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Study of magnitude and risk factors for refractive errors in tertiary hospital of north Karnataka

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Abstract: *Background and Objectives:* Refractive errors are leading cause of avoidable blindness in world. Prevention of refractive error by identifying avoidable, modifiable and reversible biological or environmental risk factors could have great impact. Most of the earlier research is oriented towards school children, whereas in current times, onset of refractive error in 3rd and 4th decade is being noticed frequently Changing lifestyle leading to onset of refractive error in adults is new shift of prevalence, etiology of which needs to be researched. This study is designed to incorporate this lacuna to study risk factors for myopia and hyperopia in patients of less than 40 years. *Materials and methods:* Our prospective cross-sectional study included 400 cases attending routine Ophthalmology consultation. Age, gender, occupation and family history of refractive errors, visual acuity was noted along with automated refraction and cycloplegic refraction in children. Cumulative error calculated as "Spherical equivalent refraction [SER]". Responses to a questionnaire regarding time spent in different near activities were recorded. It was converted to a composite variable "Dioptre hours" considering different levels of accommodative effort for each activity. *Results:* The study sample of 400 cases included 16.5% Emmetropia, 79.25% Myopia and 4.25% Hyperopia. 59% females comprised the majority. 27- 40 years age group had maximum number of myopics and 100% Hyperopics. 58.75% of myopics were students, while 82.35% of Hyperopes had a desk job. Risk of having refractive error had an odd of 0.75 if one parent wore glasses (95% confidence interval= 0.39 to 1.42, p=0.43) and an odd of 1.16 if both parents wore glasses. Myopics showed a statistically significant positive correlation between SER and duration of reading ($p<0.05$). Compared to emmetropes, myopes spent significantly increased duration of time in mobile phones ($p<0.05$). In Hyperopics, duration spent in studying was significantly lesser compared to emmetropes ($p<0.05$). Duration of outdoor activities and reading distance did not show any significant correlation with SER in both myopics and hyperopics. *Conclusion:* Prevalence of refractive errors is highest in 26-40years age group in current times with female predominance. Excessive near work especially reading and using mobile phones leads to myopia onset and progression. Incorporating outdoor activities in curriculum, reducing online teaching programmes may reduce magnitude of refractive errors.

Keywords: Myopia, Hyperopia, Risk Factors, Mobile Phone, Outdoor Activities, Reading Distance.

Introduction

Refractive errors remain a cause of concern in India although easily correctable with spectacles, contact lenses and refractive surgeries, due to lack of screening and affordability of refractive correction. Social taboo and myths about wearing glasses, cosmetic blemish, fear of surgeries and lack of motivation to have a clear vision adds to the problem. Progressive myopia in addition may lead to severe complications like Retinal detachment, glaucoma, cataract and even blindness [1]. Etiology, risk factors and various interventions to halt the progression of refractive errors have been studied extensively over decades, which however still remain elusive. Prevention of refractive error by identifying avoidable, modifiable and reversible biological or environmental risk factors for myopia and hyperopia could have great impact on preventing vision loss.

Most of the earlier research is oriented towards school children, whereas in current times, onset of refractive error in 3rd and 4th decade is being noticed frequently. Changing lifestyle with a shift to major dependence on

digital platform and decreased outdoor activities may precipitate this scenario.

Material and Methods

Prospective cross sectional study of 400 cases under 40 years of age was conducted at a tertiary eye hospital in north Karnataka during the period from August 2020 to August 2021. 400 patients aged less than 40 years, attending routine general ophthalmology out patient department were enrolled in the study after obtaining written informed consent. Simple random sampling was followed. Patients with history of ocular surgeries/ lasers including those who underwent refractive surgeries and/or with ocular comorbidities other than refractive error were excluded from the study. Also, cases with severe anisometropia of >2 dioptres were excluded since it is mostly congenital or pathological. The study was approved by institute's ethics committee and followed the tenets of declaration of Helsinki for biomedical research.

All the consented OPD patients satisfying the inclusion and exclusion criteria were given a questionnaire, detailing the duration spent each day in doing specific activities, irrespective of their age and occupation. In case of children, consent was taken from informant parent as well who then filled up the questionnaire. The near activities included the number of hours spent per day in;

1. Studying
2. Recreational near work like pleasure reading, art & craft work etc
3. Mobile phone usage be it work related or gaming or social media
4. Computer usage, video games and board games
5. Watching television.

