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Original Article

Ophthalmology Section

Ocular Manifestations in Children with Developmental Delay: A Cross-sectional Study

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ABSTRACT

Introduction: Children with Developmental Delay (DD) are at increased risk for ocular abnormalities, which may further hinder their overall growth and neurodevelopment. Understanding the spectrum of these manifestations is essential for early intervention.

Aim: To investigate the prevalence and types of ocular manifestations in children with DD milestones, and to study antenatal, natal and postnatal factors present in these children with ocular manifestations.

Materials and Methods: The present cross-sectional study was conducted at a tertiary care centre in Western Maharashtra from September 2023 to March 2025. A total of 201 children aged six months to 15 years with a clinical diagnosis of DD were included. Each child underwent a comprehensive ophthalmic examination, including visual acuity assessment, cycloplegic refraction, squint evaluation and anterior and posterior segment examination. Relevant antenatal, natal, and postnatal histories were also recorded. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 27. Descriptive statistics were used to summarise the data. A 95% confidence level was maintained, and a p-value<0.05 was considered statistically significant

Results: The mean age of the participants was 5.73±4.07 years, with 120 (59.7%) males and 81 (40.3%) females. Ocular abnormalities were present in 166 (82.6%) children with DD, while 35 (17.4%) had normal ocular findings. Refractive errors were the most common, found in 119 (59.2%) children, including hypermetropia {55 (27.4%)}, astigmatism in {42 (20.9%)}, and myopia in {22 (10.9%)}.Other common ocular conditions included strabismus {59 (29.4%)}, Cortical Visual Impairment (CVI) {13 (6.5%)}, cataract {12 (6%)} Only round off done, The values are matching with the values given in table 5 and 6, amblyopia {7 (3.5%)}, keratoconus {8 (4%)}, and optic atrophy {7 (3.5%)}. Ocular abnormalities were slightly more frequent in children with Isolated Developmental Delay (IDD) {37 (18.4%)} than those with Global Developmental Delay (GDD) {129 (64.1%)}, though this difference was not statistically significant (p=0.942). No significant associations were observed between ocular abnormalities other than refractive errors and age group, sex, or consanguinity. However, preterm birth showed a statistically significant association with ocular abnormalities (p=0.016).

Conclusion: Children with DD, especially those with global delay, are at high-risk for ocular abnormalities. Early diagnosis and intervention for conditions such as refractive errors, strabismus, and CVI are essential to improve visual outcomes and support overall development. Routine vision screening and multidisciplinary collaboration are vital for ensuring timely care and preventing long-term visual impairment.

Keywords: Neurodevelopmental disorders, Paediatric vision screening, Refractive errors, Strabismus, Visual disorders

INTRODUCTION

The DD is a condition characterised by a slower rate of development in one or more areas of a child's growth, where the child does not achieve the expected developmental milestones for their age [1]. DD can be categorised into two categories depending on the numbers of domains involved. If only one domain is affected, the child is considered to have IDD, whereas involvement of multiple domains is referred to as GDD [1].

In India, developmental disabilities affect a significant number of children, with studies estimating that around 13.6% of children aged 6-9 years have at least one neurodevelopmental disorder, highlighting a major public health concern [2,3]. Intellectual disability alone contributes to nearly 10.8% of the total burden of mental disorders in the country [3]. DD affect a child's growth across various domains, including motor, language, social, and cognitive skills [3]. Early identification of delays in these areas is crucial, as timely interventions can significantly improve outcomes [4,5]. Ocular disorders are common in children with DD, with shared risk factors including genetic anomalies, neurological conditions, and perinatal complications [6,7]. Vision plays a vital role in a child's development, influencing learning, social interaction, and the acquisition of key developmental skills [8]. Impaired vision can disrupt these processes, potentially exacerbating DDs [9]. Common ocular conditions in children with DD include refractive errors, strabismus, and other conditions like nystagmus, optic atrophy, and CVI [10]. Undetected and untreated ocular disorders can lead to amblyopia and further hinder visual development. Given the importance of vision in overall development and the high prevalence of ocular abnormalities in children with DD, early ophthalmic screening is essential to improve outcomes and reduce the impact of visual impairments [9,11]. The present study aimed to investigate the types and distribution of ocular manifestations in children with DD, providing valuable insights for healthcare professionals and emphasising the importance of early detection and management.

MATERIALS AND METHODS

The present cross-sectional, observational study was conducted in Ophthalmology Department at a Dr DY Patil Medical College Hospital and Research Centre in western Maharashtra, from September 2023 to March 2025. Ethics committee clearance (IESC/PGS/2023/108) was obtained, and written informed consent was provided by parents or guardians prior to the enrolment of their children in the study.

Inclusion and Exclusion criteria: Children aged 6 months to 15 years with a diagnosis of DD made by the referring paediatrician

were included in the study. The diagnosis was established through clinical assessment by the paediatrician, which was supported by standardised developmental screening tools such as the Denver Developmental Screening Test II (DDST-II) [12], Vineland Social Maturity Scale (VSMS) [13], or Ages and Stages Questionnaire (ASQ) [14]. Children with neuromuscular disorders causing motor abnormalities were excluded.

