

## An Analysis of School Survey on the Prevalence Strabismus and its Association with Amblyopia and Refractive Errors

Kanchana Lakshmi Devi<sup>1</sup>, Ganti Snehitha<sup>2</sup>, Yasam Raghavendra Reddy<sup>3</sup>, Vankadara Nagasuresh<sup>4</sup>, K. Bharani Kumar Reddy<sup>5</sup>

<sup>1</sup>Post Graduate Student in Ophthalmology, Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

<sup>1</sup>Post Graduate Student in Ophthalmology, Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

<sup>3</sup>Assistant Professor of Ophthalmology, Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

<sup>4</sup>Professor and HOD of Ophthalmology, Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

<sup>5</sup>Professor of Ophthalmology, Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

---

Received: 25-06-2023 / Revised: 28-07-2023 / Accepted: 30-08-2023

Corresponding author: Dr. Vankadara Nagasuresh

Conflict of interest: Nil

---

### Abstract:

**Background:** Among the different causes producing Amblyopia in children, untreated strabismus was found to be the commonest. Children with Amblyopia fail to develop binocular vision and learning skills thereof. Such children are a risk factor to develop psychosocial difficulties later in their life.

**Aim of the study:** To conduct a clinical study to know the prevalence of strabismus in the school children; to know the types of strabismus.

**Materials: Design:** The study was a cross sectional one undertaken to determine the prevalence of strabismus among primary school children in the villages around the Viswabharathi Medical College and Hospital during November 2021 to January 2023.

**Methods:** Visual acuity, auto refraction, Hirschberg's test and cover tests were used using a pen light torch to survey 286 children were performed for 584 out of 841 students (age range 5.5–7 years). Children with all types of strabismus or those who had a history of strabismus surgery were subjected to a full ophthalmic examination including slit lamp, extra ocular muscles examination, Worth 4 dots test, and fundus examination.

**Results:** Students with strabismus with Amblyopia were 05, children with newly diagnosed refractive errors were 27 and with already diagnosed and treated refractive errors were 06 in the study. The prevalence of strabismus with Amblyopia was 1.74%. Among them children with astigmatism were 10/38 (26.31%), myopia in 09/38 (23.68%), and hypermetropia in 08/38 (21.05%) children.

**Conclusions:** Prevalence of Strabismus was evident and regular school health surveys help us to identify early visual disturbances in children. Strabismus is definitely associated with Amblyopia and refractive errors in children. Early detection and prompt treatment with appropriate lenses would assist the children developing learning skills.

**Keywords:** Strabismus, Educational skills, Amblyopia, visual axis and vision impairment.

---

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

---

### Introduction

It was observed that children have vision problems at the time of starting their schooling and failure to detect Amblyopia even in sub optimal grades leads to decreased school performance, lack of interest in learning skills and subsequently leading to school dropouts. Failure to develop educational skills may further lead to behavioural problems, e.g. learning disabilities, impaired reading performance and attention deficit disorder. [1] Since 1987 WHO has

included uncorrected refractive errors as the leading causes of Amblyopia, and vision impairment. [1] Control of refractive errors was introduced as a pilot project to prevent avoidable Blindness in their VISION 2020 programme all over the World. [2] This programme was treated on priority in India initiating large scales of school health visits. [3] This was achieved by conducting simple vision tests to school children. Providing spectacles after the simple visual acuity (VA) tests,

to those children who have significant refractive errors causing Amblyopia was considered. [4] By definition Strabismus was defined as a misalignment of visual axis of one eye to the other eye. [5] Such a misalignment causes results in inability of the two eyes to focus on the same image and loss of binocular vision. [5] The prevalence of Strabismus was 02% to 05% of the population. Strabismus indirectly causes Amblyopia and remains undetected in time to start effective and efficient treatment in school children [6, 7] Manifest strabismus resulted in Amblyopia and accounts for nearly 40% of the children. [7] Binocular single vision fails to develop in children with manifest strabismus. [8] Such children in their later life could land in psychosocial problems and snatches away their opportunity to be employed in certain occupations. [9] Another cause of such situation is lack of awareness among the General populations and families especially in India. [10] Poverty and illiteracy also played a major role in desisting populations from taking the medical aid of visual acuity testing. [11] In some traditions parents themselves avoid allowing their children especially female children to wear spectacles to rectify refractive errors. [12] In the present study school health surveys were conducted to examine the school children of all ages to assess the vision using standard visual acuity tests and the data was analysed.

