European Journal of Clinical Pharmacy

Print ISSN: 2385-409X **Online ISSN**: 3105-0409

Website: https://farmclin.com/

Original Research Article

A Comparative Study of Binocular Vision Anomalies in Preterm vs Full-Term Children Aged 3-8 Years

Article History:

Received: 21-11-2025
Revised: 27-11-2025
Accepted: 11-12-2025
Published: 29-12-2025

Name of Author:
Optom Pradeep[1], Jaiprabhat Ranjan[2]

Affiliation: *[1]M. Optometry Student, Department of Optometry, School of Healthcare & Allied Sciences, GD Goenka University, Gurgaon, Haryana.*
[2]Assistant Professor, Department of Optometry, School of Healthcare & Allied Sciences, GD Goenka University, Gurgaon, Haryana.

Corresponding Author:
Optom Pradeep

Abstract: ***Purpose***: The goal of this study is to see how common and what types of binocular vision anomalies are found in children aged 3 to 8 years and to compare these between preterm and full-term births. Binocular vision is important for judging distance, coordinating movements, and doing well in school. It is known that preterm birth can cause visual and brain problems, but there is not much research on its impact on binocular vision in early childhood. ***Methods:*** The goal of this study is to see how common and what types of binocular vision anomalies are found in children aged 3 to 8 years and to compare these between preterm and full-term births. Binocular vision is important for judging distance, coordinating movements and doing well in school. It is known that preterm birth can cause visual and brain problems, but there is not much research on its impact on binocular vision in early childhood. ***Results:*** Preterm children had a much higher chance of having binocular vision issues: convergence insufficiency (36.7% vs. 13.3%), accommodative insufficiency (30.0% vs. 10.0%), strabismus (25.0% vs. 6.7%) and reduced stereopsis (33.3% vs. 11.7%) when compared to full-term children ($p < 0.01$). The preterm group had a much higher rate of having more than one anomaly (41.7% compared to 11.7%). Preterm children were found to have a 3–5 times greater chance of these conditions. ***Conclusion***s: Children who are born early are more likely to have binocular vision problems which can happen together and influence their learning and movement. It is very important to perform early and thorough vision screening that checks convergence, accommodation, and stereopsis in this group. Specialized treatments like vision therapy can help children achieve better results and fair development.

Keywords: Binocular vision, preterm birth, convergence insufficiency, accommodative insufficiency, strabismus, stereopsis, early childhood vision screening.

INTRODUCTION

Binocular vision is a skill that allows us to see depth and single images by using both eyes together. It includes the use of motor and sensory functions to help the eyes focus together, see the same image and have depth perception [1]. Having good eyesight is necessary for reading, writing, playing sports and coordinating our hands and eyes. Binocular vision starts to develop soon after birth and keeps improving until it is fully mature by the time a child is 7 or 8 years old [2]. Any problem in the development of binocular vision may cause issues such as strabismus, amblyopia, convergence insufficiency and accommodative dysfunctions. Such conditions may cause children to perform poorly in school, feel less confident and have problems with their motor skills [3]. The World Health Organization defines premature birth as before 37 weeks of gestation and it is now known to be a major cause of visual and neurological problems. Thanks to progress in neonatal care, more preterm infants survive, but they are still at risk of various developmental issues, including eye problems. Some visual problems in preterm infants are caused by incomplete blood vessel growth in the retina, retinopathy of prematurity (ROP), periventricular leukomalacia and other brain injuries that happen during important stages of visual development [4]. For this reason, children born early may have a higher risk of binocular vision disorders than children born at term. A number of studies have shown that preterm birth is linked to later problems with vision such as reduced visual acuity, less contrast sensitivity, refractive errors and binocular

