



Proportion of Refractive Error and Its Associated Factors among High School Students in South India

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Authors' contributions

This work was carried out in collaboration between all authors. Author NJ designed, concept, definition of intellectual content, manuscript preparation and guarantor of this research work. Author MN performed data entry, analysis and manuscript editing. Author TPR managed literature search, data acquisition. Authors SMM and SR managed manuscript editing and review. Author SMK managed statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Background: School children are a high risk population for refractive errors (REs). Uncorrected REs can adversely affect the learning abilities and mental development of school children.

Objectives: This cross sectional study was conducted to observe the proportion of cases diagnosed with REs, to determine factors associated with it, to find out the practices of students in

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preventing these risk factors and to assess the perception towards visual aids among students with REs in schools of an urban area.

Methods: This study was done in Mangalore city in February 2013. 482 high school children were interviewed using a structured interview schedule. RE was ascertained based on records of previous diagnosis by Ophthalmologist. Data was analyzed by Chi-square test and binary logistic regression analysis.

Results: The prevalence of already diagnosed cases of RE was 94(19.5%). Most of these cases had myopia 92(97.9%). Two cases were of hypermetropia. Mean age of onset of RE was 10.2±2.1 years. Only 19(20.2%) cases were first detected in schools in spite of functioning school health services at all the surveyed schools. RE cases were significantly more in private schools in comparison to government schools ($P<0.001$). Risk factors significantly associated with RE were history of RE among siblings ($P<0.001$), inadequate reading distance ($P=0.011$) and doing homework with inadequate illumination ($P=0.021$). One third of students with RE were irregular in eye examinations.

Conclusion: Proportion of REs was high among school students. Education of students on healthy postural habits and good illumination while studying at home is essential to prevent REs in this population.

Keywords: Refractive errors; risk factors; high school students; urban area.

1. INTRODUCTION

Refractive errors (REs) are common in children and is the most common cause of visual impairment globally and the second most common cause of treatable blindness [1,2]. The control of blindness in children is one of the priority areas of the WHO's "Vision 2020-the right to sight" program which also includes REs [3].

School children are considered a high risk group because uncorrected REs can adversely affect their learning abilities [4] and mental development [5].

Children may not be aware of defective vision problem and hence may not complain. Rather they might adopt means like sitting close to the blackboard, holding books closer to eyes and even by avoiding work requiring visual concentration to adjust to poor vision. Hence awareness of REs and its risk factors, early diagnosis and treatment is required so as to prevent further disability [6].

This is possible by efficient pre-school and regular school health services (SHS) for detecting (and managing) REs by involving school health personnel and optometrist [7,8].

As school-going children (6-16 years) constitutes one-fourth of the population in developing countries and they are easily accessible at schools, this settings would be ideal for imparting health education and comprehensive eye care program [6].

It is also essential to know the perception towards visual aid among people with REs as it might influence their quality of life. Hence this study was conducted among high school students to find out the proportion of cases diagnosed with REs, to determine factors associated with its occurrence, to find out their practices in preventing these risk factors and to assess the perception towards visual aids among students with REs in an urban area.

2. METHODS

This cross sectional study was done in Mangalore city situated in Karnataka State of south India in February 2013. The study protocol was approved by the ethics committee of the institution. The study was done at four private and two government high schools (6th to 10th standard) which were selected randomly.

The sample size of 506 was obtained at 95% confidence level, 15% relative precision and reported prevalence of RE rounded to 26% from a previous Indian study [9] Using convenient sampling method, proportionately the students were selected from all the six schools.

The permission for conduct of the study was obtained from respective school principals after ensuring them strict confidentiality of the information gathered. Written informed consent from a parent or guardian in addition to the assent of each student was obtained through school diaries by providing them information about the purpose of this study.

Content and language validity of the interview schedule was done by experts. It was then pretested in a group of 10 students before its current use in the study. The students with RE were instructed to bring the medical documents related to it on the day of interview. Each student was interviewed in the language they understand and information was filled in English language by the investigators.