**Type of Study:** A cross sectional study

**Institute of Study:** Viswabharathi Medical College, Penchikalapadu, Kurnool, Andhra Pradesh

**Duration of Study:** November 2021 to January 2023

**Materials:** 286 school children were surveyed in this study during school visits in the villages in the neighborhood of the Medical College. All the students were tested for acuity of vision. An institution ethics committee was approached for the certification and the ethics committee approved proforma was used.

#### Inclusion Criteria

Children aged between 03 years to 12 years were included. Children with visual refractive errors were included. Children of both the genders were included.

#### Exclusion Criteria

Children aged below 03 years and above 12 years were excluded. Children already using spectacles were excluded. Children with congenital abnormalities of the eyes were excluded. All the

children were subjected to Ophthalmic examination to include 1) Testing uncorrected monocular distance visual acuity using Landolt C chart. 2) Testing corrected visual acuity (students with glasses). 3) Non cycloplegic auto refraction by auto refractometer. 4) Rough estimation of a deviation by Hirschberg's test and cover test using a torch pen light. 5) A cycloplegic autorefraction in children with defective vision ( $VA < 6/9$ ), children with squinting eyes and uncooperative children, after instillation of cyclopentolate 1% eye drops for at least 2 hours.

Children with any type of strabismus or previous history of strabismus surgery were further examined by using: 1. Thorough history taking from the parents by using an approved questionnaire to obtain the following data; age, sex, developmental history, history of spectacle correction, occlusion or penalization therapy, history of previous ocular surgery or trauma and family history. 2. Anterior segment examination using slit lamp. 3. Ocular alignment examination by Hirschberg's test and cover test. 4. Extra ocular muscles examination including eye movements and signs of previous ocular surgery or trauma. 5. Testing of UCVA and BCVA. 6. Worth four dots examination for binocular vision. 7. Fundus examination using direct ophthalmoscope. 8. Awareness of parents about the diseases and how to deal with them. Institution Ethics committee was obtained after deliberations. An approved proforma and consent letter were used to collect the data. All the schools visited during the survey were planned with the local authorities beforehand. Informed consent was taken from the parents of all participant children.

#### Results

In the present study three schools were visited and 286 children were screened for features of strabismus. School 1 had 166 students but only 97 children (58.43%) could be examined. In school 2 the number of students enrolled were 149 but only 88 (59.06%) children were examined. In school 3 the total students were 147 and 101 (68.70%) children were examined.

The students who could not be examined were due to due to fear, denial of permission from parents and absentism among the students. The students who could not be examined were ranging from 31.29% to 41.56%. There was no significant statistical difference in the prevalence of absentism among the students ( $p$  value more than 0.05), (Table 1).

**Table 1: Showing the percentage of students examined and not examined in the study (n-286)**

Schools	Total number of children	The students who could be examined	The students who couldn't be examined	P value
1	166	097 (58.43%)	69 (41.56%)	0.191
2	149	088 (59.06%)	61 (40.93%)	0.224
3	147	101 (68.70%)	46 (31.29%)	0.118
<b>Total</b>	462	286 (61.90%)	176(38.09%)	0.228

Amblyopia with strabismus was noted in 05/286 children in the study. There were 02 (0.69%) male and 03 (01.74%) female children; 05/286 (01.74%). (Table 2) There was no significant statistical difference in the prevalence of Amblyopia and strabismus among the children surveyed (p value more than 0.05)

**Table 2: Showing the incidence of male and female children with strabismus (n-286)**

Schools	Male	Female	P value
1	01	01	0.110
2	01	00	0.147
3	00	02	0.159
<b>Total- 05</b>	02	03	--

Among the five children with Strabismus leading to Amblyopia four were found to have Esotropia (two females and two males (10.52%)).

One child was found to have Exotropia (02.63%) The total prevalence out of 286 was calculated as 1.74%. Among them one male child had left anisometropic esotropia  $\pm 30^\circ$  Amblyopia due to left moderate macular dysfunction according to ERG. Uncorrected visual Acuity (UCVA) was

6/36. After correction it was 6/6 by (-2.25, -2.25/15°) in OD. In OS, UCVA was less than  $\pm 1.00$  D with a percentage of 86.6 % correction. 05 children with strabismus had Amblyopia in this study (100%).

