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A Cross-sectional Study on Prevalence of Uncorrected Refractive Error in Paediatric Population in a Tertiary Care Hospital in a Metropolitan City of Western India in the era of Screen Addiction and its Association with Screen Time

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ABSTRACT

Aim: To find the prevalence of uncorrected refractive error in paediatric population aged 5-12 years visiting our tertiary care hospital and to look for any association between the amount of screentime and presence of refractive error.

Material and Methods: A single-centre hospital-based cross-sectional observational study was carried out at our out-patient department and the recorded data was analysed. The study included 158 children aged between 5 years and 12 years satisfying specific inclusion and exclusion criteria. Prevalence of uncorrected refractive error in this study population was determined by the cycloplegic refraction. Parents of the subjects were invited to fill up a questionnaire to report the time spent by their children on digital screen and outdoors. Descriptive and Inferential Statistical analysis of the data was performed by SPSS software version 26 using chi-square test as the test of significance. Conclusions were obtained by calculating and comparing P value with level of significance of 5%.

Results: In our study 78.5% of the study population, with an average daily illuminated screentime of 5 hours, had uncorrected refractive error. Most common refractive error was astigmatism followed by hypermetropia and myopia. Mean daily screentime was higher among myopic and astigmatic. The prevalence of refractive error showed an increasing trend with increase in daily screentime, with more rise for near screen usage. Outdoor time was found to have a protective role against myopia and astigmatism.

KEYWORDS: Paediatric refractive error, screen time, outdoor activity, near screen time

I. INTRODUCTION

Uncorrected refractive error is one of the most common causes of moderate to severe visual impairment worldwide and is also the second leading cause of the treatable blindness among the world population.[1] The presence of uncorrected refractive errors and the associated deficit in vision may be difficult to identify among children, as the initial symptoms remain unnoticed and the parents are not aware about regular vision check-up of their children until they develop some gross visual symptoms. Uncorrected refractive error in childhood can cause amblyopia. So, screening for the refractive errors is very important and should be performed as a part of the annual physical examination among all children.

From the physiological perspective, the human eye is hypermetropic during birth[2] and has a power ranging between +0.5 D to +4.0 D. The emmetropization process during growth predisposes the children towards the progression to myopic vision. An age-related shift in the refractive error, from hypermetropia among young children to myopia among older children, has indeed been observed[2]. Presently, it is believed that apart from the physiological aspect, various environmental factors are also responsible for increased prevalence of myopia among young children, more consistently increased near work and decreased outdoor activity[3,4,5]. Various prior studies have identified a positive association between refractive error, specifically myopia and near-work activities such as studying, reading, and screen time among children[4]. There is some evidence to suggest excessive expansion of Bruch's membrane, possibly in response to hyperopic defocus of the retina, which may be one of the mechanisms leading to uncontrolled axial elongation of the eye

resulting myopia[4]. It is proposed that accommodative lag during near work may result in excessive eye growth imposing hyperopic defocus. Additionally, time spent outdoors has been found to be protective against refractive error, specifically myopia[5], which might be due to light stimulation of retinal dopamine which discourages axial growth[6]. Previous literature also reported the association of sunlight and serum vitamin D level with refractive error prevalence.[2]

Digital screen time has become a growing concern in modern human civilisation. Until two decades back children were spending a substantial time in outdoor games and activity. But now laptops, computers, smartphones, tablets, gaming consoles have become an integral part of every child's daily routine. While screens can entertain, teach, and keep children occupied, too much screentime has its own adverse effects. And off late, the COVID pandemic and its restrictions on outdoor time has made the situation worse. Online virtual classes replaced classroom teaching adding a compulsory screentime for the children. Though certain literatures pointed out that increased screentime is associated with refractive error in children, however consistent evidence of this association is lacking.[6]

We conducted the present study to find out prevalence of uncorrected refractive error in children visiting the out-patient department of Ophthalmology in a tertiary care hospital of western metropolitan city in India and look for any hidden pattern of association of usage of illuminated screen and refractive error in children.

II.MATERIALS AND METHODS

This analytical cross-sectional observational, hospital based single centre study was carried out on 5 to 12 years old children visiting our out- patient department during the period of 11 months from October 2020 to August 2021. The study was approved by Institutional Review Board and was adherent to the tenets of Declaration of Helsinki.

