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## Income Disparities in Outcomes of Horizontal Strabismus Surgery in a Pediatric Population

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### Abstract

**Purpose:** To examine postoperative outcomes in pediatric patients undergoing strabismus surgery to determine the potential impact of socioeconomic disparities on ophthalmic outcomes.

**Methods:** This study included 284 children undergoing strabismus surgery at a tertiary institution with at least 11 months of follow-up and no prior strabismus surgery or other neurologic or ophthalmologic conditions. Demographics, insurance, operative parameters, and appointments scheduled/attended were collected via chart review. Ocular alignment was recorded preoperatively and postoperatively at 3, 12, and 24 months. Two-sided *t* tests and chi-squared analyses were used to compare demographic and operative parameters. Logistic regression was employed to determine predictive factors for ophthalmic outcomes.

**Results:** There was no difference in failure rates between patients with Medicaid and patients with private insurance 24 months postoperatively (45.9% vs 50.5%, respectively,  $P = .46$ ). Patients

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with Medicaid were more likely to not follow up postoperatively (28.2% vs 9.6%, respectively,  $P < .01$ ), whereas patients with private insurance were more likely to complete more than three follow-up appointments in 24 months (21.5% vs 39.0%, respectively,  $P < .01$ ). Postoperative attendance was linked to Medicaid status ( $P < .01$ ) but not travel time, neighborhood income levels, or social deprivation index factors.

**Conclusions:** There was no difference in failure rates between patients with Medicaid and patients with private insurance. Medicaid status was significantly predictive of loss to follow-up.

## INTRODUCTION

Strabismus is one of the most common eye conditions in children, with an incidence between 1.5% and 5% in the United States.<sup>1,2</sup> Strabismus may cause double vision, eyestrain, headaches, and strabismic amblyopia.<sup>3</sup> Surgical correction of strabismus is an option to improve symptoms and restore normal ocular alignment. The success rate for strabismus correction ranges between 65% and 80%, depending on length of follow-up, type of strabismus, and definition of success.<sup>4-6</sup>

Low socioeconomic status (SES) may be a barrier to achieving strabismus correction success. Previous studies have found low SES to be associated with worse ophthalmologic and non-ophthalmologic outcomes, in addition to difficulties in receiving care.<sup>7</sup> Individuals with Medicaid in low SES groups have difficulties obtaining eye care appointments and have lower rates of glaucoma care and annual diabetic eye examinations.<sup>8</sup>

The impact of low SES on strabismus surgical outcomes is not well understood. A previous study with a limited sample size of 69 patients and relatively limited 6-month postoperative follow-up period found no impact of SES on outcomes.<sup>9</sup> The primary purpose of this study was to compare postoperative outcomes in a larger cohort of pediatric patients undergoing strabismus surgery over at least an 11-month period to determine the impact of low SES and health disparities and evaluate the impact of neighborhood socioeconomic characteristics on outcomes.

## PATIENTS AND METHODS

After institutional review board approval (#201812027), a retrospective chart review was conducted of patients undergoing horizontal strabismus surgery at a tertiary academic care center between October 2015 and March 2017. Surgical treatment was performed by one of three fellowship-trained pediatric ophthalmologists (SMC). Patients younger than 18 years with at least 11 months of follow-up (or reoperation before 11 months) were included. Exclusion criteria were prior intraocular, refractive, or strabismus surgery; paralytic or restrictive strabismus; significant neurological impairment; or other ocular pathology or malformation affecting vision that could not be corrected with glasses. The eligibility and exclusion criteria (Figure A, available in the online version of this article) were modeled on prior studies by the Pediatric Eye Disease Investigator Group. Because Medicaid eligibility is determined by a modified adjusted gross income, enrollment in Medicaid was used as a proxy for SES. Further granular data on SES were obtained from the 2007 American Community Survey and the Social Deprivation Index (SDI), which is a validated measure of

area deprivation based on a composite of poverty, education, single-parent household, rental housing, overcrowding levels, lack of transportation, and non-employment levels. SES and travel time data were obtained through ArcGIS Desktop (Environmental Systems Research Institute [ESRI]), a Geographic Information System.