Since each of these activities require different level of accommodative effort, a composite variable "Dioptre Hours" for near work was derived as suggested by Muttti et al in their similar study[2]. The purpose of this variable was to quantify the amount of near work not only in terms of time, but also with respect to accommodative effort involved. This diopter hours "Dh" was defined as Dh= 3 x (hours spent studying+ recreational near work + mobile phone usage) + 2 x hours on computer or video games + hours spent watching television.

Beside age, gender & occupation of individual, family history suggestive of any refractive error at younger age (thus ruling out presbyopia) was recorded. Visual acuity for distance and near was tested using ETDRS charts using standard protocols. Near visual acuity testing also involved measurement of preferred reading distance as distance in centimeters (cm) between glabella and centre of chart held by patient as per his/her comfort. The data was categorized as a reading distance of either less than 30 cms or more. All cases were subjected to objective autorefractor using Nidek autorefractor, followed by subjective acceptance for final prescription. Younger patients <12 year old were subjected to an additional cycloplegic refraction using Homatropine 2% eyedrops, 3 drops at a gap of 10 minutes between each drop bilaterally.

A spherical equivalent (SE) was calculated for each eye as spherical error + half of cylindrical error. A cumulative refractive error for both eyes termed as "Spherical Equivalent refraction (SER)" was calculated using average SE of both eyes in case of anisometropia <1D and higher of the two was taken in case anisometropia was 1-2D. Myopia was defined as an error of atleast -0.75D and Hyperopia as atleast +0.75D of SER. Anything from +0.5D to -0.5D was considered as Emmetropia to reduce the number of false positives, corresponding to accuracy of autorefractors [3] and to reach a level of refractive error likely to produce clinical symptoms.

The data tabulated in Microsoft Excel 2010 was statistically analyzed using SPSS 17.0.

Results

The study sample of 400 cases included 66 (16.5%) of Emmetropia, 317 (79.25%) cases of Myopia and 17 (4.25%) of Hyperopia with comparable distribution among both genders. 59% females comprised the majority [Fig 1]. The cases were categorized into 4 age categories as less than 6 years, 7-17years, 18-26 years and 27-40 years, to correlate with definition of types of myopia and also difference in type of activities these group of patients were routinely involved. Majority of cases were aged between 27-40 years in our

study followed by those between 18-26 years. [Fig 2] 100% cases of Hyperopia were 26-40 year old in our study. However, the exact age of onset of refractive error was difficult to comment due to unavailability of previous records and unreliable history. The mean refractive error in each group is as mentioned in Figure 2.

Fig-1: Gender wise prevalence of refractive error

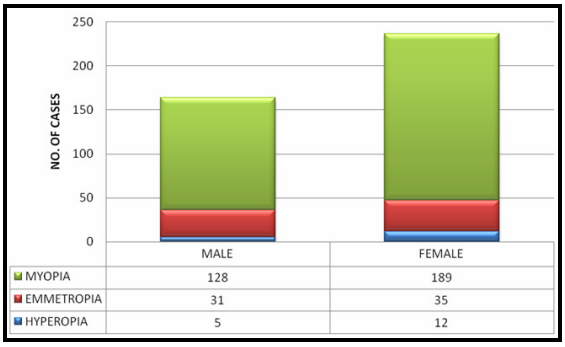
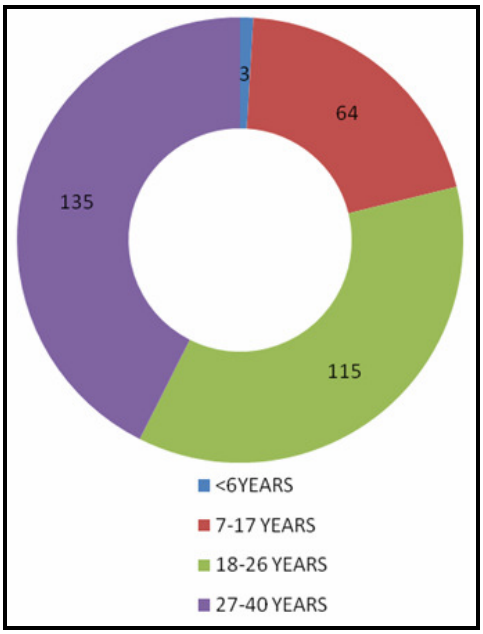


Fig-2: Age wise prevalence of myopia



Another categorization was made as per occupation of patients depending on type of working distance, need for using digital devices and fine motor skills involved. All students were categorized as group 1. Occupations involving fine near focus like tailor and carpenters formed group 2. Jobs requiring need for reading, using computers like engineers, businessmen, teachers, receptionist, bankers and homemakers grouped as group 3. People mostly involved in variable range of focus like maids, farmers, drivers, waiters were categorized as group 4. Majority of cases in our study were students (58.75%), while 82.35% of Hyperopes belonged to group 3. [Table 1].

