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Original Research Article

Prevalence and determinants of refractive error among school children in two Southern districts of Karnataka

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ABSTRACT

Background: Refractive error (RE) is a major cause of visual impairment in schoolchildren, affecting learning and long-term eye health. Its prevalence varies across India, with limited data from southern Karnataka. This study assessed RE prevalence and determinants among children aged 6-16 years.
Methods: A school-based cross-sectional study was conducted from July to October 2025 among 1,070 students selected through cluster sampling using probability proportionate to size (PPS). Within each school, participants were chosen by simple random sampling. Data were collected using a structured proforma capturing sociodemographic, familial, clinical, and behavioural factors. Visual acuity was assessed using a standardized Snellen chart protocol. Statistical analysis included descriptive measures and Chi-square tests to determine associations between RE and selected variables.
Results: The prevalence of RE was 8.2%. Age and educational grade showed significant associations (p=0.005), with older children presenting higher impairment. Significant determinants included history of eye infection (p=0.027), family history of glasses (p=0.024), and screen exposure (p=0.014), with RE rising from 6.2% in low screen-time groups to 16.7% in high-exposure groups. Gender, parental education, family type, and history of eye injury were not significantly associated.
Conclusions: RE remains a notable concern among schoolchildren in southern Karnataka. Findings highlight the role of biological and behavioural determinants, underscoring the importance of strengthened school-based screening and early preventive interventions.

Keywords: Refractive error, Schoolchildren, Visual impairment, Screen hours

INTRODUCTION

Refractive error (RE) remains one of the foremost causes of visual impairment among children globally and continues to be recognised as a major public health challenge due to its significant consequences on learning capacity, psychosocial well-being, and overall quality of life.[1,2] Worldwide, uncorrected REs constitute a substantial proportion of avoidable childhood visual disability, accounting for more than half of all cases.[3] The burden of RE has shown a notable upward trend, particularly in school-going populations, driven by increasing academic demands, prolonged engagement in near-work activities, and widespread exposure to digital screens in daily life.[4,5]

In the Indian context, reported prevalence estimates of RE vary considerably, ranging from 5-25%, reflecting heterogeneity in sociodemographic characteristics, lifestyle behaviours, educational environments, and access to eye-care services across regions.[6,7] School-aged children represent a particularly vulnerable group, as the visual demands of the classroom increase with academic progression, and environmental exposures-such as extended screen time-have become increasingly common.[8] Importantly, early identification and timely correction of REs are critical to preventing adverse consequences such as suboptimal academic performance, reduced attention span, headaches, and long-term complications, including amblyopia.[9,10]

A growing body of evidence indicates that multiple determinants-including age, gender, parental refractive history, ocular morbidities, socioeconomic status, and behavioural factors such as screen exposure-play a role in the development of RE.[11-13] However, the interplay of these determinants varies geographically, underscoring the need for region-specific data to inform targeted preventive and corrective strategies. Despite ongoing emphasis on school vision screening initiatives in India, there remains a paucity of systematically documented data from the southern districts of Karnataka, particularly Mysuru and Chamarajanagar.

With this background, this study undertaken to estimate prevalence of REs and to examine its associated demographic, familial, clinical and behavioral determinants among school children aged 6-16 years in 2 southern districts of Karnataka. Generating such evidence is essential for strengthening local school health programmes and informing public health policies aimed at reducing burden of preventable childhood visual impairment.[14]

METHODS

A school-based cross-sectional study was conducted over four months, from 1st July to 31st October 2025, across educational institutions located in Mysuru and Chamarajanagar districts of Karnataka. The target population comprised schoolchildren aged 6 to 16 years, representing the primary, higher primary, and high schools. All students within this age range who were enrolled in the selected institutions during the study period formed the accessible population. Children were included if they met the age criteria and were regularly attending school at the time of data collection. Those with physical or cognitive disabilities that hindered accurate visual acuity testing, as well as students who did not provide written assent or for whom parental or guardian consent was unavailable, were excluded to preserve the reliability of the assessment process.

The sample size was calculated using the single-proportion formula, assuming an expected RE prevalence of approximately 35%, based on prior study conducted by Munoli et al in Raichur, Karnataka.[15] A 95% confidence interval and acceptable precision level were applied with marginal error of 3%, followed by adjustments for design effect and anticipated non-response rate of 10%, resulting in a final sample size of 1,070 children. To ensure representative sampling across the two districts, 49 schools were selected as clusters. The PPS sampling technique was used to allocate required number of participants from each school based on its total enrolment of students aged 6-16 years. Within each school, list of eligible students served as sampling frame, and required number of participants was identified using lottery method of simple random sampling, thereby ensuring equitable selection and minimising sampling bias.

Data collection employed a structured proforma, organised into three sections. Section one captured key sociodemographic variables, including the child's age, gender, and Parental educational status. Section two obtained information on familial and clinical determinants, such as family history of RE, previous ocular infections or injuries, and patterns of exposure to digital screens. Section three was dedicated to documenting the visual acuity assessment findings, which were obtained using a standardized Snellen chart method protocol. All visual acuity evaluations were conducted meticulously under the direct supervision of the principal investigator to ensure procedural accuracy, consistency, and adherence to recommended clinical guidelines.