Demographic and surgical parameters were recorded. For each preoperative and postoperative visit, visual acuity, presence and/or absence of amblyopia, stereopsis, fusion, and ocular alignment were recorded. Visual acuity was measured by Snellen or Allen charts, HOTV, or Induced Tropia Testing based on the age and ability of the patient. Amblyopia was defined as more than one line of difference in Snellen/Allen charts or asymmetry in Induced Tropia Testing. Ocular alignment was measured with the alternative cover test, Krimsky test, or Hirschberg test. For surgical failure criteria, we followed the convention of the Pediatric Eye Disease Investigator Group, defining failure as undercorrection with misalignment of more than 10 prism diopters (PD) at near or distance, overcorrection with misalignment of more than 6 PD at near or distance, or undergoing a reoperation for horizontal strabismus.<sup>10</sup> If a patient failed to initially meet the criteria but met the success criteria at their most recent follow-up visit within 24 months of operation, they were considered a success.

Based on power analysis and a 1:2 ratio of patients with Medicaid to patients with private insurance in our cohort, a minimum sample of 250 was calculated to provide a 6% difference in the incidence of suboptimal surgical outcomes between groups. Demographic and surgical variables were analyzed using two-sided  $z$  tests or  $t$  tests, whether categorical or ordinal. A chi-squared test with post-hoc Pearson residuals was performed to test the association between insurance status and suboptimal surgical outcome risk. A logistic regression analysis was performed to assess the impact of various variables on surgical failure rates. Statistical analysis was conducted using R software (RStudio, Inc).

## RESULTS

Of the 1,453 patients identified, 284 patients met the inclusion criteria: 98 patients received Medicaid (Medicaid group) and 186 patients had private insurance (private insurance group) (Figure 1). Similar proportions of patients with Medicaid and patients with private insurance were excluded (81% and 80%, respectively) (Table A, available in the online version of this article). Of the patients with Medicaid, 83% received their medical benefits through a managed care organization, similar to the 69% of Medicaid beneficiaries in managed care organizations nationally.<sup>11</sup> As shown in Table 1, patients in the private insurance group were more likely to be White (see also Table B, available in the online version of this article), but they did not differ in other relevant demographic and surgical parameters. The Medicaid and private insurance groups were similar with respect to preoperative horizontal deviation at distance (25.3 vs 25.4 for the Medicaid and private insurance groups, respectively,  $P = .94$ ) and at near (28.4 vs 27.2 for the Medicaid and private insurance groups, respectively,  $P = .36$ ). There was no difference in preoperative amblyopia (present in 37 and absent in 61 in the Medicaid group [37.8%] and present in 63 and absent in 123 in the private insurance group [33.9%],  $P = .51$ ) and alignment (esophoria/esotropia in 62 in the Medicaid group [63.3%] and 103 in the private insurance group [55.4%]; exophoria/ exotropia in 36 in the Medicaid group [36.7%] and 83 in the private insurance group [44.6%],  $P = .20$ ).

Failure rates were similar between groups at 24 months (45.9% [95% CI 36.1% to 55.8%] vs 50.5% [95% CI 43.4% to 57.7%] in the Medicaid and private insurance groups, respectively). Because a substantial portion of patients were excluded for less than 11 months of follow-up while still meeting all other eligibility requirements, a secondary analysis of follow-up appointments within 24 months of operation between groups was performed. As shown in Figure 1, patients with Medicaid were far more likely to have no follow-up appointments (28.2% [95% CI 22.1% to 34.3%] vs 9.6% [95% CI 6.1% to 13.1%] in the Medicaid and private insurance groups, respectively), although patients in the private insurance group were more likely to have more than three follow-up appointments (21.5% [95% CI 15.9% to 27.1%] vs 39.0% [95% CI 33.2% to 44.8%] in the Medicaid and private insurance groups, respectively). Patients in the Medicaid group were also more likely to never schedule a follow-up appointment (15.8% [95% CI 10.9% to 20.7%] vs 5.9% [95% CI 3.1% to 8.7%] in the Medicaid and private insurance groups, respectively).