Sample size calculation: The sample size was calculated using WINPEPI 11.3 software, considering a prevalence rate of ocular manifestations in children with DD of 0.85, a margin of error of 0.05, and a 95% confidence level. The calculated sample size was 201 [15].

Study Procedure

Parental consanguinity was noted [16]. Antenatal history (including pregnancy-induced hypertension, seizures, Gestational Diabetes Mellitus (GDM), infections, intrauterine growth retardation, and fever with rash), natal history (type of delivery, full-term or preterm), and postnatal history were documented. For this study, the postnatal period was defined as the time from birth up to one year of age, encompassing early neonatal complications and later infancy-related events. Postnatal data included birth weight, asphyxia, seizures, jaundice, hypoglycaemia, and Neonatal Intensive Care Unit (NICU) admission. Each child underwent a preliminary general examination, and the type of DD (IDD or GDD) was recorded based on the paediatrician's diagnosis [17].

A detailed ophthalmic examination was performed, including:

Visual acuity assessment: Each child's vision was assessed based on their level of understanding and developmental stage, using the most appropriate method for their condition. Preference was given to techniques that encouraged active participation and higher mental engagement whenever possible.

The following methods were used during the evaluation process:

Central, Steady, Maintained (CSM) method, Cardiff Acuity Charts, Sheridan Gardiner test, and Snellen's visual acuity charts [18].

Wherever possible, both uncorrected and best-corrected visual acuity for distance and near vision was recorded using these age-appropriate charts. In cases where standard visual acuity testing could not be performed, alternative approaches were adopted. These included observing the child's visual behaviour during clinical examination, noting eye fixation and tracking, identifying signs of nystagmus, and checking if the child resisted covering either eye., Parents were asked about their child's visual behaviour at home specifically whether the child could fixate on or reach out to grab objects, providing insight into the child's functional vision in everyday settings [19].

- **Visual Acuity and Refractive Error Classification:**

For the purpose of classification in this study, hypermetropia was defined as a refractive power of more than +3.00 dioptres, myopia as less than -0.50 dioptre, and astigmatism as a cylindrical error greater than -1.00 dioptre [15].

- Cycloplegic Refraction was Performed Following Methods:

  Children <5 years: 1% atropine ointment (TDS for 3 days)

  Children 5-8 years: 2% Homatropine eye drops (one drop every 10 min for six times)

  Children >8 years: 1% Cyclopentolate eye drops (one drop every 15 min for three times) [15-20].

  Ocular Motility Examination: Evaluated in all nine directions of gaze whenever possible [21].

- **Strabismus assessment:** Hirschberg Test and Cover/Uncover test were used. Strabismus was graded using the Prism Bar Cover Test [20].
- **Ptosis evaluation:** Ptosis was documented and assessed when present.
- **Anterior segment examination:** Torchlight examination, with slit lamp examination when feasible.
- **Fundus examination:** Direct and indirect ophthalmoscopy, with indirect ophthalmoscopy using a 20-diopter condensing lens under mydriasis [18].

Neurological studies were done wherever additional assessment was required.

- **Consanguinity classification**

First-Degree Consanguinity (C-I Degree): This includes immediate family members such as parents, children, and full siblings, who share approximately 50% of their genes [16].

Second-Degree Consanguinity (C-II Degree): This category encompasses grandparents, grandchildren, uncles, aunts, nephews, nieces, and half-siblings, sharing about 25% of their genetic material [16].

Third-Degree Consanguinity (C-III Degree): This includes first cousins, great-grandparents, and great-grandchildren, with an estimated 12.5% shared genetic material [16].

STATISTICAL ANALYSIS

Data were analysed using SPSS version 27. Descriptive statistics were used to summarise the data. The Chi-square test was used to evaluate the relationship between ocular manifestations and DD. A confidence level of 95% was maintained, and $p<0.05$ was considered statistically significant. Microsoft Excel was used for data visualisation and tabulation. For statistical analysis, percentages within subgroups (e.g., age groups, refractive error types) in the tables were calculated based on row totals to align with Chi-square testing. Overall percentages calculated from the total sample size are reported in the Discussion to facilitate comparison with previously published studies.

RESULTS

A total of 201 children with DD participated in the study, and their demographic profile is summarised in [Table/Fig-1].

