REVIEW

Prevalence of Refractive errors in children in India – A systematic review.

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Running Title: Prevalence of refractive errors in children

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Background, Uncorrected refractive error is an avoidable cause of visual impairment which affects children in India. The objective of this review is to estimate the prevalence of refractive errors in children ≤ 15 years.

Methods, The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were followed in this review. A detailed literature search was performed to include all population and school-based studies published from India from the year 1990 using the Cochrane Library, Medline and Embase up to Jan 2017. The quality of the included studies were assessed based on a critical appraisal tool developed for systematic reviews of prevalence studies.

Results, Four population and eight school based studies were included. The overall prevalence of refractive error per 100 children was 8.0 (CI: 7.4 – 8.1) and in schools it was 10.8 (CI: 10.5 – 11.2). The population based prevalence of myopia, hyperopia (≥+2.0D) and astigmatism was 5.3%, 4.0% and 5.4% respectively. Combined Refractive error and myopia alone were higher in urban areas compared to rural areas (OR: 2.27(CI: 2.09 – 2.45) and (OR: 2.12(CI: 1.79 – 2.50) respectively. The prevalence of combined refractive errors and myopia alone in schools was higher among girls than boys (OR: 1.2(CI: 1.1 – 1.3) and (OR: 1.1(CI: 1.1 – 1.2) respectively. However, hyperopia was more prevalent among boys than girls in schools (OR: 2.1(CI: 1.8 – 2.4).

Conclusion, Refractive errors in children in India is a major public health problem and requires concerted efforts from various stakeholders including the healthcare workforce, education professionals and parents to manage this issue.

Uncorrected Refractive error (URE) is the most common cause of visual impairment around the world [1] and in children URE and its consequences have a profound effect on their overall development most importantly on educational and psychosocial development [2, 3].

In India, varied prevalence rates of myopia and hyperopia have been reported in children [4-6]. These studies have confirmed that many children are in need of spectacle correction and in rural India around 86% of children presented without correction for RE [4].

Children often do not complain of defective vision and may not even be aware of their problem. They may adjust to poor vision by strategies such as changing position in the classroom and moving objects closer and tending to avoid tasks that require more visual concentration. It is recommended to screen children for early detection and intervention to provide them with the best opportunities to learn and develop [7].

In India as of January 2017,(http://www.indiaonlinepages.com/population/india-current-population.html) there are 365 million children aged < 15 years (29% of the population are children aged less than 15 years (National Health Profile 2015, published by Government of India), and providing vision screening for all children is a daunting task. The availability of eye care services in the country varies between and within regions. Given these disparities, school based vision screening services are considered cost effective in detecting correctable causes of decreased vision[8] and as part of the National Program for Control of Blindness, school vision screening is widely practised at present in the country [9]. Hence, it is necessary to estimate the prevalence both at the community and at the school level to aid planning and implementation of refractive error services in children.

Region specific prevalence estimates are necessary for policy decisions and evidence based allocation of resources. However, cost and logistics limits make population based studies from each region prohibitive. In such a scenario, a systematic review provides pooled estimates for policy decisions and an indication of regional variation. There are no systematic reviews on the question of prevalence of refractive error in children. The main aim of this review is to estimate population and school based prevalence of refractive errors among children ≤ 15 years in India.

'METHODS' This review included data collected in India and published between January 1, 1990 and January 1, 2017. OVID, Embase, EbscoHost and Cochrane library databases were searched using a strategy with terms based on medical subject headings using (MeSH) in the title and abstract. Broad search strategy combined terms related to epidemiology (including MeSH search using exp prevalence * and exp epidemiology * and keyword search using the words prevalence, epidemiology, incidence, rates and proportions), terms related to disease (including MeSH search using exp refractive error *, exp myopia*, exp hypermetropia*, exp astigmatism*, exp presbyopia*and keyword search using the term refractive error, myopia, hypermetropia and astigmatism), and terms related to population (including MeSH search using exp India * and keyword search using the words India) see Appendix for full search strategy . Also, manual search was done based on the reference lists of the eligible articles and reviews for any additional articles. A manual search was conducted for all age groups and this report includes only data related to refractive errors in children aged less than 15 years. And an additional search was conducted to include any studies which reported the prevalence of refractive errors among school going children in India. The systematic review met the criteria outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2009 guidelines. The protocol for this review was not published.