Further SES analysis illustrated in Table 2 demonstrated that patients in the Medicaid group included for analysis were more likely to live in neighborhoods with lower median household incomes (median census tract household income: \$48,352 vs \$68,491,  $P < .01$ ; median block group household income: \$49,014 vs \$71,305,  $P < .01$ ; zip code median household income: \$47,653 vs \$61,192,  $P < .01$  in the Medicaid and private insurance groups, respectively) and higher measures of social deprivation (zip code SDI score: 52.5 vs 32.4,  $P < .01$ , in the Medicaid and private insurance groups, respectively). Patients in the Medicaid group excluded solely for having less than 1 year of follow-up did not differ in SES characteristics from patients with more than 1 year of follow-up (Table C, available in the online version of this article). As shown in Table 3, single-parent family scores were the only statistically significant predictor of surgical success among patients with more than 1 year of follow-up, but not to a clinically significant degree (odds ratio: 1.02,  $P = .04$ ). Among patients who met all eligibility criteria and patients excluded solely for less than 1 year of follow-up, postoperative attendance was linked to Medicaid status ( $P < .01$ ), but not to other factors such as travel time, social deprivation composite scores, neighborhood measures of income, poverty levels, and no car scores (Table D, available in the online version of this article).

## DISCUSSION

Strabismus is a common eye condition among children, prompting surgical correction to prevent the development of visual complications. Sufficient follow-up after an operation is a necessary component of long-term success because 20% to 40% of patients need additional treatment after strabismus surgery.<sup>4-6</sup> However, a significant percent of children in the United States are either enrolled in Medicaid or uninsured (39% and 5%, respectively, in 2017) and may face significant barriers to care and disparate outcomes.<sup>12</sup>

In this study, we compared the failure rate of strabismus surgery in children with private insurance and children who were socioeconomically challenged who received Medicaid. We found no statistically or clinically significant difference in failure rates by 24 months. Although patients with Medicaid were more likely to live in low SES neighborhoods, neither Medicaid status nor SES were predictors of surgical failure. Patients with Medicaid

were more likely to both never schedule a follow-up appointment and have zero follow-up appointments, whereas patients with private insurance were more likely to have more than three follow-up appointments. Medicaid status was predictive of the number of appointments scheduled and attended, whereas neighborhood socioeconomic variables and travel time were not.

Our results validate our use of Medicaid as a proxy for SES. Some patients may become eligible for Medicaid on the basis of disability, as opposed to family income. However, our selection criteria, which excluded patients with significant neurological impairment, would limit this potential confounder. The analysis of socioeconomic indicators for patients in the Medicaid group confirmed that the Medicaid group had a lower median income than patients in the private insurance group (Table 2).

Our failure rates are higher than those cited in the literature. This is most likely due to our stricter definition of failure examining outcomes for at least 1 year. For example, Dembinski et al<sup>9</sup> examined outcomes only up to 6 months and found an overall failure rate of 29%. The failure rate found by Kampanartsanyakorn et al<sup>4</sup> was 39.8% at 6 weeks postoperatively. In contrast, a study by Donahue et al<sup>10</sup> had similar failure criteria as the current study and yielded a failure rate of 46% at 3 years after bilateral lateral rectus recession. The failure rate in the current study may also be falsely inflated if those with successful surgeries were more likely to be lost to follow-up. This possibility is supported by a study in pediatric primary care where a perception of “excellent health” by families was associated with missed appointments.<sup>13</sup>

The current study highlights the significance of loss to postoperative follow-up among patients with Medicaid. Other studies in various specialties have shown similar rates of missed appointments.<sup>14–16</sup> Missed appointments were associated with younger patient age and follow-up after 30 days or more, both of which applied to our patient population.<sup>14–16</sup> Several studies have examined specific barriers to follow-up after failed pediatric vision screenings. Kimel<sup>17</sup> found the most common barriers to be work-scheduling conflicts, family issues, cost, appointment problems, and large family size. Transportation issues were only reported by 9% of families, although this finding may be particularly variable by geographic location. Kimel<sup>17</sup> and Williams et al<sup>18</sup> found lack of awareness of the need to follow up and issues with communication to be among the main barriers faced.