vision issues [5]. Among children born early, strabismus is more common, with a rate of 15%–20%, while it is found in only 2%–4% of full-term infants [6]. It has also been found that preterm children may struggle with fusion, stereopsis and accommodative responses which can lead to problems with their learning and movement in early childhood [7,8]. Although many studies point out the visual effects of being born prematurely, there is still a shortage of detailed studies comparing binocular vision in preterm children during their early years. Between the ages of 3 and 8, the brain is especially flexible and can benefit a lot from early detection and treatment of binocular vision problems [9]. This age group is significant because it includes preschool and early primary school, when kids are required to do tasks that depend on their near vision and good eye coordination. In addition, many pediatric and ophthalmologic exams do not pay enough attention to binocular vision disorders. Many children with binocular vision anomalies are not diagnosed because their symptoms are not obvious or because the signs are not easy to spot [10]. This is especially the case for preterm babies, as their follow-up may only involve checking the structure of the retina and looking for major problems such as ROP, not detailed testing of their vision. Therefore, understanding the differences in binocular vision between preterm and full-term children could assist in improving screening, guiding doctors and influencing policies for children's vision. Studies have pointed out that unnoticed vision issues can negatively affect a student's school performance [11]. In addition, research indicates that vision therapy can be helpful in treating binocular dysfunctions when given to children at an early age [6,12]. But, there is not much research comparing the types and rates of these anomalies in preterm and full-term babies, mainly in low-resource or community-based settings. Therefore, the present study will compare binocular vision anomalies in children between 3 and 8 years, grouped by whether they were born preterm or full-term. The purpose is to measure how many binocular vision disorders there are in each group and to look for any significant differences that could guide actions in healthcare and public health. The study aims to help detect and treat binocular vision problems early, especially among preterm children. It also aims to highlight the need for vision screening that includes tests of how the eyes function in pediatric healthcare. All in all, although prematurity is known to increase the risk of developmental problems, its effects on binocular vision in early childhood have not been thoroughly studied in comparison with other groups. Our goal is to use research to fill that gap and offer evidence that can guide early intervention, helping children achieve their best in vision, learning and movement.

LITERATURE REVIEW

The process of developing binocular vision is well-organized and starts when a child is an infant and continues into early childhood. It relies on the connection of sensory and motor pathways to help the eyes work together and see in three dimensions [1,3]. For it to progress well, a baby needs its brain to develop, its body to grow properly and interaction with the environment. If this process is interrupted, it can lead to strabismus, convergence insufficiency and accommodative dysfunction, all of which are common in children [3,5].

Many studies have looked at how binocular vision affects both visual-motor coordination and academic performance. Niechwiej-Szwedo et al. [1] pointed out that binocular vision plays a key role in controlling children's upper limb movements and spatial awareness. This is especially important in classrooms, since students regularly need to do fine motor activities and watch moving objects. Chaturvedi et al. [6] also found that binocular vision therapy can greatly help patients with amblyopia and similar conditions.

It is well known that being born early increases the chances of abnormal or delayed vision. Structural and functional changes in the visual pathway are common in preterm infants such as retinopathy of prematurity (ROP), underdevelopment of the retina and problems with cortical processing [4,11]. Ingvaldsen et al. [11] found that children born extremely preterm have lasting changes in their retinas and visual system which may increase their risk of binocular dysfunctions.

Studies have found that preterm babies are more likely to have binocular vision problems. Mukhtar et al. [7] compared children with dyslexia and found that preterm subjects had a much higher rate of convergence and accommodative anomalies. In a similar way, Liu et al. [8] studied the link between preterm birth and developmental coordination disorder (DCD) which is similar to the visual-motor integration problems seen in binocular vision disorders.

Researchers use studies of full-term children to establish a baseline. Hossain et al. [12] examined binocular vision in school-aged children and found that while some anomalies are still present in full-term children, they are less severe and happen less often than in preterm children. Harrington et al. [9,13] pointed out that undiagnosed vision issues can affect a child's academic performance, making it important to identify and treat these problems early, no matter when the child was born.

The Convergence Insufficiency Symptom Survey (CISS) has been used in different languages and populations, making the diagnosis more consistent. Boccardo et al. [5] showed that the Italian version of

the CISS is reliable and should be used together with objective clinical tests, as subjective symptoms are important too.

In addition, although studies such as Flitcroft et al. [2] mainly look at high myopia in children, they point out a wider issue in managing eye health early on. These results highlight the importance of checking binocular function during eye exams, mainly for children who were born prematurely.