The schedule contained questions relating to the socio-demographic information of the participant, presence or absence of RE (verified from the medical documents), age at diagnosis of RE, place of diagnosis, frequency of eye examination (verified from the medical documents), type of visual aid being used, perception towards usage of aids and discomforts experienced if any with its usage. Students who were not diagnosed for refractive errors before but who were presently symptomatic for the same were excluded from the study to avoid misclassification bias as a result of occult REs. However these students were advised referral to an Ophthalmologist for disease verification and management.

Various life style habits likely to result in REs were also enquired from participants. Appropriate distance for watching television was taken as 10 feet or more for a standard 21 inch television and for reading books to be at least 12 inches [10,11]. Studying in dim light was considered with use of less than 100 watts ambient light or was self-reported [10]. At the end of data collection the investigators provided information on REs, other common ophthalmic morbidities and their prevention and healthy life style habits to the students using posters and charts. Data was entered and analyzed using SPSS Inc. Illinois, USA version 17.0. The Chi-square test and binary logistic regression analysis was used to test association of risk factors with presence of RE among students. P value ≤ 0.05 was considered as statistically significant association.

3. RESULTS

Mean age of students were 12.5 ± 1.2 years. 94(19.5%) students had RE (Table 1).

Mean age at diagnosis of RE was 10.2 ± 2.1 years and the median and mode age was 11 years. Most cases were diagnosed in hospitals 75(79.8%). Greater proportion of RE cases were diagnosed in hospitals 75(79.8%). Only 19(20.2%) cases were diagnosed in schools. (Table 2)

Table 1. Socio demographic distribution of high school students

Age (years)	No.	Percentage
10	11	2.3
11	96	19.9
12	169	35.1
13	79	16.4
14	98	20.3
15	29	6.0
Gender		
Male	280	58.1
Female	202	41.9
Type of school		
Government	168	34.9
Private	314	65.1
Total	482	100.0

Table 2. Characteristics of refractive error (RE) among high school students

Characteristics	No.	Percentage
Age at diagnosis of RE (years)		
5	4	4.3
6	3	3.2
7	5	5.3
8	7	7.4
9	8	8.5
10	14	14.9
11	26	27.7
12	21	22.3
13	5	5.3
14	1	1.1
Age (years)		
11	18	19.1
12	31	33.0
13	15	16.0
14	21	22.3
15	9	9.6
Gender		
Boys	62	66.0
Girls	32	34.0
Type of school		
Government	18	19.1
Private	76	80.9
Place of diagnosis of RE		
At hospital	75	79.8
At school	19	20.2
Type of RE		
Myopia	92	97.9
Hypermetropia	2	2.1
Type of visual aid being used		
Spectacles	93	98.9
Contact lens	1	1.1
Total	94	100.0

Out of the 94 students with RE, 61(64.9%) experienced symptoms of blurring of vision, 27(28.7%) had headache and 22(23.4%) had watering in the eyes before the diagnosis of RE.

RE were present significantly more among students in private schools 76(24.2%) in comparison to those studying in government schools 18(10.7%) ($P<0.001$). History of RE among siblings was found to be significantly associated with presence of RE among participants ($P<0.001$). (Table 3) 110(22.8%) students were unaware of the appropriate distance to be maintained between the eyes and television. 64(13.3%) were unaware of

appropriate reading distance. Reading distance ($P=0.011$) and inadequate lighting environment while doing homework ($P=0.021$) was found to be significantly associated with presence of REs. (Table 3).

Using binary logistic regression, only reading distance (Adjusted Odd Ratio =1.952, 95% CI, 1.043 to 3.655, $P=0.037$) and type of school (AOR=2.035, 95% CI, 1.108 to 3.739, $P=0.022$) was significantly associated with REs (Table 4).

Television and computer viewing hours was significantly more among private school students than government school students (Table 5).