Age group (in years)	Female n (%)	Male n (%)	Total n (%)	GDD n (%)	IDD n (%)	Total n (%)
6 months - 2 years	24 (36.4%)	42 (63.6%)	66 (32.8%)	53 (33.8%)	13 (29.5%)	66 (32.8%)
2+ years - 5 years	23 (39.0%)	36 (61.0%)	59 (29.4%)	43 (27.4%)	16 (36.4%)	59 (29.4%)
5+ years - 8 years	14 (45.2%)	17 (54.8%)	31 (15.4%)	24 (15.3%)	7 (15.9%)	31 (15.4%)
8+ years - 10 years	6 (35.3%)	11 (64.7%)	17 (8.5%)	15 (9.6%)	2 (4.5%)	17 (8.5%)
10+ years - 15 years	14 (50.0%)	14 (50.0%)	28 (13.9%)	22 (14.0%)	6 (13.6%)	28 (13.9%)
Total	81 (40.3%)	120 (59.7%)	201 (100%)	157 (100%)	44 (100%)	201 (100%)

[Table/Fig-1]: Distribution of children according to age group, sex, and type of Developmental Delay (DD) (= 201).
GDD: Global developmental delay; IDD: Isolated developmental delay

Among these participants, males predominated, accounting for {120 (59.7%)} children, compared to {81 (40.3%)} females. The majority of the subjects were within the younger age groups, specifically six months to two years {66 (32.8%)} and 2 to 5 years {59 (29.4%)}. Within children diagnosed with GDD, higher proportions were observed among the age groups six months to two years {53 (33.8%)} and 2 to 5 years {43 (27.4%)}, while IDD was more common in the two to five years group {16 (36.4%)}, followed closely by six months to two years {13 (29.5%)}.

Refractive errors were analysed in [Table/Fig-2], with a total prevalence of {119 (59.2%)} among the study participants. Hypermetropia was the most common refractive error, affecting {55 (27.4%)} children, followed by astigmatism in {42 (20.9%)} and myopia in {22 (10.9%)}.

Age-wise analysis revealed that hypermetropia predominantly affected the youngest age group (6 months to 2 years) with 20 cases (30.3%). Among this group, hypermetropia greater than +3.00 diopters were considered clinically significant. Astigmatism was most prevalent in children aged two to five years {11 (18.6%)}, whereas myopia was highest in the six months to two years cohort {10 (15.2%)} and declined to {4 (6.8%)} in the two to five years group.

When comparing sexes, hypermetropia was more common in females {28 (34.6%)} than in males {27 (22.5%)}. Myopia was higher in males {15 (12.5%)} compared to females {7 (8.6%)}. Astigmatism was also slightly more frequent in females {19 (23.5%)} than in males {23 (19.2%)}.

Analysed by DD type, children with GDD had higher proportions of hypermetropia {48 (30.6%)} and astigmatism {30 (19.1%)}, whereas those with IDD showed relatively greater percentages of astigmatism {12 (27.3%)} and myopia {8 (18.2%)}. However, statistical analysis revealed no significant association between refractive errors and age group (p=0.521), sex (p=0.13), or type of DD (p=0.08).

Category	Astigmatism n (%)	Hypermetropia n (%)	Myopia n (%)	Normal n (%)	Row Total n (%)	p-value
Age group						
6 months - 2 years	10 (15.2%)	20 (30.3%)	10 (15.2%)	26 (39.4%)	66 (100%)	0.521
2+ years - 5 years	11 (18.6%)	14 (23.7%)	4 (6.8%)	30 (50.8%)	59 (100%)	
5+ years - 8 years	7 (22.6%)	9 (29.0%)	3 (9.7%)	12 (38.7%)	31 (100%)	
8+ years - 10 years	7 (41.2%)	5 (29.4%)	1 (5.9%)	4 (23.5%)	17 (100%)	
10+ years - 15 years	7 (25.0%)	7 (25.0%)	4 (14.3%)	10 (35.7%)	28 (100%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
Sex						
Male	23 (19.2%)	27 (22.5%)	15 (12.5%)	55 (45.8%)	120 (100%)	0.13
Female	19 (23.5%)	28 (34.6%)	7 (8.6%)	27 (33.3%)	81 (100%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
Type of DD						
GDD	30 (19.1%)	48 (30.6%)	14 (8.9%)	65 (41.4%)	157 (100%)	0.08
IDD	12 (27.3%)	7 (15.9%)	8 (18.2%)	17 (38.6%)	44 (100%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	

[Table/Fig-2]: Distribution of refractive errors according to age group, sex, and type of Developmental Delay (DD) in children (sample size=201).
Chi-square test at a 95% confidence level, with a p-value of <0.05 (*) considered statistically significant. GDD: Global developmental delay; IDD: Isolated developmental delay; n (%) – number with percentage.
**all the percentages are calculated from row total

[Table/Fig-3] presents the distribution of refractive errors in relation to various perinatal risk factors. The majority of children without consanguinity (NC) demonstrated the highest frequencies of astigmatism {41 (21.6%)}, hypermetropia {54 (28.4%)}, and myopia {21 (11.1%)}, with {74 (38.9%)} showing normal refractive status. Among consanguineous groups, most children exhibited normal vision, with only isolated cases of astigmatism or hypermetropia. No significant association was found between consanguinity and refractive errors (p=0.321).