The development of binocular vision starts at early infancy and is influenced by both biological timing and environmental stimulus. Maurer et al. [16] showed that cortical responses to stereoscopic stimuli in preterm infants start earlier after birth, but that developmental milestones are the same as those in full-term infants when corrected by gestational age, indicating that binocular development is not only a matter of exposure to the environment, but may be driven by a neurobiological clock. Ricci et al. [17] discovered that when the binocular milestones such as convergence and fusion are determined using the postnatal age, the preterm infants were seen to be delayed but when they were corrected by postmenstrual age, the delays were no more. This highlights the importance of applying gestational corrections to the early binocular development. Binocular developmental status is also reflected on optic disc morphology. Yin et al. [18] found that the signs of immature disc, including the double-ring signs, were more common in neonates born at less than 34 weeks, which means that the preterm delivery impairs the development of retina and optic nerve needed to coordinate the binocular functioning. Al-Khathlan et al. [19] conducted a study in children aged 610 years and found that preterm children had a higher visual acuity deficit, anisometropia, and amblyopia than full-term children, even without strabismus. This implies that there is still a hidden binocular dysfunction among preterm children even though they seem to be clinically in line. Almgren et al. [20] studied the group of low-birthweight adolescents and stated that saccades and accommodation were relatively well preserved, but convergence, stereopsis, and tracking were impaired. Such long-term effects suggest that the early binocular dysfunction might not be age-correctable and that it might have an influence on academic and motor development. Holmstrm et al. [21] followed infants of extremely low birth weight (<1000g) and identified high rates of strabismus, refractive errors and cortical visual impairment at school age, irrespective of ROP history. The results suggest that neurologically mediated binocular deficits are associated with prematurity itself. Binocular functioning is greatly affected by refractive errors. Verma et al. [22], reported that preterm infants were more likely to develop myopia (16%) and hyperopia (20%) at one year age and this was associated with birth weight and gestational age. The same was found by Holmstrm et al. [23], who noted astigmatism in 26 percent and myopia in 10 percent of preterm children at 30 months. O Connor et al. [24] pointed out that children born preterm had elevated incidences of strabismus, refractive error and poor binocular vision at age 10-12 despite not having ROP. These findings were supported by Al-Haddad et al. [25], which indicated that preterm birth was a sole factor that elevated the risk of binocular dysfunction. Exotropia in preterm children has increased chances of recurrence or over correction when corrected surgically. Yang et al. [26] discovered that despite the similar rates of surgical success to full-term children, the neurodevelopmental background of preterms affected worse binocular recovery and stereoacuity. The review of diagnostic inconsistencies in CI by Miguel et al. [27] revealed that there are inconsistent standards in the studies, such as cutoff values of near point of convergence and fusional ranges. They stressed age-related, objective criteria of CI diagnosis in children populations, particularly in high-risk groups such as preterms.

Although there is a lot of evidence, there is still a lack of studies that directly compare binocular vision anomalies in preterm and full-term children between the ages of 3 and 8. Most studies in the past have looked at older children or at single conditions such as amblyopia or strabismus, but not at the full range of binocular function. In addition, a lot of studies do not divide participants by gestational age or adjust for variables such as socioeconomic status, refractive error or neurological problems.

Because binocular vision is vital for development in school and relationships and preterm children are more likely to have visual problems, we must conduct more research on this topic. The purpose of this study is to fill this gap by examining and comparing the frequency and types of binocular vision anomalies in preterm and full-term children aged 3–8 years using a wide range of clinical and functional tests.

MATERIALS & METHODS

Study Design

The purpose of this study was to observe and compare binocular vision anomalies in children born preterm with those born full term. The main goal was to study how often binocular vision dysfunctions occur in children between 3 and 8 years, since this is a key period for developing vision, movement and learning skills.

Participant Recruitment and Study Population

Those participating in the study were selected by purposive sampling from pediatric optometry and ophthalmology departments at tertiary care hospitals

and school vision screening programs in Delhi, India. The recruitment process lasted for six months. Participants were chosen by considering their pregnancy history and their ability to cooperate during the eye tests.

Participants were divided into two comparison groups based on gestational age:

- The preterm group consisted of children born before 37 completed weeks of gestation.
- The full-term group included children born at or beyond 37 weeks of gestation.

Gestational age at birth was confirmed via official birth records or neonatal discharge summaries provided by caregivers. A total of 120 children were enrolled in the study, with 60 children assigned to each group. Both groups were age- and gender-matched to minimize confounding.

Inclusion and Exclusion Criteria

Children were included in the study if they were between 3 and 8 years old and had either been born preterm or full-term as explained above. To avoid any confusion from poor vision, participants had to have a best-corrected visual acuity of 6/9 (20/30) or better in both eyes. The participants were evaluated during a short pre-screening to ensure they could cooperate with clinical testing.

Children were not included in the study if they had major neurological or developmental disorders (such as cerebral palsy, epilepsy, autism spectrum disorder), as these conditions could affect visual-motor integration by themselves. Other reasons for exclusion were: a history of eye trauma or surgery, congenital eye problems (such as congenital cataract or coloboma), manifest nystagmus or uncorrected refractive error of more than ±5.00D spherical equivalent or 2.50D cylinder in either eye. The purpose of these criteria was to find binocular vision problems that are not caused by refractive or structural issues.