Table 3. Association of various risk factors with presence of refractive error among students (n=482)

Risk factor	Students with refractive error		Students without refractive error		Total
	No.	%	No.	%	No.
Age					
10	0	0.0	11	100.0	11
11	18	18.7	78	81.3	96
12	31	18.3	138	81.7	169
13	15	19.0	64	81.0	79
14	21	21.4	77	78.6	98
15	9	31.0	20	69.0	29
				$\chi^2=5.55$, DF=5, $P=0.353$	
Gender					
Boys	62	22.1	218	77.9	280
Girls	32	15.8	170	84.2	202
				$\chi^2=2.97$, DF=1, $P=0.085$	
Type of school					
Private	76	24.2	238	75.8	314
Government	18	10.7	150	89.3	168
				$\chi^2=12.7$, DF=1, $P<0.001$	
Diet					
Vegetarian	5	17.9	23	82.1	28
Non vegetarian	89	19.6	365	80.4	454
				$\chi^2=0.051$, DF=1, $P=0.821$	
History of RE among siblings					
Yes	63	27.4	167	72.6	230
No	31	12.3	221	87.7	252
				$\chi^2=17.4$, DF=1, $P<0.001$	
No. of reading hours per day					
< ½ hour	9	18.0	41	82.0	50
½ to 1 hour	25	18.8	108	81.2	133
1 to 3 hours	52	20.2	206	79.8	258
3 to 5 hours	7	19.4	29	80.6	36
>5 hours	1	20.0	4	80.0	5
				$\chi^2=0.185$, DF=4, $P=0.996$	
No. of television viewing hours per day					
< ½ hour	25	21.9	89	78.1	114
½ to 1 hour	38	18.4	169	81.6	207

Risk factor	Students with refractive error		Students without refractive error		Total
	No.	%	No.	%	No.
1 to 3 hours	24	17.6	112	82.4	136
3 to 5 hours	3	16.7	15	83.3	18
>5 hours	4	57.1	3	42.9	7
					$\chi^2=7.31$, DF=4, $P=0.12$
No. of computer viewing hours per day (n=233)					
< ½ hour	31	22.5	107	77.5	138
½ to 1 hour	21	37.5	35	62.5	56
1 to 3 hours	7	21.9	25	78.1	32
>3 hours	3	42.9	4	57.1	7
					$\chi^2=5.93$, DF=3, $P=0.115$
Reading distance practiced					
Adequate	74	17.7	344	82.3	418
Inadequate	20	31.2	44	68.8	64
					$\chi^2=6.49$, DF=1, $P=0.011$
TV distance practiced					
Adequate	70	19.7	286	80.3	356
Inadequate	24	19.0	102	81.0	126
					$\chi^2=0.022$, DF=1, $P=0.881$
Proper illumination while studying at home					
Yes	13	11.8	97	88.2	110
No	81	21.8	291	78.2	372
					$\chi^2=5.36$, DF=1, $P=0.021$
Switching on light while watching television in the night					
Yes	69	20.5	267	79.5	336
No	25	17.1	121	82.9	146
					$\chi^2=0.755$, DF=1, $P=0.385$

Table 4. Binary logistic regression analysis of association of risk factors with refractive error among high school students (n=482)

Characteristics	Unadjusted OR	95% C.I for Unadjusted OR		P value	Adjusted OR	95% C.I for Adjusted OR		P value
		Lower	Upper			Lower	Upper	
History of refractive error among siblings	2.69	1.332	3.736	<0.001	1.669	0.956	2.912	0.072
Reading distance	2.11	0.961	3.115	0.011	1.952	1.043	3.655	0.037
Illumination at home	2.08	1.236	4.325	0.021	1.946	0.987	3.835	0.054
Type of school	2.66	1.728	5.187	<0.001	2.035	1.108	3.739	0.022

Proportion of RE cases diagnosed at government schools 7(38.9%) under school health services (SHS) was significantly more than that diagnosed at private schools 12(15.8%) ($\chi^2=4.815$, DF=1, $P=0.028$) Fig. 1.

Only 81(16.8%) participants received Vitamin A solution in their preschool age group.

29(30.9%) cases with REs experienced discomfort in usage of visual aids. The contact lens user complained of discomfort during

outdoor activities. 77(81.9%) students preferred spectacles over contact lens (Table 6).

Reasons for preference of spectacles over contact lens were stated by 64 out of 77 students. This included easy to use 38(59.4%), convenience in usage 11(17.2%), comfortable to wear 7(10.9%), positive impact on appearance 5(7.8%), affordability 2(3.1%) and easy to carry 1(1.6%). Reasons for preference of contact lens stated by students were due to it being a modern

technology 10(58.8%) and because of its positive impact on appearance 7(41.2%).