Table-1: Prevalence of refractive error (in dioptres) in various occupations

Occupation category		Emmetropia	Myopia	Hyperopia
Group - 1	SER [Mean ± SD]	0.42± 0.21	1.41± 0.56	1.25
	N	47	187	1
Group - 2	SER [Mean ± SD]	0.4± 0.2	1.15± 0.75	1
	N	5	13	1
Group - 3	SER [Mean ± SD]	0.40± 0.16	1.47± 1.17	1.13± 0.35
	N	23	84	14
Group - 4	SER [Mean ± SD]	0.43± 0.16	1.52± 1.19	1.25
	N	11	32	1

The prevalence of refractive errors was comparable whether or not their parents had any evidence of refractive error. 82.2% cases with no history of parental refractive error needed refractive correction, while the 86.6% and 80.6% cases needed correction if one or both parents had refractive errors respectively. [Table 2] However, the risk of having refractive error had an odd of 0.75 if one parent wore glasses (95% confidence interval= 0.39 to 1.42, p=0.43) and an odd of 1.16 if both parents wore glasses (95% confidence interval= 0.58 to 2.33, p=0.72) indicating increased risk in case of parental refractive error.

Table-2: History of parental refractive error

Parents with refractive error	Emmetropia	Myopia	Hyperopia
None	38	174	9
Either of two	15	91	6
Both	13	52	2

The correlation of SER has been studied with respect to duration of various near activities. In myopics, a statistically significant positive correlation is seen between SER and duration of reading ($p<0.05$, Spearman's correlation coefficient, Figure 3).

None of the other near activities were seen to have a strong correlation to myopic SER. Accommodation weighted variable Dioptre hours was also found to have an insignificant correlation. When compared to emmetropes, myopes tended to spend significantly increased duration of time in mobile phones ($p<0.05$, Independent T-test, Table 3).

In Hyperopics, none of the near activities including Dh were significantly correlated to SER. However, duration spent in studying was significantly lesser compared to emmetropes ($p<0.05$, independent T-test, table 3). Duration of outdoor activities and reading distance did not show any significant correlation with SER in both myopics and hyperopics.

Fig-3: Graph depicting significant correlation between myopic spherical equivalent refraction with duration of studying [spearman's correlation coefficient, p=0.045]

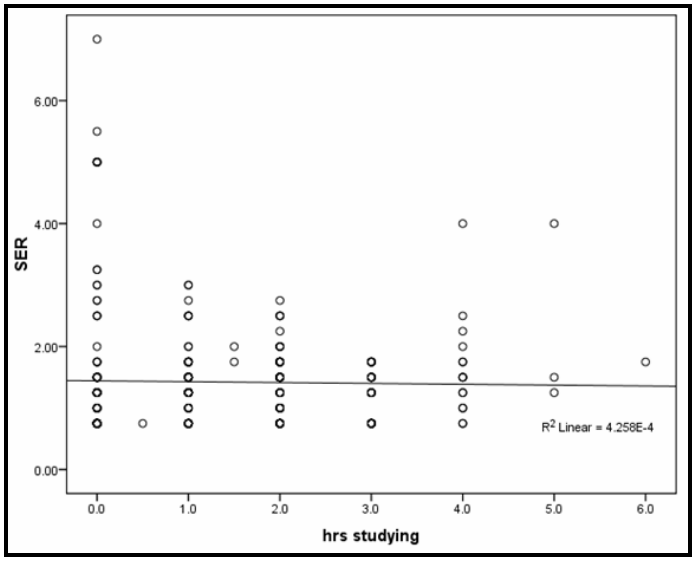


Table-3: Time spent in various near [hours/ day], dioptre equivalent [dioptres] and outdoor activities [hours/week]

	Emmetropia	Myopia	Hyperopia
Studying	1.12±1.38	1.3±1.26	0.41±0.87*
Recreational near work	0.87±1.34	0.62±1.01	0.97±0.94
Mobile phones	1.03±0.53	1.9±0.46*	1±0.69
Computer/ video games/ board games	0.8±1.34	0.8±1.16	0.62±0.9
Television	1.2±0.9	1.03±0.78	1.24±0.69
Dioptre equivalent	11.86±5.24	11.08±4.96	9.62±5.3
Outdoor activities	11.42±4.02	10.91±3.7	10.94±4.09
*p<0.05, Independent T-test.			