Sample Size Estimation

The sample size was chosen based on estimates from previous studies that showed a major difference in the occurrence of binocular anomalies between preterm and full-term populations. If the researchers wanted to detect a 20% difference in convergence insufficiency between the groups, with 80% power and an alpha level of 0.05, they needed at least 54 participants in each group. Since there was a risk of some data being lost or assessments being incomplete, the sample was increased to 60 participants per group, giving a total of 120 participants.

Clinical Assessment Protocol

All children were examined by licensed optometrists who have received training in how to assess vision in children. The protocol for the examination involved a set of tests to check both the movement and sensory aspects of binocular vision

Visual Acuity and Refractive Status: The vision of each participant was assessed with charts that matched their age and reading ability such as the Lea Symbols chart for young children and the Snellen chart for those who could read. Testing was done with the participants wearing their best glasses at a standard distance of 3 meters or 6 meters. The children who needed glasses were tested using their usual prescription.

Ocular Alignment: The cover–uncover test and alternate cover test were done at both 6 meters and 40 centimeters to check ocular alignment. Prism diopters were used to measure the deviations with prism neutralization. When strabismus is obvious, Hirschberg's test was first used as a way to screen patients. A strabismus diagnosis was given if the eye deviation was seen consistently during several attempts.

Near Point of Convergence (NPC): The near point of convergence was measured by moving an accommodative target on a fixation stick slowly toward the child's nose at a rate of about 1–2 cm per second. The points where the bone was broken and recovered were marked in centimeters. A break point of 10 cm or more was seen as evidence of convergence insufficiency, in line with the usual standards.

Stereopsis Evaluation: The Randot Preschool Stereoacuity Test was used to measure stereoscopic depth perception. The test was given with the viewer at 40 cm and with standard lighting. The results were given in arc seconds; anyone with stereoacuity worse than 200 arc seconds was considered to have reduced stereoacuity.

Accommodative Function: Amplitude of accommodation was assessed using the push-up method with a near-point card. The nearest point of sustained clear vision was measured in centimeters and converted to diopters. Accommodative facility was tested using ±2.00 diopter flippers at a 40 cm working distance. The number of complete cycles (plus to minus lens clearing) within 60 seconds was recorded, with fewer than 5 cycles per minute considered abnormal.

Diagnostic Criteria

Diagnoses of binocular vision anomalies were established using standardized clinical thresholds as detailed in Pickwell's Binocular Vision Anomalies and other peer-reviewed sources. Criteria included:

- Convergence Insufficiency: Near exophoria exceeding distance by ≥4 prism diopters, NPC >10

cm, and reduced positive fusional vergence.

- Accommodative Insufficiency: Amplitude of accommodation significantly below age norms and reduced facility (<5 cycles/min).
- Strabismus: Presence of a manifest ocular deviation observed on cover testing.
- Reduced Stereopsis: Stereoacuity greater than 200 arc seconds.

Participants could be diagnosed with more than one binocular vision anomaly. Diagnoses were confirmed by a second examiner blinded to group allocation to reduce examiner bias.

Data Management and Statistical Analysis

All the clinical findings were added to a secure, anonymous database and checked for accuracy by a second reviewer. IBM SPSS Statistics (version 24.0) was used for the statistical analysis. The data for all demographic and clinical variables were summarized using the mean, standard deviation, frequency and percentage distributions.

For categorical variables, chi-square (χ^2) tests were used to compare the preterm and full-term groups and for continuous variables, independent-samples t-tests were applied. In addition, odds ratios (ORs) with 95% confidence intervals were used to estimate the relative risk of each binocular vision problem in preterm children compared to full-term children. A p-value below 0.05 was taken as evidence of statistical significance.

RESULTS

Participant Characteristics

The study included 120 children between the ages of 3 and 8, with 60 preterm and 60 full-term births. The mean age for preterm infants was 5.6 ± 1.4 years, while it was 5.5 ± 1.5 years for full-term infants and there was no significant difference between the groups ($p > 0.05$). The number of males was similar in both groups, with 52% in the preterm group and 55% in the full-term group ($p > 0.05$). Because the groups were similar in demographics, it made them more alike and reduced the chances of other factors affecting the results.

.

Prevalence of Binocular Vision Anomalies

The study found that preterm babies were much more likely to have binocular vision anomalies than full-term babies in all the categories studied. The anomalies that were looked into were convergence insufficiency, accommodative insufficiency, strabismus and reduced stereopsis. Table 1 and Figure 1 show the distribution of the species.