Other studies have examined reasons for lack of follow-up in primary care settings for underserved children and adults. Kaplan-Lewis and Percac-Lima,<sup>19</sup> Jhanjee et al,<sup>20</sup> and Samuels et al<sup>13</sup> found the most common reason for missing appointments to be forgetting. Kaplan-Lewis and Percac-Lima<sup>19</sup> found the second most common reason for missed appointments to be miscommunication (patients who believed they had cancelled the appointment, thought their appointment was a different date/time, had tried to call the clinic but did not get through, or did not recognize the need to call and cancel). Jhanjee et al<sup>20</sup> also found visit nonadherence to strongly correspond to parental employment, insurance type, parental depressive symptoms, and transportation availability. Another study evaluating follow-up of adult patients after emergency department discharge found no correlation

between travel distance, appointment time convenience, and emergency department visit satisfaction on likelihood to follow up.<sup>21</sup>

Patients in the Medicaid group may also have been disproportionately affected by inequities stemming from the effect of race on medical care, because this group had a larger proportion of Black patients. In addition to the barriers listed previously, racial and ethnic minority groups are more likely to have mistrust in the medical system, lower health literacy, and poorer communication quality with providers, which may also contribute to missed follow-up appointments.<sup>22–24</sup>

Although these potential barriers to follow-up are challenging to delineate, proposed interventions to address these barriers include SMS-based appointment reminders, assistance from a follow-up coordinator, transportation assistance, telemedicine, and interventions to improve patient–provider interactions in racial and ethnic minority groups. A meta-analysis has shown that text message reminders were effective in improving appointment attendance.<sup>25</sup> The success of these text message reminders has also been specifically demonstrated in a low-income and predominantly Black patient population.<sup>26</sup>

The literature also suggests that improved direct communication with families about the importance and logistics of follow-up via a follow-up coordinator may improve appointment attendance. A 9-year study of 147,809 children in Iowa found that the addition of a part-time follow-up coordinator increased the follow-up rate after abnormal photo screening results from 36.1% to 89.5%.<sup>27</sup>

Rideshare-based transportation assistance has been proposed as a more accessible alternative to the nonemergency medical transportation offered by Medicaid.<sup>28</sup> However, nonemergency medical transportation is limited by the need for advanced scheduling and long travel and wait times.<sup>28</sup> Both a prospective randomized controlled trial in Philadelphia<sup>28</sup> and a meta-analysis<sup>29</sup> did not find rideshare-based transportation to increase appointment adherence. However, this may be variable by geographic location, particularly because this trial found that fewer than half of the patients in their sample population were not interested in ridesharing.<sup>28,29</sup>

Although the adoption of the new workflow and technology for telemedicine is a challenge, telemedicine has also been proposed as a method to improve access to care and its adoption has been rapidly accelerated by the coronavirus 2019 pandemic.<sup>30,31</sup> Studies suggest that strabismus may be assessed with good reliability via telemedicine performed by a qualified assistant using digital technology. In prior decades, investigators found moderate agreement between telemedicine and in-person assessments of horizontal deviations and large manifest deviations, but less reliability for vertical and latent strabismus.<sup>32,33</sup> More recently with improved technology, these telemedicine examinations have been shown to have agreement with in-person examination horizontal and vertical definition including both tropias and phorias.<sup>34,35</sup> However, there is concern that implementing these new technologies may further perpetuate existing disparities.<sup>30</sup> Careful application of these technologies, such as offering store-and-forward or asynchronous recordings for patients with limited internet connectivity, is central to improving health care equity.<sup>30,36</sup>