Discussion

Refractive errors continue to be the most common cause of reversible blindness and the incidence is on rise worldwide. Globally in 2015, leading cause of moderate- severe visual impairment was refractive errors (116.3million) followed by cataract, of whom 7.4 million were blind due to untreated refractive error. A systemic review anticipated the rise in these numbers by 2020 [4]. Myopia being most common

refractive error is highly prevalent in East Asia. Though the concern is not that severe in India, there has been progressive increase in prevalence over years [5]. Nearly half of world's population will be myopic and one tenth will have high myopia by 2050 as predicted [6].

Myopia has long been associated with educational performance and close work occupations. Near work is proposed to be the culprit in development of myopia [7]. Various theories are suggested to validate the same. Earliest assumption attributed the correlation to increased accommodation [8]. This was questioned when time and accommodation weighted measures of near work adjusted for parental refractive error failed to demonstrate significant associations between near work and accommodation [2]. Since hyperopic defocus was proved to be powerful stimulus for eye growth in animal models [9], accommodative lag was advocated to be causative. However, cause effect relationship is still controversial [10].

Whether myopics develop accommodative lag or inherent accommodative lag leads to onset of myopia still needs to be answered. Overall, role of accommodation has been questioned as progression of myopia is barely controlled by appropriate refractive correction [11] in clinical setting. Currently, plausible evidence of role of accommodation comes from effectiveness of low dose Atropine in slowing myopia progression [12]. Hyperopia on the other hand is mostly associated with certain racial and genetic predispositions and environmental factors do not seem to affect its onset and progression [13].

The present study is designed to verify role of alleged risk factors in prevalence of refractive error in regional population aged under 40years. Among 400 cases, the study predominantly included cases belonging to older age groups owing to older population attending our OPD. It's a chance occurrence and not a representative sample of whole study group, thus having minor implications. 100% of hyperopia cases were aged 26-40 years in our study. Standardized large sample studies have demonstrated a significantly higher incidence of myopia in younger children compared to older ones revealing increasing incidence in recent times [5]. Hyperopia shows a bimodal incidence with increased occurrence in early childhood and in >40 years, which is attributed to physiological ocular changes [13].

Literature conclusively suggests higher incidence of refractive errors in girls compared to boys [5]. In India, girls tend to read and write more and the social norms warrant them to spend greater amount of time indoors. This has been suggested to increase the myopia occurrence in females. Current study complies with the above fact. As previously discussed, occupations involving near work tend to predispose to myopia [7].

Our results are concurrent to this observation, where 79.5% of student and 68.4% of fine near workers were myopic. Among 316 myopics included, students (59%) and group 3 Occupations involved in digital device usage (26.5%) comprised the majority, thus validating role of near work involved in development of myopia. Although 82.3% of hyperopes belonged to group 3 occupations, the sample size of 17 is too meager to be conclusive and it could only reflect coincidental inclusion of 4^{th} decade cases in this group. Myopia is considered to be mainly genetic. Prevalence of myopia ranges between 30-40% when both parents are myopic, 20-25% when one parent is myopic and <10% if none are myopic [14].

Some authors believe that it's the shared intense near work environment which is inherited rather than myopigenic genes. Others propose inherited genetic susceptibility to effect of near work environment rather than inherited myopia itself. Heredity as a risk factor was tested in our study, which illustrated increased risk of having a refractive error with increasing number of parents with refractive error, though statistically insignificant. Mutti et al considers heredity as most important factor associated with juvenile myopia. Refractive error and axial length of children's eyes were more closely related to parental refractive error than their near work habits in their study [2].

However, they did not find an evidence to suggest children inherit myopigenic environment or a susceptibility to effects of

near work. Juvenile cases comprised only 20.25% of our sample, thus results are not comparable. Our results suggest minor effect of heredity in onset of myopia.

Among various near activities studied, time spent in studying is positively correlated to myopic SER, whereas reading for pleasure, art and craft work do not show similar trends possibly because of intensity of focus required for studying compared to relaxed state in other activities. Though mobile phone usage is weekly correlated to myopic SER, myopes reported greater use of mobile phones compared to emmetropes.

In contrast to general parental concern regarding use of computers and watching TV leading to myopia, our study did not find significant correlations with these activities. The required myopic correction showed a weak negative correlation with reading distance implying closer the reading distance, more is the myopic error. Earlier studies have also reported significant association between studying and pleasure reading with myopic SER, while watching television and use of computer did not influence myopia [2].