Table 1 shows that convergence insufficiency was found in the largest number of participants, affecting 36.7% of the preterm group and 13.3% of the full-term group. Thirty percent of preterm children were found to have accommodative insufficiency which was much higher than the 10% seen in full-term children. In the same way, preterm children had a higher rate of strabismus (25.0%) than full-term children (6.7%). Out of the preterm group, 33.3% had reduced stereopsis, while only 11.7% of the full-term group did.

Table 1: Prevalence of Binocular Vision Anomalies in Preterm and Full-Term Children

	Group 1 (Prediabetes)	Group 2 (Newly diagnosed T2DM)	Group 3 (T2DM > 5 years)
Age	42 ±11.18	43 ± 8.72	55 ± 12.59
Sex	Male = 16 Female = 14	Male = 17 Female = 13	Male = 17 Female = 13
BMI	27.4 ± 4.62	29.45 ± 4.9	28.4 ± 5.31
Waist circumference	96 ± 19.01	106 ± 18.3	102 ± 16.87
Family History of DM	Yes = 20 No = 10	Yes = 21 No = 9	Yes = 14 No = 16
Physical activity	Yes = 5 No = 25	Yes = 1 No = 29	Yes = 6 No = 24

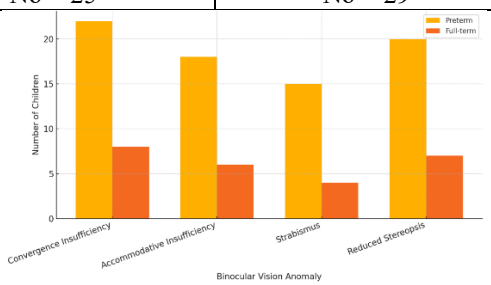

Figure 1: Prevalence of Binocular Vision Anomalies – Bar Chart

The chi-square test on the data showed that all four anomalies had statistically significant differences ($p < 0.01$). The

findings show that premature birth is strongly linked to binocular vision disorders in early childhood.

Co-Occurrence of Binocular Vision Anomalies

Apart from single cases, the study also looked at how multiple binocular vision disorders can affect the same person. The preterm group had a much higher rate of multiple simultaneous anomalies than the full-term group which is clear from Table 2 and Figure 2.

The most frequent co-occurring pair was convergence insufficiency and accommodative insufficiency, present in 16.7% (n = 10) of preterm children compared to 3.3% (n = 2) of full-term children. Other common combinations included convergence insufficiency with reduced stereopsis (13.3% vs. 3.3%) and accommodative insufficiency with strabismus (8.3% vs. 0%). Notably, 41.7% of preterm children exhibited two or more binocular vision anomalies, compared to only 11.7% of full-term children.

Table 2: Co-Occurrence of Binocular Vision Anomalies in Preterm and Full-Term Children

Anomaly Pair	Preterm (n = 60)	Full-term (n = 60)
Convergence + Accommodative Insufficiency	10	2
Convergence + Strabismus	6	1
Convergence + Reduced Stereopsis	8	2
Accommodative + Strabismus	5	0
Accommodative + Reduced Stereopsis	7	1
Strabismus + Reduced Stereopsis	6	1

