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Refractive Status of Premature and Low-Birth-Weight Babies With or Without Retinopathy of Prematurity at One Year of Age

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Abstract

Background

Advances in neonatal care have improved the survival of premature infants, increasing the population at risk of retinopathy of prematurity (ROP) and its associated refractive abnormalities. These refractive changes may have important implications for visual development and long-term visual outcomes.

Objective

This study aimed to compare refractive status at one year of age among premature and low-birth-weight (LBW) infants with and without ROP.

Methods

This analytical cross-sectional study was conducted at Chittagong Medical College Hospital, Bangladesh, from January 2024 to June 2025. A total of 110 infants were included: 53 with ROP and 57 without ROP. Cycloplegic refraction was performed. Spherical equivalent (SE) was calculated, and factors associated with refractive outcomes were evaluated.

Results

Infants with ROP had significantly lower birth weight and gestational age and longer NICU stay and oxygen therapy than those without ROP (all $p < 0.001$). Mean spherical value (−0.09 ± 0.91 vs. 1.84 ± 0.63 D) and SE (−0.07 ± 0.92 vs. 1.80 ± 0.64 D) were significantly lower in the ROP group (both $p < 0.001$). Myopia was more frequent in the ROP group (50.9% vs. 3.5%). ROP stage showed a strong negative correlation with SE ($\rho = -0.756$, $p < 0.001$), indicating an increasing myopic shift with advancing ROP stage. In multivariable analysis, ROP distribution remained significantly associated with SE after adjustment for sex, birth weight, gestational age, and duration of oxygen therapy ($B = -1.745$, $p < 0.001$).

Conclusion

ROP was associated with a more myopic refractive profile at one year of age. Regular refractive assessment and long-term ophthalmic follow-up are warranted for infants with ROP.

Categories: Ophthalmology, Pediatrics
Keywords: low birth weight, myopia, refractive error, retinopathy of prematurity, spherical equivalent

Introduction

Retinopathy of prematurity (ROP) is an important retinal vascular disorder affecting premature and low-birth-weight infants and remains a potentially preventable cause of childhood visual impairment [1,2]. Advances in neonatal care have improved the survival of increasingly premature infants but have also increased the number of children at risk of ROP and its long-term ocular sequelae [3]. Even when ROP regresses without treatment, affected infants may subsequently develop refractive abnormalities that require continued ophthalmic surveillance [1].

Infantile refractive development relies on emmetropization, a rapid process where axial length, corneal curvature, and lens power adjust to reduce neonatal hyperopia toward low hyperopia or emmetropia by 24 months of age [4]. The refractive status of premature infants can be influenced by both prematurity itself and the presence of ROP [5]. The study revealed a strong link between prematurity, ROP, and eye development, with premature infants showing significant differences in eye structure and vision compared to full-term infants, even despite spontaneous regression of ROP [1]. One of the most well-known visual impairments linked to premature birth is myopia. Premature births significantly increase the risk of developing hyperopia, astigmatism, and anisometropia, among other refractive errors, in addition to myopia

[6]. Many studies reported that there is decreased visual acuity in babies born prematurely regardless of the presence of ROP compared with the babies born at term [7,8].

Although refractive abnormalities following ROP have been documented, evidence specifically addressing refractive status at approximately one year of age remains limited, as many previous studies have assessed children over broader age ranges or at later follow-up periods [9,10]. Early identification of refractive errors is particularly important because uncorrected refractive abnormalities during visual development may adversely affect subsequent visual function.

Despite growing literature globally on refractive outcomes in premature infants, there is a paucity of data-particularly in countries like Bangladesh-focused specifically on refractive status at one year of age, a critical period for visual maturation and emmetropization. Therefore, this study aimed to compare refractive status at one year of age between premature and low-birth-weight infants with and without ROP, assess the correlation between ROP stage and refractive outcomes, and identify factors independently associated with refractive status. We hypothesized that infants with ROP would demonstrate a more myopic refractive profile than those without ROP.

