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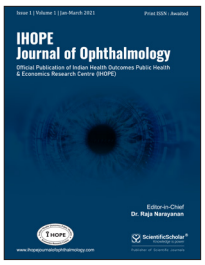

Original Article

Prevalence of retinopathy of prematurity

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ABSTRACT

Objectives: Retinopathy of prematurity (ROP) is a significant cause of preventable blindness among prematurely born babies. Advances in neonatal care support low-birth-weight babies and premature infants. These infants are more at risk of developing ROP. However, ROP is a preventable and treatable condition if newborns are screened in time. The study aims to identify the prevalence of ROP and assess the factors associated with ROP among newly born children in rural areas of South Gujarat.

Materials and Methods: This was a hospital-based prospective study for 1 year and 5 months, that is, 2022, September to 2024, February 2024. All the preterm babies falling within inclusion criteria that is, babies born ≤34 weeks and or those with ≤2 kg and/or babies with a history of oxygen support, were included in the study. Bivariate statistics, Chi-square test, and logistic regression models were applied using the STATA version 14 software.

Results: The study found that 4.8% of newborns had ROP. Extremely preterm adjusted odds ratio (AOR: 11.2, 95% confidence interval [CI]: 3.0–41.5) and very-low-birth-weight (AOR: 4.6; 95% CI: 1.7–12.5) infants exhibiting the highest risk. Furthermore, extremely low-birth-weight infants (AOR: 9.4; 95% CI: 2.8–31.8) and very-low-birth-weight infants (AOR: 7; 95% CI: 2.8–17.5) have a substantially higher likelihood of developing ROP than low-birth-weight infants. Surat district has having higher risk of developing ROP from south Gujarat.

Conclusion: A low prevalence rate may be associated with low oxygen usage in rural areas, which needs further studies to confirm the association. These findings underscore the importance of targeted interventions and improved access to prenatal and neonatal care to mitigate the burden of ROP-related complications.

Keywords: Prevalence, Retinopathy of prematurity, Newborns, Low birth weight, Preterm

INTRODUCTION

Retinopathy of prematurity (ROP) is a significant cause of preventable blindness among babies born prematurely across both developed and developing countries.[1] While ROP may cause severe visual impairments, the condition fortunately carries a good prognosis, given early screening and management. Thus, an effective screening protocol is essential for the timely detection and treatment of this avoidable disease.[2] The World Health Organization has recognized that prematurity is one of the major causes of neonatal mortality. An estimated 13.4 million babies were born too early in 2020. That is more than 1 in 10 babies. Approximately 900,000 children die in 2019 of complications of preterm birth.[3]

Recent advancements in neonatal care have led to an increase in the survival of low-birth-weight infants, resulting in a rise in ROP incidence. Globally, ROP is estimated to affect more than

50,000 infants annually. In India, every year, 500 children are estimated to become blind from ROP.[4]

In India, recent advances in health care and the implementation of various maternal and child health programs, like Rashtriya Bal Swasthya Karyakram (RBSK), have led to a rise in the survival rate of mothers and neonates. Neonatal care supports low-birth-weight babies and premature infants. These infants are more at risk of developing ROP since the chances of manifestation of this disease increase with increased survival. All premature infants do not develop ROP. Most studies report ROP incidence at 38% in India among babies with a weight of <1.5 kg. ROP is a developmental disorder that occurs in the incompletely vascularized retina of premature infants and is an important cause of blindness among children in both developed and developing countries. Advancements in neonatal healthcare have improved the survival rate of very-low-birth-weight babies, but this has also led to an increased prevalence of ROP. It increases the economic burden and has social implications for society. However, ROP is a preventable and treatable condition if newborns are screened. The present study aims to (i) identify the prevalence of ROP in the rural population of South Gujarat and (ii) assess the factors associated with ROP among newly born children in rural areas of South Gujarat.

MATERIALS AND METHODS

Study design

This was a hospital-based, prospective study for the period of 1 year 5 months, that is, 2022, September and 2024, February. All the newborn babies falling within inclusion criteria, that is, babies born ≤34 weeks and/or ≤2 kg and/or babies with a history of oxygen support, were dilated with drops prepared from combination drops of Tropicamide 0.8% w/v and Phenylephrine hydrochloride 5% w/v. (2.5 mL of combination drop diluted with 2.5 mL of distilled water). Under topical anesthesia, fundus photos up to ora serrata were taken by trained ophthalmic assistants using 3 netra neo cameras (Forus health), and the photos were sent directly to the retina surgeon for reporting in real-time at the base hospital. As the reporting was in real time, any image which was not clear for ROP grading was removed and was asked to retake. Babies with positive findings were referred to the base hospital and again confirmed by the retina surgeon with indirect Ophthalmoscopy and 20 D lens. It may be noted that babies who are at high risk for ROP include those with respiratory distress, artificial oxygenation therapy, and blood transfusion. The babies whose parents refused to give consent for retina examination of their babies were excluded from the study.

