



# Strabismus, Strabismus Surgery, and Reoperation Rate in the United States

## *Analysis from the IRIS Registry*

Michael X. Repka, MD, MBA,<sup>1</sup> Flora Lum, MD,<sup>2</sup> Bhavya Burugapalli, MPH<sup>2</sup>

**Purpose:** To describe the rates of strabismus, strabismus surgery, and strabismus surgery reoperations among all age groups in the United States.

**Design:** Retrospective analysis of electronic health record data.

**Participants:** Patients from the IRIS (Intelligent Research in Sight) Registry.

**Methods:** Description of the types and rates of strabismus and strabismus surgery from 2013 to 2016 with subgroups by age, sex, race/ethnicity, and region of the United States.

**Main Outcome Measure:** The 1-year reoperation rate for strabismus surgery performed during 2013–2015 for all age groups.

**Results:** A total of 30 827 185 unique patients were identified; 846 477 (2.75%) had a diagnosis of strabismus: 3.02% of male patients and 2.55% of female patients (difference = 0.47%, 95% confidence interval [CI], 0.46–0.48,  $P < 0.0001$ ). Strabismus surgery was performed in 40 780 (0.13%) unique patients during the 4 years. The rate of surgery ranged from 1.99% for children birth to 5 years of age to 0.05% for adults 40 years of age and older. Horizontal surgical codes were reported 38 813 times, vertical surgery codes were reported 9304 times, and superior oblique codes were reported 711 times. Adjustable sutures were used for 3027 patients (7.42%). Cases with a code for repeat eye muscle surgery or restrictive myopathy were reported for 6098 patients (14.9%). Esotropia accounted for 30.06% and exotropia in 21.77% of diagnoses reported for surgery. The rate of undergoing a reoperation within 1 year of a strabismus surgery was 6.72%, lowest for the group 6 to 9 years of age (3.95%) and increasing with age ( $P < 0.001$ ) to 11.5% for patients 65 years of age and older.

**Conclusions:** Strabismus is an uncommonly reported diagnosis in ophthalmologic practice. Overall, approximately 1 in 750 patients in the IRIS Registry received strabismus surgery (1 in 20 with a strabismus diagnosis) during a 4-year period. Reoperations during the first year after surgery were performed for 1 in 15 patients, increasing with age at surgery. “Big” data from clinical data registries represent real-world care that can be used to develop benchmarks for clinical outcomes and to identify areas for practice improvement and training program design. *Ophthalmology* 2018;■:1–8 © 2018 by the American Academy of Ophthalmology

Strabismus is traditionally considered an eye disorder affecting children, with infantile onset or those cases associated with high hyperopia and disorders of accommodation. However, strabismus affects patients of all ages. Teens and adults have binocular misalignment associated with childhood-onset strabismus, but many develop new strabismus from trauma, surgery, neurologic disease, or orbital disease. Recent population-based estimates of the prevalence of strabismus are available for children younger than 6 years of age in the United States, but are lacking for older age groups. In population-based studies in Baltimore and Los Angeles, the prevalence of strabismus ranged between 2.1% and 3.5% in children 6 to 71 months of age, with the prevalence increasing with age.<sup>1–3</sup> The Baltimore Pediatric Eye Disease Study found a higher rate of strabismus among non-Hispanic white children (3.3%) compared with African American children (2.1%).<sup>1</sup> The Multi-Ethnic

Pediatric Eye Disease study found similar rates of strabismus in non-Hispanic white and Asian children (3.2% and 3.5%, respectively), whereas rates among African American and Hispanic children were lower (2.5% and 2.4%, respectively).<sup>2,3</sup> A similar prevalence rate (2.4%) has been found in a multi-ethnic birth cohort of 4- and 5-year-old children in the United Kingdom.<sup>4</sup> In adults, a population-based study from the Rochester Epidemiology project found the annual incidence of new-onset adult strabismus of 0.054% (95% confidence interval [CI], 0.050–0.058) for individuals 19 years of age and older, with a lifetime risk for adult-onset strabismus of approximately 4%.<sup>5</sup>

Another source of prevalence data comes from medical claims. A review of Medical Expenditure Panel Survey (2003–2008) data provided an estimate of the prevalence of strabismus or binocular vision disorder.<sup>6</sup> The authors found the prevalence of strabismus to be 0.24% for children birth