Children were eligible for inclusion if they had a minimum daily screen time of at least 45 minutes for the last 6 months. Those who had poor vision due to causes other than refractive error, previous history of ocular injury or surgery , already using spectacles, family history of high refractive error or those with special needs were excluded from the study.

Visual acuity of the children was checked and recorded using Snellen's distance vision chart by single experienced optometrist. Cover tests, extraocular movement, anterior segment examination with slit lamp and fundus examination with Indirect Ophthalmoscopy were undertaken to ensure the maintenance of exclusion criteria. The primary parental caregiver of each participant (decided among the caregivers) was invited to complete a self-administered semi-structured questionnaire that collected data on presence or absence of parental high myopia, history of any ocular surgery of the child, time spent outdoor and on near and distant illuminated screen. Self-reported data on the amount of time spent in outdoor physical activity and screentime were recorded after compiling the data obtained from the self-administered questionnaire filled by the primary parental caregiver of each child.

Cycloplegic refraction done using 1% cyclopentolate eye drops in each eye twice at 10

minutes interval at least an hour before examination. Streak retinoscope used in a semi-dark room at a distance of one meter and post mydriatic test done after 72 hours of cycloplegic refraction. All data including final diagnosis of refractive error were meticulously recorded in a pre-set eye examination form.

The following criteria were used to classify the refractive error [8]:

Myopia: > -0.50 D

Hypermetropia: Up to 6 years, more than +1.25 D^2 (to exclude physiological hypermetropia).

For rest of the children, equal to or more than +0.50D.

Astigmatism: Any cylindrical error.

III.STATISTICAL ANALYSIS

The data were entered using Microsoft excelsheet and analysed using SPSS statistical software version 26. The minimum sample size was calculated to be 146, using openeti.com version 3, open-source calculator. According to the reference article "Usage of illuminated screen as a risk factor for Refractive error in children" by author Anjila Basnet and Pragya Singh Basnet, the proportion of the most common refractive error among the children was astigmatism (24.7%)[8]. With absolute precision 7% at level of significance 5% and confidence level 95%, the minimum sample size obtained was 146. Descriptive and Inferential statistical analysis were carried out and results on continuous measurements were presented as Mean ± SD and results on categorical measurements in Percentage. The test of significance used for Statistical analysis is Chi square test. Conclusions are obtained by calculating & comparing P value with level of significance i.e.,5%.

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IV. RESULTS

Out of total 158 children enrolled in our study, there were 102 (64.6 %) boys and 56 (35.4%) girls. Mean age of the population was 8.6 years with standard deviation of 2.25 years.

I. Duration of use of illuminated screen:

The most commonly used illuminated devices were found to be mobile phones, followed by television. The mean screentime (both near and distant) was found to be 5 hours/day, out of which 3.36 hours/day was only near screentime amongst our entire study population.

The mean daily screentime was comparable in both boys and girls, which was found to be 5.17 hours (for near + distance) in boys out of which only near screentime was 3.44 hours and for girls it was 4.93 hours (for near + distance) out of which 3.23 hours was the average screentime for only near devices.

The children in our study were divided into two categories according to their screen usage hours per day.

Group A: Those with daily illuminated screentime for up to 2 hours were listed as low users. Out of 158, 39 children (24.7%) were in this group.

Group B: Those using screen devices daily for more than 2 hours were grouped as high users. 119 (75.3%) subjects were in this group

We found that in each type of refractive error, the number of children from group B was higher than that from group A, whereas the emmetropic category had equal number of children from group A and group B.

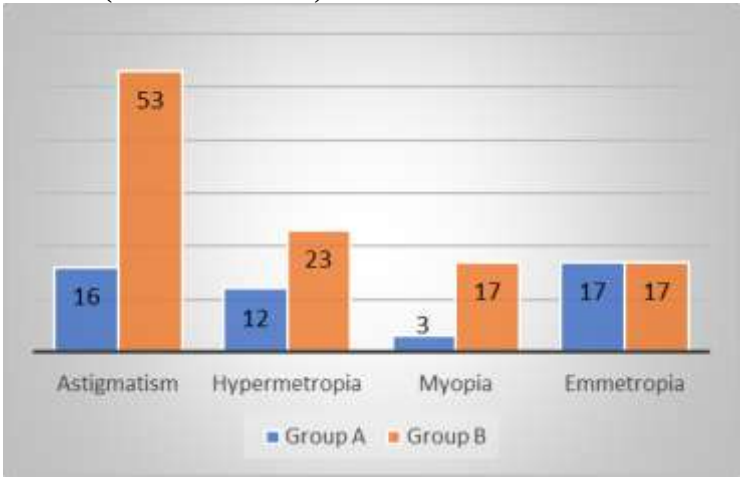

Figure 1: Frequency distribution of group A and B in relation to different refractive status