We must also address the role of implicit bias and systemic racism, because racial disparities in health care have been shown to persist even after adjusting for other social determinants of health.<sup>37,38</sup> Research has shown that implicit racial bias (unconscious racial attitudes and stereotypes) is associated with decreased trust and satisfaction in patients from underrepresented racial and ethnic minority groups and therefore lower adherence, health care utilization, and health outcomes.<sup>39–43</sup> Increasing physician diversity is an important component of remedying this, because patient-physician race concordance is associated with improved trust, communication, patient ratings of care, and adherence.<sup>24,38,44,45</sup> This is particularly relevant within ophthalmology, where 6% to 7.7% of ophthalmologists are from underrepresented racial and ethnic minority groups, compared to the 11.2% of all practicing physicians and 33% of the general population of the United States.<sup>38,46</sup> Additionally, studies have proposed numerous ways in which all physicians can improve the trust and adherence of patients from underrepresented racial and ethnic minority groups, including values affirmation, culturally respectful, and personally tailored communication skills training, and exercises to enhance the sense of commonality between patient and physician.<sup>43,47,48</sup> Future directions may include qualitative assessments to understand which barriers affect our specific patient population and further studies to implement and evaluate the interventions discussed previously.

Limitations of our study include the retrospective nature of our study and unequal group distributions. Differences in the group distribution reflected our study site patient population. The choice of 11 months as the minimum follow-up for inclusion was based on clinical judgment as to the amount of follow-up required to provide relative confidence in a durable outcome. Based on the data collected, 62% of the patients who ended up meeting failure criteria did so by 11 months. This suggests that the 11-month threshold captures the majority, although not all, of the patients who end up meeting failure criteria by 24 months. Other issues include the inability to control for the degree of adherence to glasses or patching/atropine for amblyopia because these were inconsistently documented. The degree of control could not be accounted for because this is not captured in alignment measurements. Baseline visual acuity was not controlled for because the methods for measuring acuity were variable. However, both groups had similar baseline characteristics in terms of demographic, socioeconomic, and operative characteristics. Although a significant proportion of patients were lost to follow-up, those with sufficient follow-up were similar to those with insufficient follow-up in terms of neighborhood measures of median income, car access, and travel time. Although this study used neighborhood-level data as a proxy for the barriers to care faced by patients, it did not evaluate individualized income and car access data. Strengths include our large sample size, generalizability of results due to multiple surgeons performing the procedure, and 1 to 2 years of follow-up data.

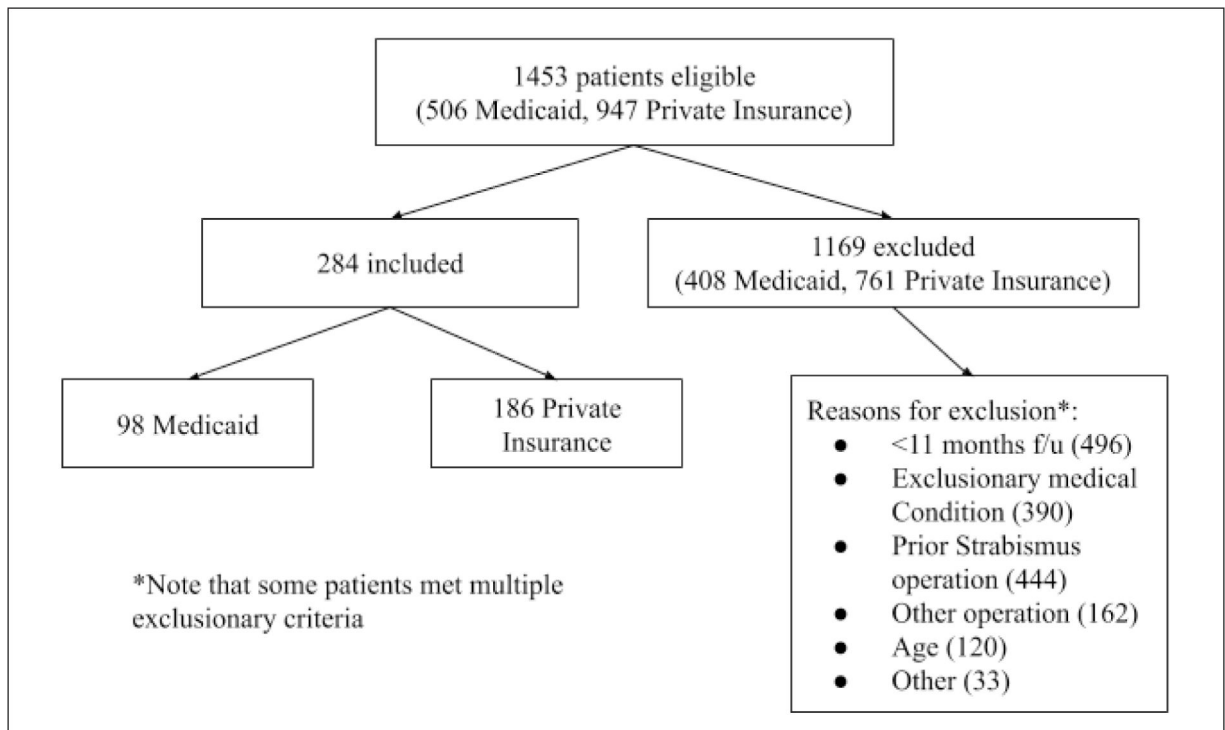
There are no differences in horizontal strabismus surgery outcomes between patients with Medicaid and patients with private insurance with at least 1 year of follow-up. Medicaid status strongly predicts follow-up visit scheduling and attendance, but travel distance and neighborhood-level SES do not.