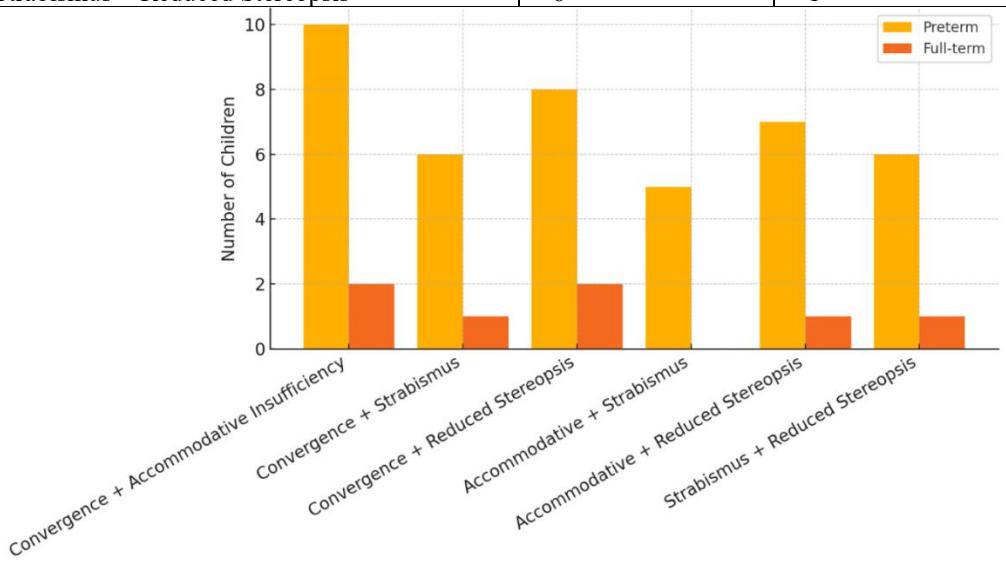

Figure 2: Co-Occurrence of Binocular Vision Anomalies – Bar Chart

It seems that visual dysfunctions in preterm children are not just single problems but may be related to a wider disturbance in how the eyes and senses work together. Such results are important for both identifying and treating diseases.

Statistical Comparisons and Risk Estimates

All the co-occurring conditions were found to be statistically different using chi-square testing ($p < 0.05$). The relative risk of each anomaly in preterm children was measured using odds ratios (ORs). The odds ratio for convergence insufficiency was 3.8, for accommodative insufficiency 3.9, for strabismus 4.7 and for reduced stereopsis 3.8. According to these metrics, children who are born preterm have a 3–5 times higher risk of binocular vision problems than children born at full term.

In addition, the chance of having several concurrent anomalies was 5.1 times greater in the preterm group, pointing to the extra visual difficulties they encounter. The results back up the idea that being born prematurely greatly increases the risk of binocular vision problems.

Clinical and Functional Interpretation

The high number of anomalies in preterm babies may lead to serious consequences. Difficulties in reading, knowing where you are in space and fine motor skills can affect children with convergence insufficiency and reduced stereopsis

which are important for school success. In addition, if accommodative issues are not found, they can cause a student to appear inattentive or misbehave which may result in the wrong diagnosis in school. This shows that it is important to screen all children born early for binocular vision problems.

DISCUSSION

This study looked at and compared the rates and types of binocular vision problems in preterm and full-term children who were 3 to 8 years old. The study shows that preterm birth is linked to more cases of convergence insufficiency, accommodative insufficiency, strabismus and reduced stereopsis in children which supports the idea that prematurity is a major risk factor for poor binocular vision development.

Interpretation of Key Findings

Convergence insufficiency was the most common issue found in this study, with 36.7% of preterm children having it and only 13.3% of full-term children. This result is in line with previous studies that found that preterm babies have trouble controlling their eye movements and fusing images [1, 3, 7]. If children have trouble focusing their eyes early on, it may negatively affect their reading and writing skills which are important for learning.

Likewise, 30.0% of preterm children had accommodative insufficiency compared to 10.0% of full-term children. Since accommodation and vergence are closely connected, problems with accommodation may happen together with or worsen convergence issues. It is possible that both conditions are more common in preterm children because their oculomotor control system is not fully mature which fits with theories about prematurity-related problems [4, 6].

Strabismus was found in 25.0% of the preterm group which is much higher than the 6.7% found in the full-term group. It is especially significant because strabismus can affect binocular fusion and may also cause amblyopia if it is not treated. In the past, studies following premature infants over time have found that they are more likely to develop strabismus which is often linked to problems such as retinopathy of prematurity (ROP), periventricular leukomalacia or intraventricular hemorrhage [8].

About a third of the preterm participants had reduced stereopsis, while only 11.7% of the full-term group did. It may be because the visual cortex and its connecting pathways are not fully developed, as stereoacuity depends on both eyes sending the same and accurate data. Having trouble judging distances can make it harder for children to keep their balance, coordinate movements and judge space.

Comparison with Existing Literature

The results agree with earlier research that shows preterm children are more likely to have visual-motor and sensory problems. Ingvaldsen et al. (2023) found that children born extremely preterm often have lasting changes in their visual pathways and Liu et al. (2023) pointed out that early gestational age is linked to developmental delays [11, 8]. More than 40% of preterm children in our study had multiple binocular vision problems, while only 11.7% of full-term children did which is not widely reported in the literature and deserves more attention.

Mukhtar et al. (2024) and Chaturvedi et al. (2023) also found the same patterns in children with learning difficulties, suggesting that binocular dysfunction could be a link between being born early and poor academic performance [6, 7]. The results support the idea that it is better to assess binocular vision in many ways, not just by symptoms or strabismus.

Possible Mechanisms

Binocular dysfunctions in preterm children are probably caused by a combination of factors. Studies of brain structure and function have found that parts of the visual system in preterm infants such as the dorsal visual stream, brainstem nuclei and white matter tracts, are not fully developed. The development of the eye's structure such as the muscles and ability to fuse images, may not be complete in infants born before full gestation [2].