Frequency of eye examination was once in 3 months in 3(3.2%), once in 6 months in 26(27.6%), once a year in 34(36.2%). The remaining 31(33%) students with RE underwent eye examination as and when required only.

4. DISCUSSION

In this study, 19.5% students were diagnosed cases of RE. Prevalence of RE in studies done in India and other countries ranged from 2% to

25.3% [7,9-11,12-17]. Almost 80% of RE cases were diagnosed at hospitals and only few in schools. This highlights the need to strengthen the periodic screening of REs at schools under SHS along with provision of corrective glasses. Also teachers can be trained to impart ocular hygiene awareness to students and to screen students for defective vision so as to encourage prompt referral and treatment [10]. The correction of REs is the simplest of eye care interventions. Therefore uncorrected RE during schooling days would imply inefficient and inadequate eye care service in the population concerned [11].

Table 5. Distribution of time spent on various life style habits at home among high school students

Type of school	Less than ½ hour		½ to 1 hour		1 -3 hours		3 to 5 hours		>5 hours		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
	Reading hours at home in a day (n=482)										
Government	17	10.1	39	23.2	95	56.6	15	8.9	2	1.2	168
Private	33	10.5	94	29.9	163	51.9	21	6.7	3	1.0	314
	$\chi^2=3.042$, DF=4, $P=0.551$										
	Television viewing hours in a day (n=482)										
Government	45	26.8	82	48.8	34	20.2	5	3.0	2	1.2	168
Private	69	22.0	125	39.8	102	32.5	13	4.1	5	1.6	314
	$\chi^2=9.471$, DF=4, $P=0.05$										
	Computer viewing hours in a day (n=233)										
Government	24	96.0	1	4.0	0	0.0	0	0.0	0	0.0	25
Private	114	54.8	55	26.4	32	15.4	6	2.9	1	0.5	208
	$\chi^2=15.7$, DF=1, $P<0.001$										

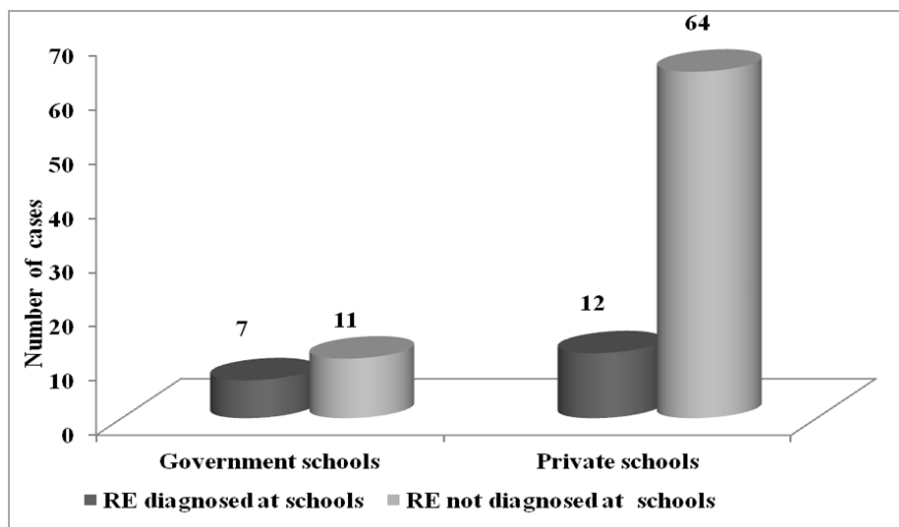


Fig. 1. Association between place of diagnosis of refractive error with type of school (n=94)

Table 6. Perception and practices of students with refractive error towards their visual aids

	Number	Percentage
Pattern of usage of visual aids		
Throughout the day	31	33.0
As and when required	63	67.0
Discomfort in usage of visual aid		
Yes	29	30.9
No	65	69.1
Type of activities causing discomfort (n=29)		
Indoor	4	13.8
Outdoor	16	55.2
Both	9	31
Impact on appearance		
Positive impact	12	12.8
Negative impact	15	15.9
No impact	67	71.3
Preferred visual aid		
Spectacles	77	81.9
Contact lens	17	18.1
Total	94	100.0

Mean age at diagnosis of RE in this study was 10.2±2.1 years. This was similar to the findings of a study done in Surat, India where the mean age at diagnosis of RE was found to be 10.9 years [7]. A study done in Ahmedabad, India the mean age at diagnosis of RE was found to be 11.2 and median and mode age was 12 years which was higher than our findings [9].