The same study also observed that accommodative weighted variable of comprehensive near activities "Dh" is correlated to myopic error. However, our study does not find statistical evidence for same. An Indian study reported that time spent in reading, computer, video games and watching TV are all important risk factors for progression of myopia rather than its onset [5]. On contrary, only a weak correlation with near activities even after adjusting for other risk factors was noted in another study [15]. However, authors concluded close working distance is significantly correlated to SER as it provides a source of hyperopic defocus, which in susceptible individuals promotes eye growth.

Hyperopic SER in our study did not correlate with time spent in any of near activities, concurrent to previous reports [13]. Nonetheless, hyperopic cases reported significantly less time spent in reading compared to emmetropes. Decreased near vision due to existing error and dependency over glasses for reading may lead to this effect. Several reports suggest beneficial effect of outdoor activities in preventing myopia onset [2, 16] and progression [5, 16]. Owing to protective effect, Rohit Saxena et al proposed certain changes in school curriculum to incorporate some outdoor activity [5]. Besides reducing magnitude of myopia, it also improves general health and well being of children.

Conclusion

Prevalence of refractive errors is highest in 26-40 years age group in current times with female predominance. There is definitive increased risk in case of parental refractive errors. Excessive near work especially reading and using mobile phones leads to myopia onset and progression. Incorporating outdoor activities in curriculum, reducing online teaching programmes may reduce magnitude of refractive errors.

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References

1. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. *Prog Retin Eye Res*. 2012; 31(6): 622-660.
2. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K. Parental myopia, near work, school achievement and children's refractive error. *Invest Ophthalmol Vis Sci.* 2002; 43(12): 3633-3640.
3. Zadnik K, Mutti DO, Adams AJ. The repeatability of measurement of ocular components. *Invest Ophthalmol Vis Sci.* 1992; 33(7): 2325-2333.
4. Flaxman SR, Bourne RRA, Resnikoff S, Ackland P, Brathwaite T, Ciciinelli MV et al. Global causes of blindness and distance vision impairment 1990-2020: a systematic review and meta- analysis. *Lancet Glob Health.* 2017; 5(12): 1221-1234.
5. Saxena R, Vashist P, Tandon R, Pandey RM, Bhardawaj A, Gupta V et al. Incidence and progression of myopia and associated factors in urban schoolchildren in Delhi: The North India Myopia Study (NIM Study). *PloS ONE.* 2017; 12(12):e0189774.
6. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, sankaridurg P et al. Global prevalence of myopia and high myopia and temporal trends

from 2000 through 2050. *Ophthalmology.* 2016; 123(5):1036-1042.
7. Goss DA. Nearwork and myopia. *Lancet.* 2000; 356(9240):1456-1457.
8. Morgan I, Rose K. How genetic is school myopia? *Prog Retin Eye Res.* 2005; 24(1):1-38.
9. Wallman J, Winawer J. Homeostasis of eye growth and the question of myopia. *Neuron.* 2004; 43(4):447-68.
10. Mutti DO, Mitchelli GL, Hayes JR, Jones LA, Moeschberger ML, Cotter SA et al. Accomodative lag before and after onset of myopia. *Invest Ophthalmol Vis Sci*. 2006; 47(3): 837-846.
11. Saw SM, Gazzard G, Au Eong KG, Tan DT. Myopia: attempts to arrest progression. *Br J Ophthalmol.* 2002; 86(11):1306-1311.
12. Sathyan S. Atropine in the treatment of childhood myopia. *Kerala J Ophthalmol.* 2019; 31(1):4-10.
13. Borchert MS, Varma R, Cotter S, tarczy-Hornoch K, McKean Cowdin R, Lin JH et al. Risk factors for hyperopia and myopia in preschool children, the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology.* 2011; 118(10):1966-1973.
14. Pacilla R, McLellan J, Grice K, Del Bono EA, Wiggs JL, Gwiazda JE. Role of genetic factors in the etiology of juvenile-onset myopia based on a longitudinal study of refractive error. *Optom Vis Sci.* 1999; 76(6): 381-386.
15. Ip JM, Saw SM, Rose KA, Morgan IG, Kifley A, Wanj JJ et al. Role of near work in myopia: Findings in a sample of Australian school children. *Invest Ophthalmol Vis Sci.* 2008; 49(7):2903-2910.
16. Xiong S, Sankridurg P, Naduvilath T, Zang J, Zou H, Zhu J et al. Time spent in outdoor ctivities in relation to myopia prevention and control: a meta-analysis and systematic review. *Acta Ophthalmol*. 2017; 95:551-566.

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