The Esotropia and Exotropia ratio was 4:1 (Table 3). There was no significant statistical difference in the prevalence of Strabismus among the students (p value more than 0.05)

**Table 3: Showing the types of strabismus noted in the study (n-286)**

Types of Strabismus	Male-02	Female- 03	P value
Esotropia	01	02	0.151
Exotropia	00	01	0.163
anisometropic Esotropia	01	00	0.174

Out of 286 children surveyed for strabismus abnormalities, 38/286 (13.28%) were found to have them. Among these 38, 05/38 children (13.15%) were diagnosed with strabismus leading to Amblyopia and the remaining 33/286 (11.53%) were found to have strabismus with refractive errors. Among the 38 children 22/38 (57.89%) were male children and 16/38 (42.10%) were

female children with a male to female ratio of 1.37:1. The mean age was  $09.85 \pm 2.14$  years.

The youngest child was aged 05.5 years and the eldest child was 11.3 years (Table 4-a).

There was no significant statistical difference in the prevalence of ophthalmic abnormalities among the genders of the students (p value more than 0.05)

**Table 4-a: Showing the incidence of Amblyopia and refractive errors diagnosed newly in the study (n-38)**

Schools	Male	Female	P value
1	07 (18.42%)	05 (13.15%)	0.310
2	09 (23.68%)	07 (18.42%)	0.647
3	06 (15.78%)	04 (10.52%)	0.069
<b>Total- 05</b>	22 (57.89%)	16 (42.10%)	--

The newly diagnosed refractive errors identified among the strabismus affected children was 27/33 (81.81%) children. Among them children with astigmatism were 10/38 (26.31%), myopia in 09/38 (23.68%), and hypermetropia in 08/38 (21.05%) children. (Table 4-b) There was no significant statistical difference in the prevalence of newly diagnosed refractive errors and their genders among the children surveyed (p value more than 0.05)

**Table 4-b: Showing the types refractive errors diagnosed newly in the study (n-27)**

Refractive errors	Male	Female	P value
Astigmatism	06(22.22%)	04 (14.81%)	0.210
Myopia	05 (18.51%)	04 (14.81%)	0.617
Hypermetropia	05 (18.51%)	03 (11.11%)	0.199
<b>Total- 05</b>	16 (59.25%)	11 (40.74%)	--

In the present study the remaining 06/38 (15.78%) children were already diagnosed and using remedial measures. They were Ametropic and the spectacles were prescribed to them before and they using glasses before school registered in the school. (Table 5) There was no significant statistical difference in the prevalence of already diagnosed refractive errors among the students and their genders (p value more than 0.05)

**Table 5: Showing the gender ratio of children already diagnosed and using spectacles (n-13)**

Refractive errors	Male	Female	P value
Ametropic	03 (50%)	03 (50%)	0.210

## Discussion

Most of the population-based studies reported prevalence of strabismus based on the age and ethnicity of the country or region. Prevalence of Strabismus in children was reported to be 0.8% in Singapore and 5.65% in China. [13] In the present study the prevalence was calculated as 1.04%. This is higher than the previous studies conducted in South Korea, China, USA, and UK [14, 15 and 16] which reported from 0.34% to 1.24%. But it was same as in Japan i.e., 1.74% (19). But as this study only evaluated the clinically significant prevalence of horizontal strabismus, the results of this study cannot be compared directly with those of other studies that evaluated only manifest strabismus. But the Avon Longitudinal Study of Parents and Children (ALSPAC) considered in their study the prevalence of latent strabismus and reported the prevalence of clinically significant divergence (manifest or latent with  $\geq 15$  PD) was 0.6% (95% CI; 0.5–0.8) and clinically significant convergence (manifest or latent with  $\geq 10$  PD) was 2.8% (95% CI; 2.5–3.3) in UK children. [6]

In this study the Esotropia and Exotropia ratio was 4:1 (Table 3). But the exodeviation: esodeviation ratio was 6.4:1 in the study by Han KE, Baek SH et al (20), which was similar to few other studies in Asian populations (ratio range: 2.5:1 to 51.0:1). [5, 6, 7, 8] This may correlate with lower hyperopia prevalence in Korea compared with other Asian populations. In contrast, Caucasian populations who have a higher prevalence of hyperopia showed a similar or inverse exodeviation: esodeviation ratio. Many potential risk factors are described that influenced strabismus, but Amblyopia was the only risk factor that could cause both types of strabismus. It was also reported in the literature that Amblyopia was 6.45 times more likely to cause Exotropia and 4.70 times more common to cause Esotropia. [21]