Early childhood activities that require close vision, reading and screen time may worsen any hidden binocular problems in preterm children. If visual development is lacking, children may feel tired, show different behaviors or struggle with school and these issues may be wrongly attributed to attention or cognitive disorders

Clinical Implications

The results of this study are important for both clinical and public health purposes. They highlight that early and thorough screening for binocular vision should be done in children who were born prematurely. Refractive error and visual acuity are usually the main concerns in pediatric eye screenings, but they are not enough to find mild binocular problems. Adding convergence, accommodation and stereoacuity tests to regular pediatric eye care may help identify and treat problems sooner.

Also, when several binocular anomalies are present, it is important to use strategies that are both integrated and tailored to each person. Preterm children may benefit a lot from vision therapy that focuses on convergence and accommodation and

recent studies suggest it can help with both their health and well-being [6].

Study, Strengths, and Limitations

This study is strong because it compares two well-defined groups using a detailed set of binocular vision tests. Using co-occurrence analysis introduces a new perspective to the research. Still, there are some limitations to the study. Initially, the research was cross-sectional, so it could not prove cause and effect. Second, the study did not look at ROP or low birth weight as separate groups which could have offered more information. Even though the sample size was large enough for prevalence, it is still necessary to conduct larger studies in different places to apply the findings to a wider range of people.

Future directions

It is important for future research to follow the progress of binocular vision in preterm children and evaluate the lasting results of early intervention. Studies that compare brain structure with binocular vision performance could reveal how the brain functions. Furthermore, looking into the academic and social effects of children with multiple binocular vision problems could guide the development of intervention plans.

CONCLUSION

This study clearly shows that preterm children are much more likely to have binocular vision problems such as convergence insufficiency, accommodative insufficiency, strabismus and reduced stereopsis than children born at full term. These anomalies were more common in the preterm group and they tended to happen together, suggesting that preterm birth disrupts binocular vision in several ways.

Since the years from 3 to 8 are crucial for both vision and learning, these findings suggest that early screening and intervention are important. Binocular vision dysfunctions which are usually not noticed in standard vision tests, can seriously affect a person's ability to see and may cause problems in school and behavior if not treated.

The findings suggest that pediatric eye care for preterm children should always include tests for convergence, accommodation and stereoacuity. If these deficits are found early and addressed with personalized strategies such as vision therapy or classroom support, it may help reduce the negative effects on at-risk populations and promote fair development and learning.

All in all, being born early increases the risk of binocular vision problems. Early screening and rehabilitation play a key role in helping these children see better, do well in school and live a better life.

REFERENCES

1. Niechwiej-Szwedo E, Colpa L, Wong A. The role of binocular vision in the control and development of visually guided upper limb movements. Philos Trans R Soc Lond B Biol Sci. 2023;378(1869):20210461.
2. Flitcroft I, Ainsworth J, Chia A, Cotter S, Harb E, Jin ZB, et al. IMI—management and investigation of high myopia in infants and young children. Invest Ophthalmol Vis Sci. 2023;64(6):3.
3. Evans BJ. Pickwell's binocular vision anomalies. 6th ed. Elsevier Health Sciences; 2021.
4. Meier K, Lundell DL, Seemiller ES, Giaschi D, Wilcox LM, Candy TR. The relationship between reflex eye realignment and the percept of single vision in young children. Sci Rep. 2021;11(1):375.
5. Boccardo L, Di Vizio A, Galli G, Naroo SA, Fratini A, Tavazzi S, et al. Translation and validation of convergence insufficiency symptom survey to Italian: Psychometric results. J Optom. 2023;16(3):189–198.
6. Chaturvedi I, Jamil R, Sharma P. Binocular vision therapy for the treatment of Amblyopia—A review. Indian J Ophthalmol. 2023;71(5):1797–1803.
7. Mukhtar IS, Ezinne NE, Mohamad Shahimin M, Mohd-Ali B, Oghre E, Zeried FM, et al. Age-Matched Comparative Analysis of Binocular Vision Anomalies among Children with Dyslexia in Northern Nigeria. Pediatr Rep. 2024;16(3):566–578.
8. Liu MX, Li HF, Wu MQ, Geng SS, Ke L, Lou BW, et al. Associations of preterm and early-term birth with suspected developmental coordination disorder: A national retrospective cohort study in children aged 3–10 years. World J Pediatr. 2023;19(3):261–272.
9. Harrington S, Davison PA, O'Dwyer V. School performance and undetected and untreated visual problems in schoolchildren in Ireland; a population-based cross-sectional study. Irish Educ Stud. 2022;41(2):367–388.
10. Lokesh AD, Gyamtso P, Madhan I, Rao D. Non-Strabismic Binocular Vision Anomalies Among Tibetan College Students of Bengaluru. [conference abstract/study—journal details not provided].
11. Ingvaldsen SH, Moljord K, Grøtting A, Omland PM, Dammann O, Austeng D, et al. Retinal structure and visual pathway function at school age in children born extremely preterm: a population-based study. BMC Ophthalmol. 2023;23(1):296.
12. Hossain MM, Iftekhar QS, Naznin SM, Chowdhury STMR, Hasan MM. Binocular Vision Anomalies in Children and Young Adults and Effectiveness of Vision Therapy. Delhi J