Category	Astigmatism n (%)	Hypermetropia n (%)	Myopia n (%)	Normal n (%)	Total n (%)	p-value
Consanguinity						
C-I Degree	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100.0%)	3 (1.5%)	0.321
C-II Degree	0 (0.0%)	0 (0.0%)	1 (50.0%)	1 (50.0%)	2 (1.0%)	
C-III Degree	1 (16.7%)	1 (16.7%)	0 (0.0%)	4 (66.7%)	6 (3.0%)	
NC	41 (21.6%)	54 (28.4%)	21 (11.1%)	74 (38.9%)	190 (94.5%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
Antenatal factors						
Asthma	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	2 (1.0%)	0.47
Fever with rash	2 (28.6%)	2 (28.6%)	0 (0.0%)	3 (42.9%)	7 (3.5%)	
GDM	3 (15.0%)	2 (10.0%)	4 (20.0%)	11 (55.0%)	20 (10.0%)	
IUGR	1 (10.0%)	3 (30.0%)	0 (0.0%)	6 (60.0%)	10 (5.0%)	
PIH	3 (21.4%)	4 (28.6%)	2 (14.3%)	5 (35.7%)	14 (7.0%)	
Seizure	0 (0.0%)	0 (0.0%)	2 (33.3%)	4 (66.7%)	6 (3.0%)	
Unknown Events (UE)	32 (22.5%)	43 (30.3%)	14 (9.9%)	53 (37.3%)	142 (70.6%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
Natal factors						
Preterm	10 (17.2%)	12 (20.7%)	6 (10.3%)	30 (51.7%)	58 (28.9%)	0.23
Term	32 (22.4%)	43 (30.1%)	16 (11.2%)	52 (36.4%)	143 (71.1%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
Mode of delivery						
Caesarean section	12 (30.8%)	9 (23.1%)	1 (2.6%)	17 (43.6%)	39 (19.4%)	0.123
Normal vaginal delivery	30 (18.5%)	46 (28.4%)	21 (13.0%)	65 (40.1%)	162 (80.6%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	

Postnatal factors						0.67
Asphyxia	6 (21.4%)	6 (21.4%)	3 (10.7%)	13 (46.4%)	28 (13.9%)	
Jaundice	6 (22.2%)	6 (22.2%)	5 (18.5%)	10 (37.0%)	27 (13.4%)	
Seizure	2 (14.3%)	6 (42.9%)	2 (14.3%)	4 (28.6%)	14 (7.0%)	
Sepsis	2 (18.2%)	3 (27.3%)	3 (27.3%)	3 (27.3%)	11 (5.5%)	
UE (Unknown Events)	26 (21.5%)	34 (28.1%)	9 (7.4%)	52 (43.0%)	121 (60.2%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	
NICU admission						0.275
Yes	16 (20.0%)	21 (26.3%)	13 (16.3%)	30 (37.5%)	80 (39.8%)	
No	26 (21.5%)	34 (28.1%)	9 (7.4%)	52 (43.0%)	121 (60.2%)	
Total	42 (20.89%)	55 (27.36%)	22 (10.94%)	82 (40.79%)	201 (100%)	

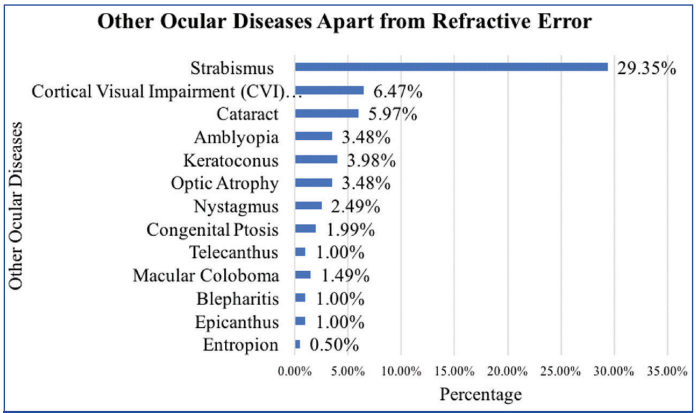
[Table/Fig-3]: Distribution of refractive errors according to various risk factors.
Chi-square test performed at a 95% confidence level; a p-value <0.05 (*) was considered statistically significant. NC: Consanguinity; GDM: Gestational diabetes mellitus; IUGR: Intrauterine growth restriction; PIH: Pregnancy-induced hypertension; UE: Unknown events; NICU: Neonatal intensive care unit. n (%) – number (percentage).