There was no significant statistical difference in the prevalence of Strabismus among the students ( $p$  value more than 0.05) In a Singaporean school survey to assess the prevalence of Strabismus children, it was observed that the children had 12.85 fold increased chances of developing Amblyopia. [22] Similarly the Sydney Myopia study (SMS) also found children with any type of strabismus is likely to develop Amblyopia than children without strabismus. ( $p$  value less than 0.001), [11] 05 children with strabismus had Amblyopia in this study (100%). (Table 3) Out of 38/286 (13.28%) children with strabismus abnormalities identified in these study 05/38 children (1.74%) were diagnosed with strabismus leading to Amblyopia.

The remaining 33/286 (11.53%) were found to have strabismus with refractive errors. There is an established link between strabismus and refractive

errors as per the review of literature [23] Incidence of Hyperopia and esotropia have been firmly established, especially in children who have significant hyperopia ( $\geq +3.00$  D), [24 and 25] In this study children with astigmatism were 10/38 (26.31%), myopia in 09/38 (23.68%), and hypermetropia in 08/38 (21.05%) children. (Table 4-b) Both astigmatism and myopia contributed to 19/38 (50%) of the children with strabismus developing refractive errors in this study. Myopia and Exotropia were found to be more common in Asian countries [26] but the strabismus, amblyopia, and refractive error in young Singaporean Children (STARS) study found that there was no correlation between strabismus and refractive errors encountered in these children. [26] Whereas the SMS confirmed that all types of refractive errors, including myopia, significant hyperopia ( $\geq +3.00$ D), astigmatism, and anisometropia, were more common in children with strabismus. [11]

Further research is needed to clarify the relationship between exodeviation, Esodeviation and refractive errors. Astigmatism more than 1.0 D was found to be associated with a 1.84-fold increased risk for clinically significant exodeviation by Han K.E et al [20] the well-known STARS study though reported astigmatism more than 1.0 D increased the risk of strabismus, but the direction of strabismus was not mentioned. [26]

This study has certain limitations. Refractive errors were not evaluated under cycloplegic conditions. However, this study results should be interpreted with a caution considering the non-cycloplegic nature of refraction measurements.

## Conclusions

Prevalence of Strabismus was evident and regular school health surveys help us to identify early visual disturbances in children. Strabismus is definitely associated with Amblyopia and refractive errors in children. Early detection and prompt treatment with appropriate lenses would assist the children developing learning skills.

## References

1. Dale E, Fajardo B, Wilson IS. Pediatric Ophthalmology and Strabismus. American Academy of Ophthalmology. 2018:86–123.
2. Benjamin WJ. Working together to grow libraries in developing countries. *Cardiovasc Imaging*. 2007; 27:11–13, 11f, 537:992–1001.
3. Sharimawat S. Associated Risk Factors Of Strabismus: The Sydney Childhood Eye Study. 2015:2–291.
4. Donnelly UM. Horizontal strabismus worldwide what are the risk factors. *Ophthalmic Epidemiol*. 2012; 19(3): 117–119.
5. Chen X, Fu Z, Yu J, Ding H, Bai J, Chen J, et al. Prevalence of amblyopia and strabismus in Eastern China: results from screening of preschool children aged 36–72 months. The