Ophthalmol. 2022;32(5):20–25.
13. Harrington S, Davison PA, O'Dwyer V. School performance and undetected and untreated visual problems in schoolchildren in Ireland; a population-based cross-sectional study. Irish Educ Stud. 2022;41(2):367–388.
14. Podraza LC, Starnes LS, Starnes JR, Patel A, Apple RK. A Novel Pediatric Clinical Skills Curriculum to Prepare Medical Students for Pediatrics Clerkship. Med Sci Educ. 2025;35(1):343–350.
15. Mason A. Bion and binocular vision. In: London Kleinians in Los Angeles: Laying the Foundations of Object Relations Theory and Practice. 2023. p.113.
16. Maurer D, Lewis TL, Brent HP. Experience-dependent plasticity in the development of binocular vision. Proc Natl Acad Sci USA. 2012;109(36):15012–15016. https://doi.org/10.1073/pnas.1203096109
17. Ricci D, Cesarini L, Romeo DM, et al. Development of eye alignment, convergence, and sensory binocularity in young infants. Invest Ophthalmol Vis Sci. 1998;39(2):544–553. https://doi.org/10.1167/iovs.98-544
18. Yin H, Chen W, Peng Y, et al. Comparative study on optic disc features of premature infants and full-term newborns. BMC Ophthalmol. 2021;21: 690. https://doi.org/10.1186/s12886-021-01833-6
19. Al-Khathlan AA, Al-Ballaa FN, AlYahya AK. Comparative study of visual dysfunctions in 6–10-year-old very preterm and full-term born children. Int Ophthalmol. 2018;38:503–512. https://doi.org/10.1007/s10792-018-0959-2
20. Almgren S, Dellborg M, Frennesson C. Eye movements and binocular function in low birthweight teenagers. Acta Ophthalmol Scand. 2008;86(3):309–313. https://doi.org/10.1111/j.1600-0420.2007.01025.x
21. Holmström GE, Larsson EK, Kugelberg U. Ophthalmologic outcome in extremely preterm infants: a population-based study in a Swedish cohort. Am J Ophthalmol. 2007;144(5):718–724. https://doi.org/10.1016/j.ajo.2007.06.019
22. Verma M, Chacko J, Thomas M. Refractive errors in preterm babies. Indian J Ophthalmol. 1993;41(4):159–162. https://doi.org/10.4103/ijo.IJO_1175_21
23. Holmström G, el Azazi M, Jacobson L, Kugelberg U. A population-based study of the refractive outcome in 10-year-old preterm and full-term children. Arch Ophthalmol. 1993;111(10):1429–1435. https://doi.org/10.1001/archopht.1993.01090090121043
24. O'Connor AR, Stephenson T, Johnson A, et al. Long-term ophthalmic outcome of low birth weight children with and without retinopathy of prematurity. Pediatrics. 2002;109(1):12–18. https://doi.org/10.1542/peds.109.1.12
25. Al-Haddad C, Fattah MA, Smeets L, et al. Ophthalmologic outcomes of children born premature without retinopathy of prematurity. J Pediatr Ophthalmol Strabismus. 2017; 54(1):32–38. https://doi.org/10.3928/01913913-20160831-02
26. Yang SH, Lee EK, Lee SY, et al. Comparison of surgical outcomes between pre- and full-term patients with exotropia. BMC Ophthalmol. 2018;18:14. https://doi.org/10.1186/s12886-018-0726-2
27. Miguel AI, Gonzalez A, Garcia-Munoz A. Review of clinical diagnostic signs for convergence insufficiency. Clin Exp Optom. 2021;104(6):631–636. https://doi.org/10.1080/08164622.2021.1961566