Materials And Methods

Study design and setting

This analytical cross-sectional study was conducted in the Department of Ophthalmology, Chittagong Medical College Hospital (CMCH), Chattogram, Bangladesh, from January 2024 to June 2025. The study included premature and low-birth-weight infants who had undergone ROP screening after birth.

Sample size calculation

The sample size was calculated using the formula for testing the difference between two proportions:

$$n = (p(100-p) + q(100-q))/(p-q)^2(z_\alpha + z_\beta)^2$$

where n represents the required sample size in each group, z_α is the standard normal deviate at a 95% confidence level (1.96), z_β is the standard normal deviate at 95% statistical power (1.64), p is the expected proportion of myopia among infants with ROP (33.3%), and q is the expected proportion of myopia among infants without ROP (3.7%). These proportions were adopted from the study by Theng et al. [6], which reported myopia in 33.3% of infants with ROP and 3.7% of infants without ROP at one-year follow-up. Substituting the values,

$$n = \frac{[33.3(66.7) + 3.7(96.3)]\,(1.96+1.64)^2}{(33.3-3.7)^2}$$

$$n = 38.13 \approx 39$$

Thus, the minimum required sample size was 39 infants in each group, giving a total of 78 infants.

Sampling technique and study population

A non-probability convenience sampling technique was used to recruit eligible infants during the study period. The final sample comprised 110 infants, including 53 in the ROP group and 57 in the non-ROP group. The unequal group sizes reflected the actual distribution of eligible infants during recruitment. Nevertheless, both groups exceeded the calculated minimum sample size requirement of 39 participants per group.

Eligibility criteria

Eligible infants were approximately one year of age, had a birth weight below 2,000 g and gestational age of 35 weeks or less, and had undergone ROP screening. Infants with severe ocular or systemic malformations, retinal or choroidal diseases other than ROP, a family history of high myopia, or previous ROP treatment with intravitreal anti-VEGF, laser, or surgery were excluded. Medical records of 142 neonates who had undergone ROP screening at the Department of Ophthalmology, CMCH, were reviewed. Of these, 115 met the eligibility criteria, while five were excluded because consent was not obtained. The remaining 110 infants were enrolled. Following ocular examination, they were categorized into the non-ROP (n = 57) and ROP (n = 53) groups.

Data collection procedure

Perinatal information, including birth weight, gestational age, NICU stay, and duration of oxygen therapy,

was obtained from medical records. ROP was classified per International Classification of Retinopathy of Prematurity (ICROP) criteria by severity, zone, and plus disease. Severity was graded as stage 1 (avascular demarcation line), stage 2 (elevated ridge), stage 3 (extraretinal fibrovascular proliferation), stage 4 (partial retinal detachment: 4A fovea-sparing, 4B fovea-involving), and stage 5 (total funnel-shaped retinal detachment). Location was categorized around the optic disc into zone I (circle with radius twice the disc-to-macula distance), zone II (ring extending to the nasal ora serrata), and zone III (remaining temporal crescent). Plus disease was recorded when posterior pole arterioles and venules exhibited marked dilation and tortuosity [11].

At the one-year follow-up, cycloplegic refraction was performed using retinoscopy. Before cycloplegic refraction, parents or guardians were counseled regarding the potential adverse effects of atropine toxicity, including flushing, fever, and rash, and their appropriate management. Each infant was prescribed 1% atropine eye ointment twice daily for three consecutive days before the scheduled examination. Atropine 1% eye ointment was selected to achieve adequate and sustained cycloplegia for accurate refractive assessment in this young pediatric population, in whom active accommodation may affect non-cycloplegic refractive measurements. At the appointment, cycloplegic refraction was performed using a Heine BETA 200 retinoscope (HEINE Optotechnik, Gilching, Germany) to obtain objective refractive measurements by a single ophthalmologist. The examining ophthalmologist was blinded to the infants' ROP status. No formal interobserver or intraobserver reliability assessment was performed. No atropine-related adverse effects were observed during the study. For each infant, spherical equivalent (SE) was calculated as sphere plus half the cylindrical power for each eye. To avoid statistical bias arising from inter-eye correlation and ensure statistical independence, only the right eye of each participant was selected for the primary analysis. Inter-eye symmetry was subsequently verified across the cohort using Spearman’s rank correlation (rho = 0.976, $p < 0.001$). Myopia was defined as SE ⩽ −0.50 D, hypermetropia as SE ⩾ +2.00 D, and astigmatism as cylindrical power ⩾ 1.00 D. Anisometropia was defined as an interocular difference in SE refractive error of more than 1.00 D [12].