For antenatal factors, children with a history of GDM most commonly had normal vision {11 (55.0%)}, while hypermetropia was observed most in those with unknown events {43 (30.3%)}. Astigmatism and hypermetropia were similarly distributed among children with fever and rash, PIH, or IUGR. None of these antenatal risk factors were significantly associated with refractive error (p=0.47). Regarding natal factors, preterm children most commonly had normal refractive status {30 (51.7%)}, whereas astigmatism and hypermetropia were again more frequent in term infants {32 (22.4%)} and {43 (30.1%)}, respectively. However, these differences were not significant (p=0.23). By mode of delivery, children born by caesarean section had higher proportions of astigmatism {12 (30.8%)}, while normal vision was slightly more common following normal vaginal delivery {65 (40.1%)}. The difference was not statistically significant (p=0.123). Postnatal factors including asphyxia, jaundice, seizures, and sepsis did not show strong associations with any specific refractive error. Among children admitted to the NICU, hypermetropia {21 (26.3%)} and myopia {13 (16.3%)} were slightly more frequent compared to those not admitted. Still, there was no significant association between NICU admission and type of refractive error (p=0.275).

In summary, while certain risk factor subgroups showed minor variations in the proportions of refractive errors, no statistically significant association was found between any perinatal, antenatal, natal, postnatal risk factor or NICU admission and the type of refractive error (all p>0.05).

[Table/Fig-4] illustrates the prevalence of various ocular diseases other than refractive errors in the study population. Strabismus was the most commonly observed condition, affecting 59 children (29.35%) with ocular diseases excluding refractive errors. The next most frequent diagnosis was CVI, present in 13 cases (6.47%), followed by cataract in 12 cases (5.97%), keratoconus in 8 cases (3.98%), amblyopia in 7 cases (3.48%), and optic atrophy in seven cases (3.48%). Other less common conditions included nystagmus in five cases (2.49%), congenital ptosis in four cases (1.99%), telecanthus in two cases (1.0%), macular coloboma in three cases (1.49%), blepharitis and epicanthus each in two cases (1.0%), and entropion in one case (0.5%). These findings emphasise that strabismus is the predominant co-morbidity in this cohort, while the other ocular conditions were relatively rare.

[Table/Fig-5] summarises the distribution of ocular diseases other than refractive errors among 201 children, analysed according to age group, sex, and type of DD. Strabismus emerged as the most prevalent condition, accounting for {59 (29.4%)} with Esotropia {37 (18.4%)} more common than exotropia {22 (10.9%)} of all cases, and its frequency increased with age, reaching the highest proportion in the 10-15 years age group 14 which is 50% of total strabismus. CVI {13 (6.5%)} and cataract {12 (6%)} were the next most commonly observed disorders. CVI was particularly notable in



[Table/Fig-4]: Distribution of other ocular diseases apart from refractive error.

the 2-5 years age group, while cataract was more frequent among the youngest children. Other conditions, including keratoconus, amblyopia, and optic atrophy, were present at lower rates. A comparison by sex revealed that strabismus was more frequent in males {32 (26.7%)} than females {27 (33.3%)}, whereas CVI and keratoconus were observed slightly more in males. Analysis by type of DD showed that strabismus remained the most common finding in both GDD {50 (31.8%)} and intellectual DD {9 (20.5%)}, with less frequently occurring conditions accounting for a higher proportion in the IDD group. Importantly, statistical analysis indicated no significant association between the distribution of these ocular diseases and age, sex, or type of DD (all p>0.05). This suggests that strabismus and other ocular co-morbidities can occur across a broad spectrum of demographic and clinical backgrounds in this pediatric population.

[Table/Fig-6] summarises the distribution of ocular diseases apart from refractive error according to perinatal risk factors. Strabismus was consistently the most common finding across almost all subgroups, accounting for {59 (29.4%)} overall. No significant association was observed between the presence of ocular diseases and consanguinity, antenatal factors, mode of delivery, or postnatal factors (all p>0.05). However, a statistically significant difference was seen with respect to birth history: preterm children showed a higher frequency of CVI {7 (12.1%)}, cataract {6 (10.3%)}, and less frequently occurring ocular diseases {7 (12.1%)} compared to children born at term, who had a higher prevalence of strabismus {49 (34.3%)} (p=0.016*). Other ocular conditions, such as amblyopia, keratoconus, and optic atrophy, were seen less frequently across all risk factor categories. NICU admission was associated with a relatively higher proportion of CVI {10 (12.5%)} and strabismus {25 (31.3%)}, but without statistical significance. Overall, except for birth history (preterm vs. term), no significant association was found between other perinatal risk factors and specific ocular co-morbidities in this paediatric population.