Inclusion and exclusion criteria:

All epidemiological studies that reported prevalence of any refractive errors from an Indian population were considered for full text review. Studies that used only qualitative methods, all review papers and all those studies published only as an abstract or presented in conferences and duplicate publications from the same study were excluded.

The review process includes four steps, (1) screening of title and abstracts and selection of studies for full text reviews, (2) full text review of the selected studies and assessment of methodological quality and (3) data extraction from the included studies and (4) analysis and interpretation. Two independent reviewers (SS, BS) completed all the first three steps and consensus was achieved through discussion in case of any discrepancies at any stage. The methodological quality of the eligible studies was assessed using the checklist developed by Munn et al for prevalence studies[10] and publication bias was assessed through funnel plots. This checklist has 10 criteria and for each criterion, the reviewers record 'Yes', 'No', 'Unclear' 'not applicable'. Data were extracted on the study year, design, sampling

technique, screening tools, cycloplegia, screening personnel, location (urban or rural), total sample size, number of children with refractive error and number of children with different types of refractive error.

For analysis both MetaXL and Open Meta (Analyst) (http://www.cebm.brown.edu/openmeta/) were used to calculate the pooled estimate of refractive errors in children which is the primary aim of this review. For this calculation, Freeman-Tukey double arcsine transformation [11] was used with a random effects model, separately for population and school based data .

As part of the secondary aim of this review, sub-group analysis was performed to estimate the pooled prevalence by type of refractive errors (myopia, hyperopia and astigmatism), by gender and geographic location (rural versus urban). We calculated Cochran Q statistic testing for heterogeneity across studies and reported I squared [12, 13].

'RESULTS' Of 178 potentially relevant titles and abstracts, 26 full text articles were considered eligible. The review strategy is summarised in Figure 1 and the details of 14 excluded studies with the reasons are presented as Table 1. Twelve studies, including four population based cross sectional studies [4-6, 14] and eight school based studies were included in this review [15-22].

Of the four population based studies, three were from South India [4, 6, 14] and one from North India [5]. All the eight school based studies were spread across seven different states.

However, sample size, age group and the definition of refractive errors varied significantly in the included studies. The characteristics of population based and school based studies are presented in Table 2 and 3 respectively and the results of the quality assessment summarised in Table 4. Publication bias was assessed and the distribution of studies in population and school based plots were asymmetrical (LFK index: 2.31: Major asymmetry and LFK index: 123: Minor asymmetry respectively). Very high heterogeneity was found between the included studies reporting prevalence of refractive errors in children (Cochran's Q-test, $p<0.001$; $I^2= 100\%$; see Figure 2 & 3).

The overall prevalence of refractive error in children was 8.0 (CI: 7.4 -8.1) and in schools it was 10.8 (CI: 10.5 – 11.2). The population based prevalence of combined refractive errors

and myopia alone was higher in urban areas compared to rural areas (OR: 2.27 (CI: 2.09 – 2.45) and (OR: 2.12(CI: 1.79 – 2.50) respectively.

The prevalence of combined refractive errors, myopia and hyperopia was higher in urban schools compared to schools in rural areas (OR: 4.9, (CI: 4.46 – 5.507), (OR: 3.4 (CI: 3.03 – 3.92) and (OR: 14.1(CI: 10.6 – 18.9) respectively. The prevalence of combined refractive errors and myopia alone in schools was higher among girls than boys (OR: 1.2(CI: 1.1 – 1.3) and (OR: 1.1(CI: 1.1 – 1.2) respectively however, hyperopia was more prevalent among boys compared to girls in schools (OR: 2.1(CI: 1.8 – 2.4). The prevalence of refractive errors in various sub groups is presented in Table 5 & 6.

'DISCUSSION' The overall population based estimates of prevalence of refractive errors, myopia, hyperopia (≥ +2.0D) and astigmatism in children were 8.0%, 5.3%, 4.0% and 5.4% respectively, while the corresponding figures from the school based data were 10.8%, 7.2%, 2.6% and 1.8%.