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Continuous variables were evaluated for normality using the Shapiro-Wilk test. Because refractive data showed non-normal distributions ($p < 0.001$), non-parametric methods were applied. Inter-eye symmetry and correlation were evaluated using Spearman’s rank correlation (rho = 0.976, $p < 0.001$) to justify the representativeness of the selected eye data. For comparisons between the ROP and non-ROP groups, the independent-samples t-test was used for continuous variables, while the Pearson chi-squared (χ^2) test was used for categorical variables. Fisher's exact test was applied when the expected cell frequencies were insufficient for the chi-squared test. The relationship between ROP stage and neonatal and refractive parameters was assessed using correlation analysis. Spearman's rank correlation coefficient (ρ) was used for variables analyzed by the non-parametric method, while Pearson's correlation coefficient (r) was used where appropriate for normally distributed continuous variables. The strength and direction of the correlations were assessed using the respective correlation coefficients. Multiple linear regression analysis was performed to identify independent predictors of SE, which was treated as a continuous dependent variable. Regression coefficients (B), standard errors (SE), 95% confidence intervals (CI), and corresponding p-values were calculated for the independent variables included in the model. All statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Ethical Review Committee of CMCH (Memo No. 59.27.0000.013.19.PG.2024/1070, dated February 29, 2024). Written informed consent was obtained from the parents or legal guardians of all participating infants before enrolment.

Results

Table *1* shows that the study included 110 infants, comprising 57 (51.8%) in the non-ROP group and 53 (48.2%) in the ROP group. The mean age at refractive assessment was similar between the non-ROP and ROP groups (54.0 ± 1.2 vs. 54.1 ± 1.2 weeks; $p = 0.805$). Female infants accounted for 29 (50.9%) of the non-ROP group and 37 (69.8%) of the ROP group, with a significant difference in sex distribution ($p = 0.043$). Infants with ROP had significantly lower birth weight and gestational age and significantly longer NICU stay and oxygen therapy than those without ROP (all $p < 0.001$).

Variables	Non-ROP (n = 57)	ROP (n = 53)	Test statistic	p-value
Age at assessment (weeks), mean ± SD	54.0 ± 1.2	54.1 ± 1.2	t = −0.247	0.805†
Sex, n (%)			χ^2 = 4.102	0.043*
Male	28 (49.1)	16 (30.2)		
Female	29 (50.9)	37 (69.8)		
Birth weight (g), mean ± SD	1,672.0 ± 195.2	1,362.3 ± 200.2	t = 8.210	<0.001†
Gestational age (weeks), mean ± SD	32.8 ± 1.8	31.2 ± 1.7	t = 4.781	<0.001†
NICU stay (days), mean ± SD	8.5 ± 6.1	16.1 ± 9.2	t = −5.094	<0.001†
Oxygen therapy (days), mean ± SD	4.4 ± 9.3	9.3 ± 6.4	t = −4.963	<0.001†

TABLE 1: Demographic and neonatal characteristics of study participants

Data are expressed as either frequency (percentage) or mean ± SD. All tests were two-sided; $p < 0.05$ was considered statistically significant.

*p-value derived from chi-squared test.

†p-value derived from independent-samples t-test.

SD: standard deviation; ROP: retinopathy of prematurity; t: t-test statistic; χ^2: Pearson's chi-squared test statistic

Table 2 shows that the mean spherical value was −0.09 ± 0.91 D in the 53 infants with ROP compared with 1.84 ± 0.63 D in the 57 non-ROP infants ($p < 0.001$). Similarly, the mean SE was −0.07 ± 0.92 D in the ROP group versus 1.80 ± 0.64 D in the non-ROP group ($p < 0.001$). The mean cylindrical value was −0.06 ± 0.39 D in the ROP group and 0.04 ± 0.19 D in the non-ROP group, with no statistically significant difference ($p = 0.127$).