Variables	Other Ocular Diseases Apart from Refractive Error										p-value
	Amblyopia	Cataract	Cortical Visual Impairment (CVI)	Entropion	Keratoconus	Less Frequently Occurring Cases	Strabismus (Eye Misalignment)	Optic Atrophy	Normal Vision	Total	
Age group											
6 months - 2 years	3 (4.5%)	7 (10.6%)	2 (3.0%)	0 (0.0%)	1 (1.5%)	7 (10.6%)	17 (25.8%)	2 (3.0%)	27 (40.9%)	66 (100%)	0.375
2+ years - 5 years	1 (1.7%)	4 (6.8%)	6 (10.2%)	1 (1.7%)	5 (8.5%)	4 (6.8%)	12 (20.3%)	3 (5.1%)	23 (39.0%)	59 (100%)	
5+ years - 8 years	1 (3.2%)	0 (0.0%)	2 (6.5%)	0 (0.0%)	0 (0.0%)	3 (9.7%)	9 (29.0%)	1 (3.2%)	15 (48.4%)	31 (100%)	
8+ years - 10 years	0 (0.0%)	0 (0.0%)	1 (5.9%)	0 (0.0%)	2 (11.8%)	2 (11.8%)	7 (41.2%)	0 (0.0%)	5 (29.4%)	17 (100%)	
10+ years - 15 years	2 (7.1%)	1 (3.6%)	2 (7.1%)	0 (0.0%)	0 (0.0%)	2 (7.1%)	14 (50.0%)	1 (3.6%)	6 (21.4%)	28 (100%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100%)	
Sex											
Male	4 (3.3%)	8 (6.7%)	10 (8.3%)	1 (0.8%)	6 (5.0%)	10 (8.3%)	32 (26.7%)	5 (4.2%)	44 (36.7%)	120 (100%)	0.791
Female	3 (3.7%)	4 (4.9%)	3 (3.7%)	0 (0.0%)	2 (2.5%)	8 (9.9%)	27 (33.3%)	2 (2.5%)	32 (39.5%)	81 (100%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100%)	
Type of DD											
GDD	5 (3.2%)	10 (6.4%)	10 (6.4%)	1 (0.6%)	5 (3.2%)	10 (6.4%)	50 (31.8%)	5 (3.2%)	61 (38.9%)	157 (100%)	0.336
IDD	2 (4.5%)	2 (4.5%)	3 (6.8%)	0 (0.0%)	3 (6.8%)	8 (18.2%)	9 (20.5%)	2 (4.5%)	15 (34.1%)	44 (100%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100%)	

[Table/Fig-5]: Distribution of ocular findings according to age group, sex, and type of Developmental Delay (DD) in children (n=201).

Variables	Other Ocular Diseases Apart from Refractive Error										p-value
	Amblyopia	Cataract	Cortical Visual Impairment (CVI)	Entropion	Keratoconus	Less Frequently Occurring Cases	Strabismus (Eye Misalignment)	Optic Atrophy	Normal Vision	Total	
Consanguinity											
C-III Degree	0 (0.0%)	0 (0.0%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (33.3%)	0 (0.0%)	3 (50.0%)	6 (100%)	0.884
C-I Degree	0 (0.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	0 (0.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)	3 (100%)	
C-II Degree	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	1 (50.0%)	2 (100%)	
NC	7 (3.7%)	11 (5.8%)	12 (6.3%)	1 (0.5%)	7 (3.7%)	18 (9.5%)	55 (28.9%)	7 (3.7%)	72 (37.9%)	190 (100%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100%)	
Antenatal/birth history											
Asthma	0 (0.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	2 (100%)	0.744
Fever With Rash	0 (0.0%)	1 (14.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (42.9%)	1 (14.3%)	2 (28.6%)	7 (100%)	
GDM	1 (5.0%)	1 (5.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (15.0%)	2 (10.0%)	2 (10.0%)	11 (55.0%)	20 (100%)	
IUGR	0 (0.0%)	2 (20.0%)	1 (10.0%)	0 (0.0%)	0 (0.0%)	1 (10.0%)	2 (20.0%)	0 (0.0%)	4 (40.0%)	10 (100%)	
PIH	0 (0.0%)	2 (14.3%)	2 (14.3%)	0 (0.0%)	0 (0.0%)	1 (7.1%)	4 (28.6%)	0 (0.0%)	5 (35.7%)	14 (100%)	
Seizure	1 (16.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (16.7%)	0 (0.0%)	4 (66.7%)	6 (100%)	
UE	5 (3.5%)	6 (4.2%)	9 (6.3%)	1 (0.7%)	8 (5.6%)	13 (9.0%)	46 (31.9%)	4 (2.8%)	50 (34.7%)	144 (100%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100%)	
Birth history											
Preterm (n=58)	4 (6.9%)	6 (10.3%)	7 (12.1%)	0 (0.0%)	0 (0.0%)	7 (12.1%)	10 (17.2%)	3 (5.2%)	21 (36.2%)	58 (100.0%)	0.016*
Term (n=143)	3 (2.1%)	6 (4.2%)	6 (4.2%)	1 (0.7%)	8 (5.6%)	11 (7.7%)	49 (34.3%)	4 (2.8%)	55 (38.5%)	143 (100.0%)	
Total (n=201)	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100.0%)	
Mode of delivery											
Cesarean Section (n=39)	0 (0.0%)	1 (2.6%)	5 (12.8%)	0 (0.0%)	2 (5.1%)	3 (7.7%)	9 (23.1%)	2 (5.1%)	17 (43.6%)	39 (100.0%)	0.475