Statistical analysis

The collected data were first entered into Microsoft excel for cleaning and coding, and subsequently transferred to IBM SPSS statistics V.25 for comprehensive analysis. Descriptive statistics, including means, proportions, and frequency distributions, were used to summarize participant characteristics and determine the prevalence of RE. Inferential analyses, primarily Chi-square tests, were performed to assess associations between RE and key demographic, familial, behavioural, and clinical variables. Where necessary, additional statistical corrections were applied to ensure accuracy. This combined analytical approach provided a robust assessment of both the distribution and determinants of RE within the study population.

RESULTS

Among the 1,070 school children assessed in the present study, with a mean age of 12.02 years, the overall prevalence of RE was 8.2% (Figure 1), indicating that approximately one in twelve children had some degree of visual impairment necessitating further ophthalmic evaluation. Gender did not significantly influence the distribution of RE (p=0.979), with nearly identical rates among males (8.3%) and females (8.2%), suggesting that sex-based biological differences play a minimal role in early refractive development within this age range.

Age, however, demonstrated a significant association (p=0.005). Children aged 6-10 years exhibited the lowest prevalence (4.0%), while those aged 11-13 years showed the highest proportion of impairment (10.3%), reflecting increased academic visual demands and potential environmental exposures during pre-adolescent years.

Educational level, which parallels age progression, also showed a significant relationship with RE (p=0.005), with upper primary and secondary students bearing a greater burden than younger peers.

In contrast, parental education, encompassing fathers' and mothers' primary to higher education categories, did not show any statistically significant association with RE. This suggests that parental literacy alone may not influence children's visual health outcomes in this population. Similarly, family structure-whether nuclear, joint, or extended-was not significantly associated with RE (p=0.749), indicating that household type may not directly affect visual development (Table 1). Overall, the findings highlight that age-related educational progression appears to be a stronger determinant of RE than socio-demographic attributes such as gender, parental education, or family type.

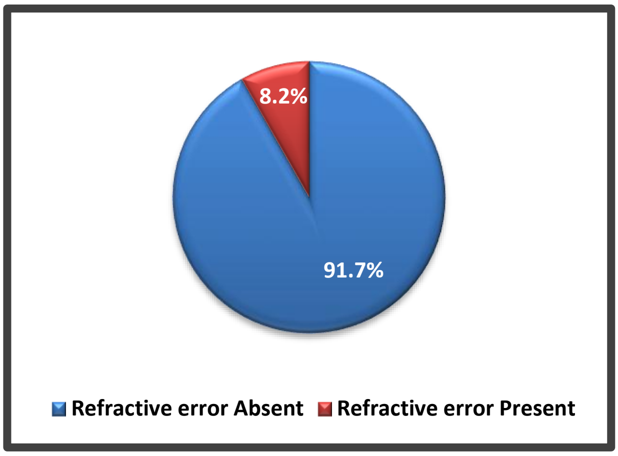

Figure 1: Prevalence of RE among school children, (n=1070).

Table 1: Association of demographic, educational, and family characteristics with RE among school children, (n=1070).

Variables	Category	RE Normal (%)	RE Impaired (%)	N	X^2 value	P value
Gender	Male	522 (91.7)	47 (8.3)	569	0.001	0.979
	Female	458 (91.8)	41 (8.2)	499		
Age (in years)	6-10	290 (96.0)	12 (4.0)	302	10.575	0.005*
	11-13	523 (89.7)	60 (10.3)	583		
	14-16	169 (91.4)	16 (8.6)	185		
Education of the child	Primary education	322 (95.8)	14 (4.2)	336	10.691	0.005*
	Higher primary education	318 (89.8)	36 (10.2)	354		
	Secondary education	342 (90.0)	38 (10.0)	380		
Father education	Primary education	219 (92.8)	17 (7.2)	236	2.105	0.551
	Secondary education	327 (91.9)	29 (8.1)	356		
	Higher secondary education	240 (92.7)	19 (7.3)	259		
	Higher education	196 (89.5)	23 (10.5)	219		
Mother education	Primary education	378 (91.7)	34 (8.3)	412	0.542	0.910
	Secondary education	355 (92.4)	29 (7.6)	384		
	Higher secondary education	192 (91.0)	19 (9.0)	211		
	Higher education	57 (90.5)	6 (9.5)	63		
Family type	Nuclear	906 (91.9)	80 (8.1)	986	0.578	0.749
	Joint	60 (89.6)	7 (10.4)	67		
	Extended	16 (94.1)	1 (5.9)	17		

*P<0.05 is considered statistically significant.

Table 2: Association of clinical, familial, and behavioural factors with RE among school children, (n=1070).