Refractive parameter	Non-ROP (n=57)	ROP (n=53)	t (df)	p-value
Spherical value (D)	1.84 ± 0.63	−0.09 ± 0.91	12.362 (81.071)	<0.001
Cylindrical value (D)	0.04 ± 0.19	−0.06 ± 0.39	1.542 (73)	0.127
Spherical equivalent (D)	1.80 ± 0.64	−0.07 ± 0.92	11.589 (90.983)	<0.001

TABLE 2: Refractive parameters of the respondents

Data are presented as mean ± standard deviation (SD). Independent-samples t-test was used for between-group comparisons. Welch's t-test was applied when the assumption of equal variances was violated, as determined by Levene's test. All tests were two-tailed, and $p < 0.05$ was considered statistically significant.

t: t-test statistic; df: degrees of freedom; ROP: retinopathy of prematurity

Table 3 demonstrates a marked difference in refractive-status distribution. Among the 53 infants with ROP, 27 (50.9%) had myopia, 19 (35.8%) had emmetropia, four (7.5%) had hypermetropia, and three (5.7%) had astigmatism. Among the 57 non-ROP infants, 26 (45.6%) had emmetropia, two (3.5%) had myopia, 28 (49.1%) had hypermetropia, and one (1.8%) had astigmatism. Inter-eye refractive differences were minimal, with no cases of anisometropia observed in the study cohort.

Refractive status	Non-ROP (n = 57)	ROP (n = 53)
Emmetropia	26 (45.6)	19 (35.8)
Myopia	2 (3.5)	27 (50.9)
Hypermetropia	28 (49.1)	4 (7.5)
Astigmatism	1 (1.8)	3 (5.7)

TABLE 3: Refractive status according to ROP status

Data are expressed as frequency (percentage).

ROP: retinopathy of prematurity

Among the 53 infants diagnosed with ROP, 22 (41.5%) had stage 1 and 31 (58.5%) had stage 2 ROP. Regarding retinal location, zone II was more frequently observed, accounting for 41 (77.4%) cases, while 12 (22.6%) cases involved zone III. Among infants with zone II ROP, 20 (37.7%) had stage 1 and 21 (39.6%) had stage 2 disease. In comparison, among those with zone III ROP, two (3.8%) had stage 1 and 10 (18.9%) had stage 2 disease. Plus disease was present in 10 (18.9%) infants, all of whom had stage 1, zone II ROP. The remaining 43 (81.1%) infants had no plus disease, including 12 (22.6%) with stage 1 and 31 (58.5%) with stage 2 ROP. Infants who had received treatment for ROP, including intravitreal anti-VEGF injection, laser therapy, or surgical treatment, were excluded from the study (Table *4*).

Clinical characteristics	Stage 1, n (%)	Stage 2, n (%)	Total, n (%)
ROP zone			
Zone II	20 (37.7)	21 (39.6)	41 (77.4)
Zone III	2 (3.8)	10 (18.9)	12 (22.6)
Plus disease			
Present	10 (18.9)	0 (0.0)	10 (18.9)
Absent	12 (22.6)	31 (58.5)	43 (81.1)
Total	22 (41.5)	31 (58.5)	53 (100.0)

TABLE 4: Distribution of ROP stage, zone, and plus disease among infants with ROP (n = 53)

Percentages are calculated using the total number of infants with ROP (n = 53).

ROP: retinopathy of prematurity

Table *5* shows that among the 53 infants with ROP, birth weight showed a weak negative correlation with ROP stage ($r = -0.144$, $p = 0.305$). Gestational age ($\rho = -0.119$, $p = 0.395$) and duration of oxygen therapy ($\rho = -0.055$, $p = 0.694$) were also not significantly correlated with ROP stage. In contrast, spherical value showed a strong negative correlation with ROP stage ($\rho = -0.756$, $p < 0.001$). Significant negative correlations were also observed for cylindrical value ($\rho = -0.224$, $p = 0.019$) and SE ($\rho = -0.756$, $p < 0.001$), indicating increasingly myopic refractive measurements with increasing ROP stage.