Dependent variables

The study has used "ROP" as the dependent variable, which is a dichotomous variable. If the infant is identified as having the condition, it is coded as 1 for "Yes," and if not, it is coded as 0 for "No."

Independent variables

For the present study, four independent variables were identified: Sex of the child (male/female), gestational age (extremely preterm/very preterm/moderately preterm/full-term), birth weight (extremely low birth weight, very low birth weight/low birth weight), and districts (Narmada/Navsari/Surat/Tapi).

Statistical analysis

Bivariate statistics were utilized to obtain preliminary results. The prevalence rate of ROP was expressed as a simple percentage. The Chi-square test and logistic regression models were applied to establish the association between the prevalence of ROP and the independent variables. The binary logistic regression was calculated using the following formula:

$$Pr(yj \neq 0 \mid x_j) = \frac{(exp(x_j\beta)}{(1 + exp(x_j\beta))} \quad (1)$$

- The formula used for logistic regression calculates the adjusted odds ratio (AOR) for each predictor variable. It estimates the probability of ROP development, comparing the odds of the event occurring versus not occurring while adjusting for other variables.

The data were analyzed using the STATA version 14.0 (STATA Corp LP College Station, Texas, USA, 2017). For all of the statistical tests, the significance level of the studied variables was considered at 1%, 5%, and 10%.

RESULTS

Distribution of sample

Table 1 presents the distribution of the sample population across various study variables and their respective characteristics. The study shows that out of 1049 infants, 4.8% tested positive for ROP, while 95.2% tested negative for ROP. Approximately equal proportions of females (50.8%) and males (49.2%) are represented in the study. Most infants in the sample were full-term (56.1%), while smaller percentages were moderately preterm (21.0%), very preterm (19.8%), or extremely preterm (3.1%). The majority of infants had low birth weight (67.5%), with smaller percentages having very low birth weight (28.2%) or extremely low birth weight (4.3%). Each district is associated with a specific percentage of the total sample. In this sample, Navsari has the highest representation (39.8%), followed by Tapi (25.5%), Surat (22.7%), and Narmada (12.0%).

Table 1: Distribution of Sample across the study variables and its characteristics, Gujarat 2022–24.

Variables	*N*	%	Description of the variable
ROP			
No	999	95.2	ROP categorized as Yes: Identified as ROP, and No: As not identified as ROP
Yes	50	4.8	
Sex of the child			
Female	533	50.8	Sex of the child was used as original
Male	516	49.2	
Gestational age			
Extremely preterm	32	3.1	Gestational age has been divided in to four category: (1) Extremely preterm: Indicates
Very preterm	208	19.8	infants born before born before 28 weeks of pregnancy; (2) Very preterm: Indicates
Moderately preterm	220	21.0	infants born between 28 and 32 weeks of pregnancy; (3) Moderately preterm: Indicates
Full-term	589	56.1	infants born between 32 and 34 weeks of pregnancy; (4) Full-term: Indicates infants born after 34 weeks of pregnancy
Birth weight (in g)			
Extremely low birth weight	45	4.3	Birth weight of the children classified as: (1) Extremely low birth weight: Denotes infants
Very low birth weight	296	28.2	with a birth weight <1000 g; (2) Very low birth weight: Denotes infants with a birth
Low birth weight	708	67.5	weight between 1000 and <1500 g; (3) Low birth weight: Denotes infants with a birth weight >1500 g–<2000 g
Districts (Zone)			
Narmada	126	12.0	Districts and Zone categories used as original
Navsari	418	39.8	
Surat	238	22.7	
Tapi	267	25.5	
Total	1049	100.0	

N: Number of observations; %: Column percentage, ROP: Retinopathy of prematurity

Table 2: Prevalence of retinopathy of prematurity with the study variables, Gujarat, 2022–24.