The Odds of having combined refractive errors and myopia alone was twice as high among urban children compared to rural children. This is similar to earlier findings [23]on the epidemiology of RE in other parts of the world and this meta-analysis provides further support for this pattern across India. This may be due to the increased educational demands leading to more near vision activities [20]. Also, the greater use of electronic gadgets such as tablets, smart phones and computer games may be the contributing factor for increased prevalence rates in urban areas. Though near work is considered as a risk factor for increased myopia, the association between myopia and near work remains elusive [24].

Comparison between the included studies was complicated by the inherent variability in the methodology adopted in each study resulting in significant heterogeneity. The Refractive Error in School Children (RESC) protocol has been considered as a standard methodology for estimating refractive errors in children [25]. However, in India two population based studies [4, 5] adopted the RESC protocol but unfortunately the age group enrolled in these two studies were different making it difficult for direct comparison. Adoption of standard methods including RE definition, standardised age group sampling across studies will enable comparisons between studies.

Assessment of refractive errors in younger children is quite challenging both technically and logistically. Cycloplegia followed by retinoscopy or autorefraction is a widely acceptable

way of assessing ametropias in children [26] and 11 out of 12 included studies met these criteria. Moving forward, it will be key to ensure that cycloplegia is integral to any studies of refractive error in children in India.

School based data showed that, myopia was higher among girls than boys, perhaps reflecting different environmental factors as the tendency of girls to spend a greater number of hours reading and writing at home and significantly lesser hours outdoors as compared to boys [20]. Estimating prevalence by gender was not possible from the population based studies due to inadequate information.

Considering the progressive nature of myopia in young children and the risk associated with high levels of myopia, vision screening programs should include follow up services. Furthermore, eye health messages highlighting and encouraging children to increase outdoor activities may reduce this risk factor for myopia in Indian children [27].

The range of refractive errors is quite high in very young children, particularly hyperopia. It is unclear whether correction of refractive error affects emmetropisation [28]. One population based study included in the present review used a cut off of ≥ +0.5D as hyperopia, which escalated the overall prevalence of refractive error in children [6]. Most of these children will not require spectacle correction, hence, for estimating the spectacle need a clinically significant level hyperopia of ≥+2.0 D cut off was used and is recommended for future studies of prevalence. However symptoms and binocular visual function should also be taken into consideration and there are clear guidelines available for prescribing spectacles in different age groups in children [29]. Studies in other settings have demonstrated a link between hyperopia and lower educational attainment [30].

Although it is ideal to screen every single child for refractive errors, considering the number of children to be screened and the given resource constraints, a population based screening for childhood refractive errors may not be feasible in India. A pragmatic approach is essential for addressing this issue. For example, the World Health Organisation recommends, vision screening for refractive services in schools as most of the refractive error problems occurs in children of school age [31].

In India, as part of the National Program for Control of Blindness, School Eye Health Screening Program has been in place for more than two decades [9]. Millions of children have been screened every year and this program is found to be cost effective in screening for refractive errors in children in India with volunteer support from school teachers reducing associated costs [8].

To optimise the benefit from the existing school eye health program, a few changes are suggested. Standard protocols across the program would increase comparability of data across the country. Comparable data are important to assess the impact of the program and to develop strategies aimed at increasing screening coverage and compliance. Also, this review could not determine the appropriate age for vision screening in children and suggests that future studies should determine this factor and develop strategies for achieving higher screening coverage in schools [32, 33].

To our knowledge this is the first systematic review on prevalence of refractive errors in children in India. Most of the population based estimates are from the southern region and this limits extrapolation to the entire country as the disparities within the country are well known, with some of the states in the Southern and Western regions having better health indices compared to the Northern region [34]. Also, these estimates are based on data published from 1997 to 2015 and therefore quite old. Since myopia is an emerging public health issue contemporary data are required for reliable estimation across the country. Providing refractive services for children imposes major logistical challenges considering that the population of India is the second highest population in the world, with 1.34 billion people (http://www.indiaonlinepages.com/population/india-current-population.html) and 29% of the population are children aged less than 15 years (National Health Profile 2015, published by Government of India). The population based estimates on refractive error in children in India indicate that 33.4 million children in the country are in need of spectacles to correct their vision. Similarly, if we screen 100 school students aged more than 7 years, 14 of them are likely to need spectacles, of which about 70% would require correction for myopia and follow-up screening on an annual basis, and correction if necessary.