- British journal of ophthalmology. 2015. Epub 2015/08/12.
6. Williams C, Northstone K, Howard M, Harvey I, Harrad RA, Sparrow JM. Prevalence and risk factors for common vision problems in children: data from the ALSPAC study. *The British journal of ophthalmology*. 2008; 92(7):959–64.
  7. Chia A, Dirani M, Chan YH, Gazzard G, Au Eong KG, Selvaraj P, et al. Prevalence of amblyopia and strabismus in young Singaporean Chinese children. *Investigative ophthalmology & visual science*. 2010; 51(7): 3411–7.
  8. McKean-Cowdin R, Cotter SA, Tarczy-Hornoch K, Wen G, Kim J, Borchert M, et al. Prevalence of amblyopia or strabismus in asian and non-Hispanic white preschool children: multi-ethnic pediatric eye disease study. *Ophthalmology*. 2013; 120(10):2117–24.
  9. Fu J, Li SM, Liu LR, Li JL, Li SY, Zhu BD, et al. Prevalence of amblyopia and strabismus in a population of 7th-grade junior high school students in Central China: the Anyang Childhood Eye Study (ACES). *Ophthalmic Epidemiol*. 2014; 21(3):197–203.
  10. Robaei D, Rose K A, Kifley A, et al. Factors associated with childhood strabismus: findings from a population-based study. *Ophthalmology*. 2006; 113: 1146 –1153.
  11. Pediatric Eye Disease Investigator Group. A comparison of atropine and patching treatments for moderate amblyopia by patient age, cause of amblyopia, depth of amblyopia, and other factors. *Ophthalmology*. 2003; 110(8):1632–7.
  12. Jost RM, Yanni SE, Beauchamp CL, et al. Beyond screening for risk factors objective detection of strabismus and amblyopia. *JAMA Ophthalmol*. 2014; 132(7):814–20.
  13. Lekskul A, Supakit Vilekarn T, Padungki atsagul T. Outcomes of under correction in surgical management and binocular vision gained of adult intermittent exotropia. *Clin Ophthalmol*. 2018; 12:1763–7.
  14. Williams C, Northstone K, Howard M, Harvey I, Harrad RA, Sparrow JM. Prevalence and risk factors for common vision problems in children: data from the ALSPAC study. *The British journal of ophthalmology*. 2008; 92(7):959–64.
  15. Giorgis AT, Bejiga A. Prevalence of strabismus among pre-school children community in Butajira Town. *Ethiop J Health Dev*. 2001; 15(2).
  16. Agaje BG, Delelegne D, Abera E, et al. Strabismus prevalence and associated factors among pediatric patients in southern Ethiopia: a cross-sectional study. *J Int Med Res*. 2020; 48(10):030006052096433.
  17. Cotter SA, Varma R, Tarczy-Hornoch K, et al. Risk factors associated with childhood strabismus: the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology*. 2011; 118(11):2251–2261.
  18. Matsuo T, Matsuo C. The prevalence of strabismus and amblyopia in Japanese elementary school children. *Ophthalmic Epidemiol*. 2005; 12(1):31–6.
  19. Han KE, Baek SH, Kim SH, Lim KH; Epidemiologic Survey Committee of the Korean Ophthalmological Society. Prevalence and risk factors of strabismus in children and adolescents in South Korea: Korea National Health and Nutrition Examination Survey, 2008-2011. *PLoS One*. 2018 Feb 14; 13(2):e0191857.
  20. Satterfield D, Keltner JL, Morrison TL. Psychosocial aspects of strabismus study. *Archives of ophthalmology (Chicago, Ill: 1960)*. 1993; 111(8):1100–5. Epub 1993/08/01.
  21. Chia A, Lin X, Dirani M, Gazzard G, Ramamurthy D, Quah BL, et al. Risk factors for strabismus and amblyopia in young Singapore Chinese children. *Ophthalmic Epidemiol*. 2013; 20(3):138–47.
  22. Robaei D, Rose KA, Ojaimi E, Kifley A, Martin FJ, Mitchell P. Causes and associations of amblyopia in a population-based sample of 6-year-old Australian children. *Archives of ophthalmology (Chicago, Ill: 1960)*. 2006; 124(6):878–84.
  23. Abrahamson M, Magnusson G, Sjostrand J. Inheritance of strabismus and the gain of using heredity to determine populations at risk of developing strabismus. *Acta ophthalmologica Scandinavica*. 1999; 77(6): 653–7.
  24. Cotter SA, Varma R, Tarczy-Hornoch K, McKean-Cowdin R, Lin J, Wen G, et al. Risk factors associated with childhood strabismus: the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology*. 2011; 118(11):2251–61.
  25. sakuma T, Yasuda M, Ninomiya T, Noda Y, Arakawa S, Hashimoto S, et al. Prevalence and risk factors for myopic retinopathy in a Japanese population: the Hisayama Study. *Ophthalmology*. 2012; 119(9):1760–5.
  26. Dirani M, Chan YH, Gazzard G, Hornbeak DM, Leo SW, Selvaraj P, et al. Prevalence of refractive error in Singaporean Chinese children: the strabismus, amblyopia, and refractive error in young Singaporean Children (STARS) study. *Investigative ophthalmology & visual science*. 2010; 51(3):1348–55.