Variable	Correlation coefficient (r/ρ)	p-value
Birth weight	−0.144	0.305
Gestational age	−0.119	0.395
Oxygen therapy duration	−0.055	0.694
Spherical value	−0.756	<0.001
Cylindrical value	−0.224	0.019
Spherical equivalent	−0.756	<0.001

TABLE 5: Correlation of ROP stage with neonatal and refractive parameters among infants with ROP

All tests were two-tailed, and $p < 0.05$ was considered statistically significant.

r: correlation coefficient; ρ: Spearman's rank correlation coefficient; ROP: retinopathy of prematurity

Table 6 shows that multiple linear regression analysis was performed to identify factors associated with SE, adjusting for sex, birth weight, gestational age, duration of oxygen therapy, and distribution of ROP. The overall regression model was statistically significant ($F(5, 98) = 32.660$, $p < 0.001$), explaining 62.5% of the variation in right-eye spherical power ($R^2 = 0.625$; adjusted $R^2 = 0.606$).

Predictor	B	SE	95% CI for B	t	p-value	VIF
Sex	-0.208	0.16	−0.525 to 0.109	-1.299	0.197	1.056
Birth weight (kg)	0.55	0.409	−0.261 to 1.362	1.346	0.181	1.697
Gestational age (weeks)	0.013	0.045	−0.076 to 0.102	0.291	0.771	1.23
Oxygen therapy (days)	0.01	0.016	−0.021 to 0.041	0.648	0.518	1.292
Distribution of ROP	-1.745	0.213	−2.167 to −1.322	-8.187	<0.001	1.955
Model statistics	Value					
R^2	0.625					
Adjusted R^2	0.606					
F-statistic (df)	32.660 (5, 98)					
Model p-value	<0.001					

TABLE 6: Multiple linear regression analysis of factors associated with spherical equivalent

The dependent variable was spherical equivalent. Statistical significance was set at $p < 0.05$.

B: unstandardized regression coefficient; SE: standard error; CI: confidence interval; VIF: variance inflation factor; ROP: retinopathy of prematurity

Among the predictors, distribution of ROP showed a significant negative association with SE power (B = −1.745, 95% CI: −2.167 to −1.322, $p < 0.001$). However, sex, birth weight, gestational age, and duration of oxygen therapy were not significantly associated with the outcome after adjustment for the other variables. No concerning multicollinearity was observed, with variance inflation factor (VIF) values ranging from 1.056 to 1.955. Regression diagnostic plots indicated an approximately normal residual distribution and no obvious major violation of homoscedasticity.

Discussion

Our study included a total of 110 participants (57 in the non-ROP group and 53 in the ROP group). The distribution of ROP among our study participants showed that 51.8% did not develop ROP, while 48.2% did.

Numerous factors, such as the fact that the study was conducted in a tertiary care facility, the possibility that the infants included in it were a higher-risk group, and the methods chosen for this study, could account for the relatively high incidence rate.

The mean age of the ROP and non-ROP groups at the time of refractive evaluation was not significantly different (54.0 ± 1.2 weeks for non-ROP vs. 54.1 ± 1.2 weeks for ROP, p = 0.805), according to the demographic analysis. This suggests that both groups' follow-up periods were similar, enabling a standardized evaluation of refractive status at one year of age. Additionally, there was a statistically significant difference in the distribution of sexes (p = 0.043), with the ROP group having a much higher proportion of females (69.8%) than the non-ROP group (50.9%). Our ROP group demonstrated a higher female prevalence, in contrast to some studies that suggest a male predominance in ROP [13]. This discrepancy suggests that sex-specific biological or care-related factors, such as hormonal impacts, differences in neonatal care methods, or social perceptions of female babies, may be at play.