The findings of this study and in another study done in New Delhi, India [18] suggest that screening for myopia must be done earlier at approximately 11 to 12 years of age rather than the current practice at schools of screening beginning at 12 to 14 years.

In this study an increase in prevalence of REs with increase in age was noted but it was not statistically significant. Other studies have found a significant increase in cases of RE with age thereby showing that ametropia is related to number of years of schooling [7,9,16]. As students move to higher classes a significant relationship exists between RE and educational level [9]. A study done in Iran found significant decrease in RE with age which was different from our observations [19].

Among REs, proportion of myopia was found to be 97.9% in this study. In other studies also myopia was the most common RE and it ranged from 31.6% to 91.5% [7,9-11,14,16] This can be attributed to strain resulting from near work due

to academic assignments or while watching television and computers for long hours very common among school going children [9,11].

On the other hand, the proportion of cases with hypermetropia in other studies ranged from 4.6% to 28.6% which was higher than the observations of this study [7,9-11,14,16].

No case of astigmatism was found in this study. In other studies the proportion of RE cases with astigmatism ranged from 0.04% to 35.5% [7,9-11,16].

There was no association of gender with presence of RE among participants in this study as also observed in previous studies [9,11].

However significantly greater proportion of REs among girls was also observed by other studies [20,21].

Most cases with RE complained of blurring of vision before diagnosis of RE which was also observed in 67% cases in the study done in Surat, India. However watering of the eyes observed in 17.3% cases during disease detection in the latter study was lower than our observations [7]. Health education activities at schools should emphasize signs and symptoms of ocular disorders for its early identification.

In this study proportion of RE cases was significantly more among students with history of RE among their siblings. Several studies have found genetic factors influencing the prevalence of RE which again supports our observations [10,22-25].

No association of number of hours spent in reading books and presence of REs was observed in this study. However a study done in Singapore and China a multivariate logistic regression model showed the odds ratio of 2.81 for myopia among children who read more [26].

No association was also found between television or computer viewing hours or watching these at a near distance with presence of REs in this study. Only presence of RE was seen more among students who view television or computers for more than 5 hours and 3 hours respectively per day. But other studies have observed a significant association between prolonged indulgence in computer/video games and television and watching it closely with REs [10,27].

Our study found a significant association between close study habits and studying or working at home in dim light with presence of REs which was similar to the findings of the study done in Lahore, Pakistan [10].

Proportion of cases with RE was significantly more in private schools in this study when compared to government schools which were similar to observations made in a study done in Nepal [11]. A study done in Shimla, India also observed RE cases to be more in private schools but this difference was not statistically significant [15].

Greater prevalence of RE among private school students could be probably because they are from higher socioeconomic background and hence television and computer viewing practices and its duration are significantly more in them in comparison to students from government schools as supported by our findings and also of a study done in Nepal [11]. The study done in Nepal also found increased homework load among private school [11].

In a study done in Surat, India 94.7% cases with RE used spectacles. Of all these spectacle users, the study reported that in 29.7% cases the eyesight was not found to be with the best possible corrections and 31% of users complained of discomfort while using visual aids which was similar to our findings [7]. This emphasizes the need of periodic eye examination by Ophthalmologists.

5. CONCLUSIONS

SHS need to be improved for early identification of REs among school children. Students also need to be educated about signs and symptoms of REs to seek timely medical examination. Close reading habits and study under poorly lit conditions at home seen significantly more among RE cases implies the need for educating students on importance of healthy postural habits and good reading illumination. Discomfort in using visual aids and irregular eye examinations reported in about one-third of RE cases each emphasizes the need for at least one annual eye examination. These measures will help in preventing long term permanent visual disability among children due to correctable causes of blindness such as REs.

6. LIMITATIONS

This study was done only among urban schools. The desired sample size could not be attained

due to non-consenting or non-availability of records among some students. Another important limitation of this study was lack of ophthalmic examinations to identify new cases of REs among the study participants. The temporal association between risk factors with refractive error onset also could not be established due to the cross-sectional design of this study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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