Table 1. Number and Proportion of Patients with Strabismus by Sex, Race/Ethnicity, and Region

Demographic Factor	No.	Proportion with Strabismus (%)	Difference in Proportions	Ratio of Proportions
Sex				
Male	12 884 494	3.02	0.47% (95% CI, 0.46–0.48) P < 0.0001	Reference 0.84
Female	17 881 462	2.55		
Missing	61 229	1.80		
Race/Ethnicity*				
White	20 304 747	2.90	Reference	Reference
African American	2 106 501	2.62	–0.28% (95% CI, –0.26 to –0.30) P < 0.0001	0.90
Asian	858 861	2.47	–0.43% (95% CI, –0.40 to –0.46) P < 0.0001	0.85
Native American	111 419	2.32	–0.58% (95% CI, –0.49 to –0.67) P < 0.0001	0.80
Native Hawaiian	58 569	1.99	–0.91% (95% CI, –0.79 to –1.02) P < 0.0001	0.68
Biracial/Multiracial	22 962	3.28	0.38% (95% CI, 0.16–0.62) P < 0.0006	1.13
Unknown	7 364 126	2.40		
Region				
East	12 263 043	2.82	Reference	Reference
Midwest	6 252 435	3.60	0.78% (95% CI, 0.76–0.80) P < 0.0001	1.28
South	4 722 112	2.37	0.45% (95% CI, 0.43–0.47) P < 0.0001	0.84
West	5 625 859	2.38	0.44% (95% CI, 0.42–0.46) P < 0.0001	0.85
Missing	1 963 736	1.55		

CI = confidence interval.

\*Race/ethnicity is not a mandatory reporting field in electronic health records sampled, so some data are missing.

to 17 years of age and 0.03% for adults 18 to 39 years of age among their insured. The difference between these 2 age groups was not explained. Evaluation of claims data for aged Medicare beneficiaries (aged  $\geq 65$  years) found a diagnosis of strabismus in 0.68% of beneficiaries.<sup>7</sup> It is likely that these claims data underestimate the prevalence of strabismus because it may not have been reported if the patient was seen for another problem.

Even more limited data are available concerning rates of strabismus surgery. In adults 65 years of age and older with Medicare Part B coverage, strabismus surgery was performed in just 0.016% of beneficiaries in those claims databases.<sup>7</sup> Outcomes of strabismus surgery are difficult to assess because there are many types of strabismus. In addition, motor and sensory data are not available in claims databases, leaving reoperation rate a commonly reported performance measure.<sup>8–10</sup>

Our purpose is to describe the prevalence of strabismus, the rate and types of strabismus surgery, and the 1-year reoperation rates among all ages in the US population using data provided from practices participating in the American Academy of Ophthalmology's IRIS (Intelligent Research in Sight) Registry.<sup>11,12</sup> These practices represented approximately 42% of practicing ophthalmologists in the United States at the end of 2016.<sup>13</sup> These registry-provided data accurately describe patients seen in clinical practice, but cannot provide population-based prevalence information. The data will be enriched with pathology because

patients without an abnormality are not seen as often and old diagnoses may not be carried forward. Secondary objectives include a description of the types of strabismus surgery performed and differences in strabismus diagnosis and surgery based on age, gender, race/ethnicity, and region.

## Methods

This study was conducted to identify individuals with strabismus in the United States seen in clinical practice and to determine their

Table 2. Number of Unique Patients and Number with Strabismus by Age Group

Age (yrs)	Unique Patients	No. with Strabismus (%)
0–5	389 954	85 049 (21.81)
6–9	606 193	103 692 (17.11)
10–19	1 870 216	163 449 (8.74)
20–29	1 636 148	46 423 (2.84)
30–39	1 738 619	34 092 (1.96)
40–49	2 538 653	42 097 (1.66)
50–59	4 417 974	67 571 (1.53)
60–64	3 015 287	44 958 (1.49)
65–69	3 614 433	54 643 (1.51)
70–79	6 295 546	107 326 (1.70)
80–89	3 649 248	75 280 (2.06)
90+	1 049 016	21 804 (2.08)
Missing	5898	93 (1.58)

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