Normal Vaginal Delivery (n=162)	7 (4.3%)	11 (6.8%)	8 (4.9%)	1 (0.6%)	6 (3.7%)	15 (9.3%)	50 (30.9%)	5 (3.1%)	59 (36.4%)	162 (100.0%)	
Total (n=201)	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100.0%)	
Postnatal birth history											
Asphyxia (n=28)	1 (3.6%)	3 (10.7%)	6 (21.4%)	0 (0.0%)	0 (0.0%)	4 (14.3%)	6 (21.4%)	1 (3.6%)	7 (25.0%)	28 (100.0%)	0.302
Jaundice (n=27)	1 (3.7%)	1 (3.7%)	3 (11.1%)	1 (3.7%)	1 (3.7%)	2 (7.4%)	9 (33.3%)	1 (3.7%)	8 (29.6%)	27 (100.0%)	
Seizure (n=14)	0 (0.0%)	0 (0.0%)	1 (7.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (42.9%)	0 (0.0%)	7 (50.0%)	14 (100.0%)	
Sepsis (n=11)	0 (0.0%)	1 (9.1%)	0 (0.0%)	0 (0.0%)	1 (9.1%)	0 (0.0%)	4 (36.4%)	0 (0.0%)	5 (45.5%)	11 (100.0%)	
Unknown Event (UE) (n=121)	5 (4.1%)	7 (5.8%)	3 (2.5%)	0 (0.0%)	6 (5.0%)	12 (9.9%)	34 (28.1%)	5 (4.1%)	49 (40.5%)	121 (100.0%)	
Total (n=201)	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100.0%)	
NICU status											
Yes	2 (2.5%)	5 (6.3%)	10 (12.5%)	1 (1.3%)	2 (2.5%)	6 (7.5%)	25 (31.3%)	2 (2.5%)	27 (33.8%)	80 (100.0%)	0.173
No	5 (4.1%)	7 (5.8%)	3 (2.5%)	0 (0.0%)	6 (5.0%)	12 (9.9%)	34 (28.1%)	5 (4.1%)	49 (40.5%)	121 (100.0%)	
Total	7 (3.5%)	12 (6.0%)	13 (6.5%)	1 (0.5%)	8 (4.0%)	18 (9.0%)	59 (29.4%)	7 (3.5%)	76 (37.8%)	201 (100.0%)	

[Table/Fig-6]: Distribution of ocular diseases apart from refractive error according to perinatal risk factors.

Lastly, [Table/Fig-7] highlights the prevalence of ocular abnormalities by type of DD. Ocular abnormalities were identified in 166 (82.6) out of 201 children, affecting {129 (77.7%)} with GDD and {37 (22-2%)} with IDD. Although the proportion was slightly higher in the IDD group, the difference was not statistically significant (p=0.942).This finding underscores the widespread prevalence of ocular abnormalities among all children with DDs, emphasising the critical importance of comprehensive ophthalmological evaluations irrespective of DD classification.

Disease status	Type of DD			p-value
	GDD	IDD	Total	
Diseased/(Abnormal)	129 (77.7%)	37 (22.2%)	166 (82.6%)	0.942
Normal	28 (80.0%)	7 (20%)	35 (17.4%)	

[Table/Fig-7]: Association between disease status and type of Developmental Delay (DD).

DISCUSSION

The present study investigated the ocular manifestations in children with DD, examining the prevalence of various eye conditions and their association with demographic and perinatal factors.

Children's age in the present study averaged 5.73±4.07 years, with 32.8% of participants in the youngest age bracket (6 months to 2 years). This concurs with earlier research, which suggested DD are most often identified early in life. Afroze R et al., (2021) reported a mean age of 1.57 years, with 53.9% of the children with DD being younger than one year in their study [22].

Likewise, in their study, Kavitha V et al., (2023) found a mean age of 4.97 years [23]. The very early identification of DDs, as noted in the present study and other studies, highlights the necessity of conducting an early screening for ophthalmological intervention in this population.

The present study found out that DD was more prevalent in males (59.7%) as compared to females (40.3%). Previous literature also suggested that DD has a male predominance. Hegde V et al., (2021) and Kavitha V et al., (2023) also reported a prevalence of male (64.8% and 64.89%, respectively [15,23]. Sandfeld Nielsen L et al., (2008) reported a male: female ratio of 1.53:1, which is consistent with present study [24]. The higher frequency of DD in males is probably due to a combination of genetic and environmental factors.

The GDD was the most common type of DD in present study, being observed in 78.1% of the children, while IDD was observed in 21.9%. This finding corroborates with previous research. Hegde V et al., (2021), Joshi MS et al., (2017), and Wadhwani M et al., (2024) also reported a higher prevalence of GDD (85.93%, 84.8%, and 75%, respectively) in children with DD [15,25,26]. The overwhelming proportion of GDD reveals the multifaceted nature of developmental impairment in these children, which often is across multiple developmental domains.