Background variable	Prevalence of retinopathy of prematurity (in %)		
	N	%	95 % CI (Upper-Lower)
Sex of the child	χ^2=1.16; *P*=0.684		
Female	24	4.5	(2.9–6.5)
Male	26	5.0	(3.4–7.2)
Gestational age	χ^2=113.96; *P*<0.001		
Extremely preterm	9	28.1	(14.9–45.1)
Very preterm	32	15.4	(11.0–20.8)
Moderately preterm	3	1.4	(0.4–3.6)
Full-term	6	1.0	(0.4–2.1)
Birth Weight (in g)	χ^2=79.02; *P*<0.001		
Extremely low birth weight	10	22.2	(12.0–35.8)
Very low birth weight	33	11.1	(7.9–15.1)
Low birth weight	7	1.0	(0.4–1.9)
Districts (Zone)	χ^2=59.78; *P*<0.001		
Narmada	1	0.8	(0.1–3.6)
Navsari	5	1.2	(0.5–2.6)
Surat	33	13.9	(9.9–18.7)
Tapi	11	4.1	(2.2–7)
Total	50	4.8	(3.6–6.2)

N: Number, %: Row percentage, χ^2: Chi-square test (applied for each variable), *P*<0.05 (Significance), CI: Confidence interval

Prevalence of ROP

The Table 2 provides information on the prevalence and association of ROP based on different study variables. It also includes Chi-square tests and confidence intervals (CIs). The table highlights significant ($P < 0.05$) associations between ROP prevalence and gestational age, birth weight, and district, while no significant association is found with the sex of the child.

The prevalence of ROP is 4.8%, with a 95% CI ranging from 3.6% to 6.2%. The prevalence of ROP among females is 4.5%, while among males, it is 5.0%. However, the Chi-square test indicates that the difference in ROP prevalence between sexes is not statistically significant ($\chi^2 = 1.16$, $P = 0.684$).

The prevalence of ROP was found to be significantly associated with gestational age ($\chi^2 = 113.96$, $P < 0.001$). Extremely preterm infants have the highest prevalence of ROP at 28.1%, followed by very preterm infants at 15.4%, moderately preterm infants at 1.4%, and full-term infants at 1.0%.

Similarly, birth weight is significantly associated with ROP prevalence ($\chi^2 = 79.02$, $P < 0.001$). Extremely low-birth-weight infants have the highest prevalence of ROP at 22.2%, followed by very-low-birth-weight infants at 11.1% and low-birth-weight infants at 1.0%.

ROP prevalence also varies across different districts. Surat has the highest prevalence at 13.9%, followed by Tapi at 4.1%, Navsari at 1.2%, and Narmada at 0.8%. The Chi-square test confirms a significant association between district and ROP prevalence ($\chi^2 = 59.78$, $P < 0.001$).

Risk factors associated with ROP

Table 3 presents the results of a logistic regression model used to assess these risk factors. The study shows that extremely preterm infants are 11.2 times more likely to develop ROP (AOR: 11.2; 95% CI: 3–41.5) than full-term infants. Similarly, very preterm infants have a significantly increased risk of ROP AOR: 4.6; 95% CI: 1.7–12.5) as compared to full-term infants. Furthermore, extremely low-birth-weight infants (AOR: 9.4; 95% CI: 2.8–31.8) and very-low-birth-weight infants (AOR: 7; 95% CI: 2.8–17.5) have a substantially higher likelihood of developing ROP than low-birth-weight infants. Regarding the district of birth, new-borns from Surat (AOR: 39.1; 95% CI: 5–306.4) and Tapi (AOR: 7.4; 95% CI: 0.9-59.9) districts are at higher risk of developing ROP than those from Narmada district.

Table 3: Logistic regression model assessing the factors associated with retinopathy of prematurity among newly born children, Gujarat, 2022–24.

Variables	AOR (95% of CI)
Sex of the child	
Female	Ref.
Male	1.1 (0.6–2.1)
Gestational age	
Extremely preterm	11.2 (3–41.5)***
Very preterm	4.6 (1.7–12.5)**
Moderately preterm	0.6 (0.1–2.4)
Full-term	Ref.
Birth weight (in g)	
Extremely low birth weight	9.4 (2.8–31.8)***
Very low birth weight	7 (2.8–17.5)***
Low birth weight	Ref.
Districts (Zone)	
Narmada	Ref.
Navsari	5.4 (0.6–50)
Surat	39.1 (5–306.4)***
Tapi	7.4 (0.9–59.9)*
Model evaluation	
Constant	0.001
Number of observation	1,049
Log likelihood	−128.48
Pseudo R^2	0.36

AOR: Adjusted odds ratio, Ref: Reference category, CI: Confidence interval, ***P<0.001, **P<0.01, *P<0.05

DISCUSSION

The results of this study shed light on the prevalence of and risk factors associated with ROP among newborns in the study population. The study found that 4.8% of newborns had ROP. Other studies have reported 19.2% and 24.1% incidence of ROP.[1,5] The low prevalence found in the present study could be because the infants in the present study were from rural areas, wherein the oxygen usage is very low as compared to the urban setup. Nonetheless, the prevalence highlights the importance of early detection and intervention strategies to minimize the impact of ROP on infants who are potentially at risk of this health problem.