Uncorrected refractive error in children can significantly affect their vision, education and psychosocial [3, 30] development. The projected estimates can be useful for developing strategies to address the issue. The estimated need reveals a very challenging task for the

country to deal with and massive efforts are required to scale up the refractive error services in children.

Based on this review, there is a need for up to date population based data on the prevalence of refractive errors in children with greater representation across India. Also, it is important that future studies adopt a standard protocol such as RESC and report data on different types of RE with clinically meaningful cut off points. For example, along with the data on overall RE in children, it is recommended to report separately on clinically significant RE with ≥-1.0D and ≥+2.0D for calculating the exact need for spectacle correction.

The major limitation of this review was the data included in this review are out of date. Also, the variation in refractive error definition, particularly in reporting hyperopia, contributing to the wide range of estimated prevalence. Moreover, few school based studies in this review included relatively low amounts of RE eg: +0.50D which is not clinically significant for spectacle correction in most children.

'CONCLUSION', uncorrected refractive errors in children in India is a major public health problem and requires concerted efforts from various stakeholders including health, education and parents to manage this issue in this country.

APPENDIX

Complete Search strategy used in EBSCOHOST:

S10	S3 AND S6 AND S9	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S9	S7 OR S8	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S8	AB prevalen* OR AB incidence OR AB epidemiology	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S7	(MH "Prevalence") OR (MH "Incidence") OR (MH "Epidemiology")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S6	S4 OR S5	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S5	AB India OR AB Indian	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S4	(MH "India")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S3	S1 OR S2	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S2	AB "refractive errors" OR AB myopia OR AB hypermetropia OR AB astigmatism OR AB presbyopia	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text
S1	(MH "Refractive Errors+")		

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Table1: Characteristics of Excluded studies

S. No	Author/ Journal name/ Year	Reason for exclusion
1.	Bandrakalli P et al. Journal of Pediatric Ophthalmology and Strabismus. 2012;49(5):303-7.	Data on refractive errors leading to amblyopia is only presented in this article. (35)
2	Singh MM et al. Indian Journal Of Ophthalmology. 1997;45(1):61-5.	Data focused on elderly population and not on children. (36)
3	Jose, R et al. Indian Pediatrics 46(3): 205-208.	No prevalence data reported in this article. (9)
4	Ganekal, S et al. Ophthalmic Epidemiology. 2013; 20(4): 228-231.	Main focus of the article was on amblyopia(37)
5	Ambika, Ketal. (2013). International Journal of Nursing Education 5(1): 6-9.	Primary focus was on awareness of refractive errors among teachers.(38)
6	Saxena, R., et al. (2015).Indian Journal of Community Medicine 40(1): 38-42.	No prevalence data reported in this article(39)
7	Rewri, P., et al. (2013). Ophthalmic Epidemiology 20(5): 315-320.	No prevalence data reported in this article(40)
8	Priya, A., et al. (2015). Ophthalmic Epidemiology 22(1): 60-65.	Main focus of the article was on screening sensitivity by all class teacher and there was no data on prevalence (41)
9	Limburg, H., et al. (1995). World Health Forum 16(2): 173-178.	No data on the prevalence of refractive errors(8)
10	Limburg, H., et al. (1999). Acta Ophthalmologica Scandinavica 77(3): 310-314.	Results were analysed based on the summary report prepared from the districts. No clear information on the refraction procedures(32)
11	Gupta Y, et al. Nepalese journal of ophthalmology : a biannual peer-reviewed academic journal of the Nepal Ophthalmic Society : NEPJOPH. 2011;3(1):78-9.	No information on schools' selection and the total number of children enrolled in each school. (42)
12	Rustagi N eta l. Indian Journal Of Ophthalmology. 2012;60(3):203-6.	Poor coverage for refraction (41.5%) among the children identified with the vision problem. (43)
13	Gupta M, et al. Indian Journal Of Ophthalmology. 2009;57(2):133-8.	No definition given on how refractive error was assessed(44)
14	Ajith S et al. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2015;6(4):2024-7.	Total no of children with refractive errors was not reported(45)

