthalmology (2012). Preventing Eye Injuries. Available at: <http://www.geteyesmart.org/eyesmart/living/preventing-eye-injuries.cfm>. Accessed June 8, 2012.
- The Vision Council (2011) Jobs with elevated eye injury risk and recommended protective eyewear to counter risk. Available at: <http://www.thevisioncouncil.org/consumers/media/ResearchReports/VCASSESafetyReportv4.pdf>. Accessed June 17, 2013.

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## Disclaimer

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