The findings of this study align with previous research demonstrating the significant association between gestational age, birth weight, and the prevalence of ROP.[6-8] The present study also identified gestational age and birth weight as significant risk factors for ROP development. In addition, the district of birth also emerged as a significant factor. Surat district showed a high prevalence. This finding is supported by another study (Shroff *et al*., 2020).[9] Surat has high and advanced neonatal intensive care units, qualified neonatologists, and ROP specialists. Surat, being a major city of South Gujarat also receives referrals from nearby cities and districts. These factors may have a role in higher prevalence in Surat. A hypothesis that warrants further investigation is whether the liberal use of oxygen in preterm and low-birth-weight infants–more readily available in Surat compared to other towns–has an impact on the higher prevalence of related complications. The prevalence of ROP was highest among extremely preterm and very preterm infants, highlighting their vulnerability to retinal complications. Consistent with existing literature, extremely preterm and very preterm infants exhibited the highest prevalence of ROP, underscoring the vulnerability of these populations to retinal complications.[7]

Similarly, extremely low-birth-weight infants had a significantly higher likelihood of developing ROP compared to low-birth-weight infants. A similar study reported that ROP occurs mostly in extremely low-birth-weight and preterm infants.[6,9]

These findings emphasize the critical importance of prenatal care and neonatal support, particularly for infants born prematurely or with low birth weight, in preventing ROP-related complications.

In addition, the study found that the district of birth was associated with ROP prevalence, suggesting potential geographic variations in access to healthcare services and resources. Newborns from the Surat and Tapi districts were found to be at higher risk of developing ROP compared to those from the Narmada district. This underscores the need for targeted interventions and improved healthcare infrastructure in high-risk regions to ensure timely screening and management of ROP.

Finally, the logistic regression analysis confirmed that gestational age, birth weight, and district of birth significantly impacted the likelihood of ROP development. Extremely preterm infants were over 11 times more likely to develop ROP as compared to full-term infants, while extremely low-birth-weight infants had nearly 9 times higher odds of ROP than low-birth-weight infants. These findings highlight the importance of early identification of high-risk infants and timely implementation of preventive measures to reduce the incidence of ROP-related complications.

Limitations

The study acknowledges potential limitations that could impact its findings. Being a hospital-based study, it might not represent the true prevalence of ROP in the larger population of South Gujarat. Babies who were not brought to the hospital or who did not undergo screening could have been missed, leading to an underestimation of the prevalence.

Future directions

Screening programs can prioritize high-risk categories such as extremely preterm and very-low-birth-weight infants, particularly in districts like Surat with higher prevalence rates. Regular monitoring protocols can be implemented for hospitals and healthcare centers in South Gujarat, especially in rural and underserved areas. District-specific findings suggest a need for focused healthcare interventions in areas with higher risk. The study sets the stage for broader, population-based research to confirm findings and refine screening and treatment guidelines.

Next target of Author

- Expanding the Scope of Research: Conduct a population-based study to capture a more comprehensive prevalence of ROP beyond hospital-based data.
- Further investigate the association between liberal oxygen usage in specific regions (e.g., Surat) and the prevalence of ROP.

Challenges faced during the study

- Limited availability of advanced screening equipment and trained personnel in rural areas. (To address this, the study used telemedicine [3 netra Neo camera] for real-time screening and reporting, ensuring timely diagnosis and referral.)
- Some parents refused consent for screening, leading to potential selection bias.
- The authors overcame this by focusing on educating families about the importance of ROP screening to increase participation.

CONCLUSION

The low prevalence in the rural areas of south Gujarat, wherein oxygen usage is low may need further studies to confirm the association. This study highlights the prevalence and risk factors associated with ROP among newborns in the study population. Gestational age, birth weight, and district of birth emerged as significant predictors of ROP development, with extremely preterm and very-low-birth-weight infants exhibiting the highest risk. These findings underscore the importance of targeted interventions and improved access to prenatal and neonatal care to mitigate the burden of ROP-related complications.

Moving forward, efforts should focus on enhancing screening protocols, early detection strategies, and access to specialized care for at-risk infants. Collaborative initiatives between healthcare providers, policymakers, and community stakeholders are essential to address the multifaceted challenges posed by ROP and improve outcomes for affected infants. By prioritizing preventive health care measures in general and holistic approaches to neonatal health in particular, we can strive toward reducing the incidence and severity of ROP and improving the long-term visual outcomes for premature and low-birth-weight infants.

Finally, this study underscores the significance of gestational age, birth weight, and geographic factors in predicting the prevalence of ROP among newborns. By identifying high-risk populations and implementing targeted interventions, healthcare providers can mitigate the burden of ROP-related complications and improve outcomes for premature and low-birth-weight infants.

Ethical approval

The research/study approved by the Institutional Review Board at Ethical committee, Divya jyoti trust, number ECR/942/Inst/GJ/2017.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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