Table 2: Characteristics of the population based studies included in this review

S.no	First author & Year of publication	Location	Region	Study period	Age group	screening tools used	Cycloplegic	screening personnel	definitions used	Subject locations (%)		total no of children examined	no of Children with RE	# with myopia	#with hyperopia	# with Astigmatism
										Rural	urban					
1	Dandona R 2002(4)**	Andhra Pradesh	South	April 2000 - Feb 2001	7 to 15	Retroilluminated logMAR E chart, lensometer, streak retinoscopy and auto refraction	Yes in all children	ophthalmic technicians and ophthalmologist	Myopia -SE -0.50D and hyperopia - SE +2.00 D or more.	100	0	4074	194	163	31	15
2	Murthy GVS, 2002(5)**	New Delhi	North	Dec 2000 to Mar 2001	5 to 15	LogMAR tumbling E chart, streak retinoscopy and handheld auto refractor	Yes in all children	Ophthalmic technicians and ophthalmologist	Myopia -SE -0.50D and hyperopia –SE +2.00 D or more.	0	100	5950	898	440	458	40
3	Dandona R, 2002*(6)	Andhra Pradesh	South	July 1997 - Feb 2000	0-99*	Tumbling E, streak retinoscopy	Yes in children	optometrist and ophthalmologist	Myopia - SE worse than -0.50D and hyperopia as SE worse than +0.50D	77	23	2603	1726	81	1645	NR
4	Nirmalan PK, 2003(14)	Tamilnadu	South	July to Dec 2002	0-15	VA assessed using cambridge crowded cards, cake decorations, streak retinoscopy	Yes (at the discretion of ophthalmologist)	ophthalmic assistants and ophthalmologist	Myopia - SE worse than -0.5 D and hypermetropia - SE greater than + 2.0 D	100	0	10605	63	NR	NR	N

* Only data related to 0 – 15 years are included in this analysis; NR – not reported; ** - Studies used RESC protocol

Table 3: Characteristics of the studies that reported refractive errors in school children

S. no	Author & Year of publication	Location	Region	Study period	Age group (in years)	screening tools used	Cycloplegic	screening personnel	definitions used	Subject locations (%)		total no of children	no of Children with RE	# with myopia	#with hyperopia	# with Astigmatism
										rural	urban					
1	Basu M, 2010(16)	Surat, Gujarat	West	Aug 2006 to July 2007	7 - 15	Retinoscope,	yes (in all cases who had VA <6/12)	Ophthalmologist	Not reported	0	100	3002	457	418	21	18
2	Ghosh S 2012(17)	Kolkata	East	March 2008 to June 2009	6 - 14	Snellen, Streak retinoscope,	yes (in all cases who had VA <6/6)	Ophthalmic technicians & ophthalmologist	Myopia and hypermetropia was diagnosed if one or both eyes had problem	0	100	2570	356	307	65	234
3	Kalikivayi TJ, 1997(18)	Hyderabad	South	Dec 1993 to Mar 1995	3 – 18	Snellen for both distance and near, streak retinoscope, Hirschberg test,	Yes, for all hyperopes> 4 years ; Mohindra retinoscopy was used to test all children aged < 4 years	Optometrists	Myopia, hyperopia and astigmatism >= of 0.50D	0	100	3669	1241	341	900	410
4	Uzma N, 2009(22)	Hyderabad	South	NA	7 – 15	Snellen chart, retinoscope,	Yes, in all children	Ophthalmic nursing officer and ophthalmologist	Myopia SE of at least- 0.50D; hyperopia as +2.00 D or more.	54	46	3314	582	-	-	-
5	Saxena R, 2015(20)	Delhi	North	NA	5 – 15	ETDRS, retinoscope and handheld auto refractometer	Yes, in all children	ophthalmic technician and ophthalmologist	Myopia SE of at least- 0.50D or worse in either or both eyes	0	100	9884	-	1297	-	-