Refractive errors were highly prevalent in present study population, affecting 59.2% of children. Hypermetropia (27.4%) was the most common refractive error, followed by astigmatism (20.9%) and myopia (10.9%). This finding is consistent with other studies that have reported a high prevalence of refractive errors in children with DD. Kavitha V et al., (2023) [23], Hegde V et al., (2021) [15], Joshi MS et al., (2017) [25], and Kumar M et al., (2023) [27] found the prevalence of refractive errors in children with DD to be 74.47%, 67.96%, 79.5%, and 53.7%, respectively. However, the most common type of refractive error varied across studies, with some reporting astigmatism as the most common, while others reported hypermetropia, similar to present study [22,25].

In addition, other ocular diseases apart from refractive error the most common condition were strabismus (29.4%). It included esotropia (18.4%) and exotropia (10.9%). CVI was seen in 6.47% of cases. Cataract was present in 5.97%. Keratoconus was found in 3.98%. Amblyopia and optic atrophy were seen in 3.48% each. Nystagmus was reported in 2.49%. Congenital Ptosis was observed in 1.99%. Telecanthus, Epicanthus Blepharitis were each seen in 1.00% of cases. Macular coloboma was seen in 1.49%. Entropion was the least common, seen in 0.50%. These results highlight the need for early eye examination in children with DDs were also reported in previous studies.

Other studies also indicate the high prevalence of ocular disorders in youngsters with some DDs. About 88.29% of their subjects had eye abnormalities, up to the work of Kavitha V et al., (2023) [23]. Strabismus formed the bulk of this condition (41.5%), followed by CVI (13.8%) and cataracts (5.3%). Their study shows that of the children, 19.14% had esotropia, and 22.34% had exotropia. Hegde V et al., (2021) claimed that the 85.93% of children had eye abnormalities, with this one having strabismus (50.8%) as the most common type [15]. Other ones reported include optic atrophy,

cataracts, ptosis, and keratoconus. They said esotropia is the commonest type of strabismus in the study.

Joshi MS et al., (2017) found that 84.8% of children exhibited eye diseases, among which strabismus (46.4%) and optic atrophy (10%) were the more common [25]. Out of the children with strabismus, 52% had exotropia while 48% had esotropia. Wadhwani M et al., (2023) reported that, as regards children affected by eye abnormalities, 88.89% reported cases that had strabismus (33.33%), temporal disc pallor (22.2%), and optic atrophy (12.9%) [26]. Their research showed that esotropia was found in 20.03% of children and exotropia in 12.96%.

In the present study, consanguinity among parents was observed in 5.5% of children with DDs, with first, second and third degree relationships seen in 1.5%, 1%, and 3% respectively. Although a minority, this highlights the genetic risk associated with consanguinity. Comparable findings were noted by Kumar M et al., (2023) [27] (7.4%), while higher rates were reported by Wadhwani M et al., (2023) [26] (22.9%) and Kavitha V et al., [23] (13.83%) . These findings reinforce the role of genetic counselling and early ocular screening in such cases. Antenatal complications were noted in 28.3% of cases, most commonly GDM (10%) and pregnancy-induced hypertension (7%). This suggests a link between maternal health and developmental outcomes. Similar findings were reported by Hegde V et al., [16] (20.31%) and Wadhwani M et al., (2023) [26] (29.1%). Kumar M et al., (2023) [27] and Kavitha V et al., (2023) [23] also highlighted associations with IUGR and infections. Preterm birth (<37 weeks) was seen in 28.9% of children. While the majority were full-term, the substantial preterm rate aligns with known risks of low birth weight and neurodevelopmental compromise. Hegde V et al., (2021) [15] and Kumar M et al., (2023) [27] reported comparable findings (24.22% and 38.89% respectively), while Kavitha V et al., (2023) [23] and Wadhwani M et al., (2023) [26] showed lower rates (10.64% and 7.3%). NICU admission was required in 39.8% of cases, often due to asphyxia, jaundice, seizures, or infections. These factors are well-known to impact neurodevelopment. In comparison, Hegde V et al., [22] reported NICU stays in 50% of children, while Kavitha V et al., (2023) [23] reported admissions in 21 children, mainly due to similar complications.

Limitation(s)

This study was conducted in a single institution, which may limit the generalisability of its findings to other medical settings or more diverse patient populations. Additionally, neuroimaging was not performed for all participants, potentially restricting the depth of neurological assessment. Furthermore, as a cross-sectional study, it did not include follow-up assessments, making it difficult to evaluate long-term changes over time.

CONCLUSION(S)

Ocular conditions such as refractive errors, strabismus, amblyopia, ptosis, cataract, and optic atrophy are frequently observed in children with DDs. Early detection and management of treatable conditions such as refractive errors, strabismus, amblyopia, ptosis, and cataract can greatly improve both visual function and overall development. Regular vision screening, multidisciplinary collaboration and caregiver education are crucial for timely diagnosis and effective management, ultimately enhancing the child's ability to learn, interact, and achieve better developmental outcomes.

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