Variables	Category	RE Normal (%)	RE Impaired (%)	N	X^2 value	P value
Eye infection	Yes	86 (86.0)	14 (14.0)	100	4.875	0.027*
	No	896 (92.4)	74 (7.6)	970		
Eye injury	Yes	13 (81.3)	3 (18.8)	16	2.384	0.123
	No	969 (91.9)	85 (8.1)	1054		
Family history of RE	Yes	46 (83.6)	9 (16.4)	55	5.089	0.024*
	No	936 (92.2)	79 (7.8)	1015		
Family history of squint	Yes	30 (88.2)	4 (11.8)	34	0.583	0.445
	No	952 (91.9)	84 (8.1)	1036		
Screen activity (exposure to mobile, TV, computer etc.)	Low (0-1 hour)	289 (93.8)	19 (6.2)	308	8.524	0.014*
	Moderate (1- 3 hours)	633 (91.7)	57 (8.3)	690		
	High (>3 hours)	60 (83.3)	12 (16.7)	72		

*p<0.05 is considered statistically significant.

Our study identified a statistically significant relationship between a history of eye infection and the presence of RE (χ^2=4.875, p=0.027). Children who reported prior ocular infections had a higher prevalence of RE (14.0%) than their counterparts without such a history (7.6%). This suggests that inflammatory or infectious ocular pathologies may influence refractive outcomes, potentially through structural or physiological alterations in the cornea and ocular media.

Although children with a history of eye injury exhibited a relatively higher proportion of RE (18.8%), this association did not reach statistical significance (p=0.123). The limited number of participants reporting eye injuries (n=16) may have constrained the analytical power, warranting cautious interpretation of this finding. Similarly, family history of squint did not demonstrate a statistically significant relationship with RE (p=0.445), indicating that hereditary strabismic tendencies may not strongly influence refractive development in this sample.

Conversely, a significant association was observed for family history of wearing glasses (χ^2=5.089, p=0.024). Children with such a familial predisposition exhibited a notably higher prevalence of RE (16.4%), supporting evidence that genetic or hereditary factors contribute meaningfully to refractive status.

Finally, screen activity levels (exposure to mobile phones, television, and computers) were significantly associated with RE (χ^2=8.524, p=0.014). A transparent gradient was observed, with RE prevalence increasing from low (6.2%) to moderate (8.3%) and high exposure levels (16.7%). This dose-response pattern reinforces the role of prolonged near-work and digital device engagement as behavioural determinants of RE among school-aged children (Table 2).

DISCUSSION

In the present school-based study among children aged 6-16 years, the prevalence of RE was 8.2%, comparable to estimates reported in similar populations. Padhye et al observed an almost identical prevalence of 8.1% in Maharashtra using Snellen visual acuity screening while Maul et al reported 8.4% among South American children aged 5-15 years.[16,17] Saxena et al likewise documented a prevalence of 7.4% in North India, which closely aligns with our findings.[18] Lower prevalence figures have also been reported; for example, Bhutia et al identified a 6.7% prevalence in a large cohort in Sikkim.[19]

Age showed a significant association in our study, with older children-particularly those aged 11-13 years-exhibiting higher RE prevalence. Comparable age-related increases were noted by He et al in China and Gupta et al in Himachal Pradesh.[20,21] Gender, however, showed no significant association, consistent with observations by Maul et al and Padhye et al.[17,16] Parental education and family type similarly demonstrated no meaningful association, echoing findings from Guptha et al and Murthy et al.[20,21] Educational grade was significantly associated with RE in our study, indicating that children in higher grades exhibited greater visual impairment. This observation is consistent with the findings of Murthy et al who reported that educational advancement is accompanied by increased academic demands, prolonged reading, and near-work activities, all of which contribute to the progression of REs.[21] These parallels reinforce the understanding that school-related visual strain intensifies with grade level and may serve as a critical determinant of RE. A strong association was also observed between family history of glasses and RE, further supporting the hereditary dimension of refractive development. Joseph et al similarly documented a significantly higher RE prevalence among children with parental RE in an extensive multistate school screening programme.[22]

This alignment suggests that genetic predisposition plays a pivotal role, and children with affected family members may require more frequent screening. Additionally, high levels of screen exposure were significantly associated with RE in the present study. Srivastava et al reported comparable findings, identifying digital device use as a significant behavioural factor contributing to visual impairment and myopic shifts among school children.[23] This reinforces growing concerns regarding excessive near-work and reduced outdoor time. In contrast, no significant association was found between eye injury and RE, a pattern consistent with the observations of Hassan et al.[24] While ocular injuries may affect visual acuity, they do not consistently contribute to refractive changes, highlighting the distinction between traumatic visual impairment and refractive pathology.

Limitations

The cross-sectional study, using non-cycloplegic screening and some self-reported variables, limits causal inference; however, these methods align with practical school-screening approaches and minimally affect overall interpretability.

CONCLUSION

This study highlights that RE remains a crucial visual health concern among schoolchildren aged 6-16 years in the Mysuru and Chamarajanagar districts, with a prevalence of 8.2%. Age, educational grade, family history of glasses, and screen exposure emerged as significant determinants, indicating the influence of both hereditary and behavioural factors on refractive development. Conversely, gender, parental education, family type, and history of eye injury were not significantly associated with RE. These findings underscore the need for strengthened school-based vision screening programmes and targeted preventive strategies to reduce avoidable visual impairment among children in this region.

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