6	Padhye AS, 2009(19)	Maharashtra	West	Aug 2004 and July 2005	6 – 15	Snellen E Chart, Hirschberg's test, streak retinoscopy	Yes in all children	optometrists, ophthalmologist	Myopia SE ≥ - 0.75 D in one or both eyes. Hyperopia SE greater >+2.00 D in one or both eyes and astigmatism if >= 1.00D	40	60	12422	470	268	82	24
7	Ahmed I, 2008*(15)	Kashmir	North	NA	7 - 21	Snellen E chart, pinhole, streak retinoscopy	Yes in all children (cycloplegic autorefraction)	Optometrists, ophthalmologist	Mild, moderate and severe myopia was defined as -0.25 to -2.99 D, -3.00 to 5.99 D and -6.00 D or more respectively	0	100	3419	-	140	-	-
8	Seema S, 2009(21)	Haryana	North	Sep 2006 to July 2007	6 - 15	snellen E chart, streak retinoscope	Not done	Ophthalmic assistants	Definition of RE was not reported	100	0	1265	172	153	19	69

* Only data related to 7 – 15 years are included in this analysis

Table 4: Quality assessment of included studies

Sno	Author	Sample representation of the target population?	Appropriateness of participants recruitment	Sample size adequacy	Details of study subjects and setting description	Data analysis with sufficient coverage of the identified sample?	Objective, standard criteria used for measurement of the condition?	Condition measured reliably?	Appropriate statistical analysis?	All-important confounding factors/ subgroups/differences identified and accounted for?	Were sub populations identified using objective criteria?
Population based studies											
1	Dandona R, 2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Murthy GVS, 2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Dandona Ra, 2002	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Nirmalan PK, 2003*	✓	✓	✓	✓	✓	X	X	✓	✓	✓
School based studies											
5	Kalkivayi TJ, 1997	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Ahmed I, 2008	✓	✓	✓	✓	X	✓	✓	X	X	X
7	Padhye AS, 2009	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Seema S, 2009	✓	X	✓	U	✓	✓	✓	✓	X	✓
9	Uzma N, 2009	✓	U	U	✓	✓	✓	✓	✓	X	✓
10	Basu M, 2010	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	Ghosh S, 2012	✓	✓	✓	✓	✓	✓	✓	X	✓	✓
12	Saxena R, 2015	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓ - yes; X – No; U – Unclear; NA - not applicable

* Fix and follow light (< 2 years) and cake decoration method (2 – 4 years) was used in assessing vision in children aged < 4 years

Table5: Results of subgroup meta-analyses for population based estimates on prevalence of refractive errors (Per 100 population) in children aged 0 -15 years

Types	Overall Prevalence (95% CI)	Urban Prevalence (95% CI)	Rural Prevalence (95% CI)
Refractive errors*	8.0 (7.4– 8.1)	18.7 (17.7 – 19.6)	4.8 (4.5 – 5.1)
Myopia (≥ -0.5D)	5.3 (4.9 – 5.7)	10.8 (10.0 – 11.5)	3.5 (3.0– 4.0)
High Myopia (≥ -2.0D)	1.4 (1.2 – 1.6)		
Hyperopia (≥ + 2.0D)	4.0 (3.7– 4.4)		
High Hyperopia (≥ + 3.0D)	0.7 (0.6 – 0.9)		
Astigmatism	5.4 (5.0 – 5.8)		
High astigmatism (≥ 2.0D)	1.1 (0.9 – 1.3)		

* Includes Myopia and Hyperopia

Table 6: Results of subgroup meta-analyses on prevalence of refractive errors (Per 100 population) in school children aged 3 -18 years

Types	Overall Prevalence (95% CI)	Urban Prevalence (95% CI)	Rural Prevalence (95% CI)
Refractive errors*	10.8 (10.5 -11.2)	15.6 (15.1 – 16.2)	3.6 (3.2 – 3.9)
Boys	9.5 (9.0 – 10.1)		
Girls	12.2 (11.6 – 12.7)		
Myopia	7.2 (6.9 – 7.5)	9.1 (8.8 – 9.5)	2.4 (2.1 -2.7)
Boys	10.2 (9.7 – 10.8)		
Girls	11.6 (11.0 – 12.1)		
Hyperopia	2.6 (2.4 – 2.8)	4.6 (4.3 -5.0)	0.5 (0.4 – 0.7)
Astigmatism	1.8 (1.7 – 2.0)		

* Includes Myopia and Hyperopia

Figure 1: Summary of review strategy - PRISMA Flow Diagram

Figure 2: Forest plot on prevalence of refractive errors among children aged ≤ 15 years in India

Figure 3: Forest plot on prevalence of Myopia among children aged ≤ 15 years in India