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## Appendix

### Appendix



**Figure A.**  
Patient inclusion and exclusion by group.

**TABLE A**

Number of Patients Included/Excluded by Group

Characteristic	Medicaid		Private Insurance		Total
	No.	%	No.	%	
Included	98	19	186	20	284
Excluded	408	81	761	80	1,169
Total	506	–	947	–	1,453



**TABLE B**

Standardized Pearson Residuals for Race Analysis

Race	Medicaid (n = 98)	Private Insurance (n = 186)
White	-2.021326556	2.799641152
Black	0.804135989	-1.113769668
Unknown/not reported	0.136698838	-0.189334916

**TABLE C**

Socioeconomic Data for Medicaid Only Patients With and Without &gt; 1 Year of Follow-up

Characteristic	Medicaid (< 1 Year Follow-up)	Medicaid (> 1 Year Follow-up)	P
Census tract median household income	47,495	45,201	.42
Block group median household income	48,758	45,205	.33
Zip code median household income	47,656	46,215	.51
Zip code SDI Score	52.5	55.1	.46
FPL 100 Score	57.2	59.1	.61
Single-parent family score	54.9	56.3	.71
No car score	56.8	56.8	.99
Travel time (minutes)	86.9	92.2	.62

SDI = Social Deprivation Index; FPL = Federal Poverty Level

**TABLE D**

Univariate Predictors of Postoperative Appointment Attendance

Characteristic	P
Medicaid status	< .01
SDI score	.98
Zip code median household income	.14
Census tract median household income	.85
Block group median household income	.99
FPL 100 score	.33
Single-parent family score	.39
No car score	.96
Travel time	.44