In this study, infants in the ROP group demonstrated significantly lower birth weights (1,362.3 ± 200.2 g vs. 1,672.0 ± 195.2 g, p < 0.001), lower gestational ages (31.2 ± 1.7 weeks vs. 32.8 ± 1.8 weeks, p < 0.001), longer oxygen therapy durations (9.3 ± 6.4 days vs. 4.4 ± 9.3 days, p < 0.001), and prolonged NICU stays (16.1 ± 9.2 days vs. 8.5 ± 6.1 days, p < 0.001) compared to the non-ROP group. These findings align with established literature identifying prematurity, low birth weight, and oxygen exposure as primary triggers for ROP development [14-16]. However, contrary to traditional expectations, neither birth weight ($r = -0.144$, $p = 0.305$), gestational age ($\rho = -0.119$, $p = 0.395$), nor duration of oxygen therapy ($\rho = -0.055$, $p = 0.694$) showed a statistically significant correlation with ROP stage progression. This discrepancy highlights a critical distinction between initial disease predisposing factors and drivers of severity; while baseline clinical parameters trigger ROP onset, subsequent stage progression is likely governed by more complex dynamics, such as oxygen saturation fluctuations, postnatal comorbidities, and neonatal management protocols.

The principal finding of this study was the significantly different refractive profile between infants with and without ROP at one year of age. Infants with ROP had a significantly lower mean spherical value (−0.09 ± 0.91 D) than infants without ROP (1.84 ± 0.63 D; p < 0.001). Similarly, SE was significantly lower in the ROP group (−0.07 ± 0.92 D vs. 1.80 ± 0.64 D; p < 0.001), indicating a marked shift toward myopia. In contrast, the difference in cylindrical value was not statistically significant (−0.06 ± 0.39 vs. 0.04 ± 0.19 D; p = 0.127). In a recent study, there was no significant difference in SE among the ROP group, the non-ROP group, and the control group in subjects of four to five years of age [5]. However, similarity was found in a previous study in which the mean SE was -0.5 D in right eyes and -0.4 D in left eyes (LEs) of preterms [17].

The categorical refractive findings were consistent with these continuous measurements. Myopia was present in 27 (50.9%) infants with ROP compared with only two (3.5%) infants without ROP. Conversely, hypermetropia was present in 28 (49.1%) non-ROP infants compared with four (7.5%) ROP infants, while emmetropia was observed in 26 (45.6%) and 19 (35.8%), respectively. Astigmatism was relatively uncommon in both groups, occurring in three (5.7%) infants with ROP and one (1.8%) without ROP.

The predominance of myopia among infants with ROP is consistent with previous evidence. In a study of 261 preterm infants, refractive errors at one year were significantly more frequent among infants with ROP, with myopia being the most common refractive abnormality. Theng et al. reported myopia in 33.3% of infants with ROP compared with 3.7% of those without ROP at one-year follow-up, which is similar to the marked difference observed in the present study, although the prevalence of myopia in our ROP group was higher (50.9%) [6]. In contrast, another study reported an 18% myopia rate at one year of age in patients with moderate ROP (stages 1 and 2) [18]. Differences in the severity of ROP, characteristics of premature infants, referral patterns, and criteria used to define refractive error may account for the variation between studies.

The greater frequency of hypermetropia among infants without ROP (49.1%) may indicate relatively preserved emmetropization compared with infants who developed ROP. The high prevalence of hypermetropia in the non-ROP group is supported by previous research [8,19]. The relatively low frequency of astigmatism in the present study may partly reflect the inclusion of untreated ROP cases and assessment at one year of age, since refractive outcomes can vary according to disease severity, treatment, age, and duration of follow-up.

The distribution of ROP according to disease stage, retinal zone, and plus disease status provides important insight into the clinical characteristics of the affected infants in the present study. Among the 53 infants with ROP, stage 2 was more frequent (58.5%) than stage 1 (41.5%). Most cases occurred in zone II (77.4%), with zone III involving 22.6%. Plus disease was found in 10 infants (18.9%), all with stage 1, zone II ROP; none were observed in stage 2 or zone III. Plus disease indicates abnormal retinal characteristics and is crucial for assessing treatment needs. Notably, infants previously treated for ROP were excluded, limiting the study's representation of severe cases. The findings warrant careful interpretation, especially when comparing to populations that include treated infants.

Importantly, the relationship between ROP and refractive outcome became stronger when ROP severity was considered. Spherical value showed a strong negative correlation with ROP stage ($\rho = -0.756$, $p < 0.001$),

indicating that higher ROP stages were associated with more myopic spherical measurements. SE demonstrated the same strong negative correlation (ρ = −0.756, p < 0.001), while the cylindrical value also showed a significant negative correlation (ρ = −0.224, p = 0.019). These findings suggest that the refractive consequences are not limited to the presence or absence of ROP but may also be related to the severity of retinal disease.

After multivariable adjustment for sex, birth weight, gestational age, and duration of oxygen therapy, ROP distribution remained the primary measured factor associated with SE at one year of age (B = −1.745, 95% CI: −2.167 to −1.322; p < 0.001), whereas the other included neonatal parameters did not show statistically significant associations. Rather than indicating strict causal independence, these results suggest that the refractive changes linked to ROP distribution are more pronounced than the direct effects captured by the other measured baseline variables. However, given the observational design and the possibility of residual confounding-such as unmeasured differences in disease severity, treatment modality, ocular biometry, or genetic predisposition-the independence of this association should be interpreted with caution.

Several mechanisms may explain the association between ROP and myopia. Premature birth and ROP can interfere with normal ocular growth and emmetropization, with altered anterior-segment development and other structural changes potentially contributing to the development of myopia [4,5]. The stronger association with increasing ROP stage in the present study further supports the possibility that the severity of retinal disease is related to the degree of disruption of normal ocular development.

Several important limitations warrant consideration. First, the single-center design, relatively small sample size, and non-probability convenience sampling at a tertiary-care hospital may have introduced selection bias and limited the generalizability of the findings. Second, significant baseline differences in gestational age, birth weight, oxygen exposure, and NICU stay indicate that the study groups were not comparable with respect to neonatal risk factors. Although regression analysis was performed, not all potential confounders were included in the model; therefore, residual confounding cannot be excluded. Third, the exclusion of infants who received laser photocoagulation, intravitreal anti-VEGF therapy, or surgery limits the applicability of the findings to infants with severe ROP. Fourth, the cross-sectional assessment at one year of age does not permit evaluation of longitudinal refractive development or changes in refractive status over time. Finally, the absence of ocular biometric measurements, including axial length, anterior chamber depth, and corneal curvature, limited the assessment of anatomical factors underlying the observed refractive differences.

Conclusions

ROP was significantly associated with an altered refractive profile at one year of age, particularly myopia. Infants with ROP demonstrated significantly lower spherical and spherical-equivalent values, with myopia being substantially more frequent than in infants without ROP. Furthermore, increasing ROP stage was strongly associated with a more myopic SE.

Infants with ROP should receive long-term ophthalmic follow-up with regular refractive assessment for early detection and correction of refractive errors. Larger multicenter studies with longer follow-up are recommended.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Md. Shahriar Alam, Anannaya Das, Sumee Rani Datta, Chiranjib Mondal

Critical review of the manuscript for important intellectual content: Md. Shahriar Alam, Utpal Sen

Concept and design: Rajia Sultana, Utpal Sen

Drafting of the manuscript: Rajia Sultana, Anannaya Das, Sumee Rani Datta, Chiranjib Mondal

Supervision: Utpal Sen

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Ethical Review Committee of Chittagong Medical College issued approval 59.27.0000.013.19.PG.2024/1070. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **AI use statement:** The authors used ChatGPT (GPT-6; OpenAI, San

Francisco, CA, USA) and Gemini (3; Google, Mountain View, CA, USA) as follows: language polishing, structure or formatting in Introduction, Methods, and Discussion. Key points, statistical values, interpretations, and references were cross-checked and verified against the original study data, statistical outputs, and literature. The final content was edited and approved by the researcher. The authors confirm that they have reviewed and verified all AI-assisted content and take full responsibility for the work.
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