SDI = Social Deprivation Index; FPL = Federal Poverty Level

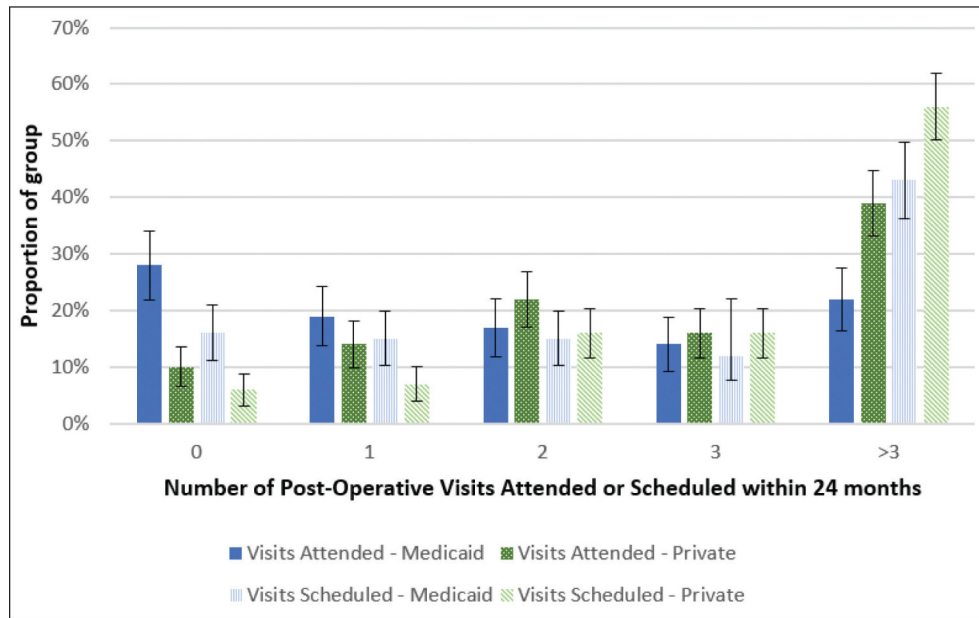
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**Figure 1.** Number of postoperative visits attended and scheduled by group among patients who met the eligibility criteria and those excluded solely for more than 11 months of follow-up.

TABLE 1

## Demographic and Operative Characteristics

Characteristic	Medicaid (n = 98)	Private Insurance (n = 186)	P
Male, n (%)	40 (41)	88 (47)	.53
Race			
White	67	164 <sup>a</sup>	
Black	22	12	
Hispanic	4	2	< .001
Asian	0	5	
Unknown/not reported	5	5	
Age at operation (mean ± SEM)	4.27 ± 0.30	4.30 ± 0.24	.94
Surgery type			
Lateral rectus recession	36	83	
Medial rectus recession	62	103	.20
Average preoperative horizontal deviation			
At distance (mean ± SEM)	25.3 ± 1.31	25.4 ± 0.73	.94
At near (mean ± SEM)	28.4 ± 1.16	27.2 ± 0.75	.36
Preoperative amblyopia			
Present	37	63	
Absent	61	123	.51
Preoperative alignment			
Esophoria/esotropia	62	103	
Exophoria/exotropia	36	83	.20
Failure rate at 24 months, n (%)	45 (45.9)	94 (50.5)	

SEM = standard error of the mean

<sup>a</sup>Significant outlier.

Note that some patients identified as multiple races, so the totals exceed 284.

TABLE 2

Socioeconomic Data for Patients With &gt; 11 Months of Follow-up

Characteristic	Medicaid	Private Insurance	P
Census tract median household income	\$48,352	\$68,491	<.01
Block group median household income	\$49,014	\$71,305	<.01
Zip code median household income	\$47,653	\$61,192	<.01
Zip code SDI score	52.5	32.4	<.01
FPL 100 score	57.2	36.2	<.01
Single-parent family score	54.9	39.1	<.01
No car score	56.8	42.7	<.01
Travel time (minutes)	86.9	61.5	<.01

SDI = Social Deprivation Index; FPL = Federal Poverty Level

**TABLE 3**

Univariate Predictors of Surgical Success

Characteristic	Odds Ratio	95% CI	P
Medicaid status	1.22	0.71 to 2.12	.89
SDI score	0.95	0.90 to 1.01	.06
Zip code median household income	1	0.90 to 1.00	.19
Census tract median household income	1	1.00 to 1.00	.16
Block group median household income	1	1.00 to 1.00	.45
FPL 100 score	1.01	0.98 to 1.04	.58
Single-parent family score	1.02	1.00 to 1.05	.04
No car score	1.02	1.00 to 1.03	.06
Travel time	1	1.00 to 1.01	.41

SDI = Social Deprivation Index; FPL = Federal Poverty Level