Table 1: Statistical analysis of daily screentime in different refractive error groups

	No.	Mean daily screen time	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Emmetropia	34	4.9412	3.42178	3.7473	6.1351	1.00	14.00
Myopia	20	5.1750	2.87583	3.8291	6.5209	1.00	12.00
Hypermetropia	35	4.8571	3.80706	3.5494	6.1649	1.00	18.00
Astigmatism	69	5.2536	3.26481	4.4693	6.0379	1.00	16.00
Total	158	5.0886	3.35364	4.5616	5.6156	1.00	18.00

II. Prevalence of refractive error in relation to daily screentime

In our study, out of 158 children, 124 (78.5 %) had uncorrected refractive error. The most commonly found refractive error was Astigmatism 43.67% (69/158) followed by Hypermetropia 22.1% (35/158) and Myopia 12.6 % (20/158).(figure 1, figure 2)

The prevalence of myopia and astigmatism was found to be higher with increased daily screentime whereas hypermetropia showed no such trend. The prevalence of myopia jumped up from 7.7% in the group A to 14.3% in group B and astigmatism went up from 41 % in group A to 44.5% in group B. This showed a definite pattern of rise in refractive error with rise in screentime.

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	Group A	Group B	Test statistics
Refractive error	30 (76.9%)	94 (79%)	Chi square value p=0.074
Total	39	119	

Table 2: Prevalence of refractive error in relation to daily screentime

	Group A	Group B	Total	Test statistics
Emmetropia	9 (23.1%)	25 (21.0%)	34	Pearson Chi square p value =0.571
Myopia	3 (7.7 %)	17 (14.3%)	20	
Hypermetropia	11 (28.2 %)	24 (20.2%)	35	
Astigmatism	16 (41%)	53 (44.5%)	69	
Total	39	119	158	

Table 3: Prevalence of different refractive errors with daily total screentime

III. Comparison of prevalence of refractive error in relation to near or distant screen devices

In our total study population, 104 children were using both near and distant screen devices, among which 79 children (76 %) had refractive error.

In our study group, 54 children were using only near screen devices, among which, 45 children (83.3%) had refractive error. There was increased prevalence of refractive error in children using only near screens (p value= 0.315 by Fisher's Exact test).

We observed that, those using only near screens had a higher prevalence of astigmatism, myopia and hypermetropia clinically (p value 0.760).(Table 2, Table #)

No children were using only distant screens in our study.

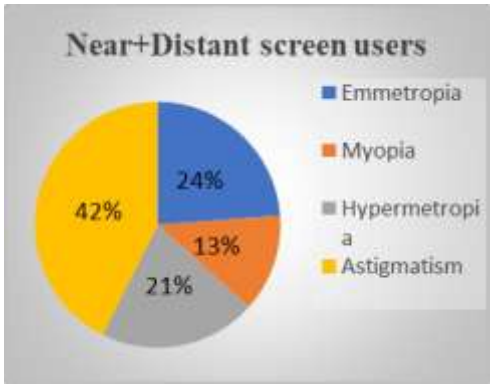

Figure 2: Distribution of different refractive error in distant and near screen users

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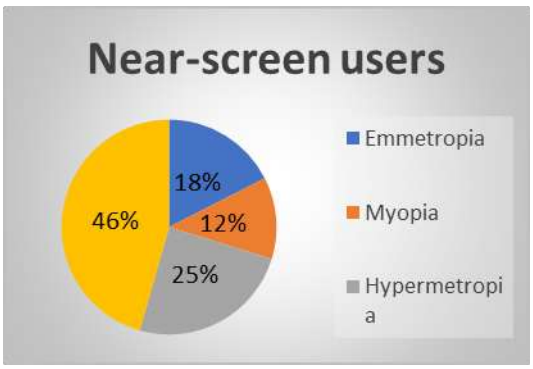

Figure3: Distribution of different refractive error in near screen users

IV. Prevalence of refractive error in relation to outdoor time

We found an inverse relation between the prevalence of refractive error with outdoor time. Refractive errors were present in 82.2% children with up to daily 2 hours outdoor time as compared to 70.6% in children who spent daily more than 2 hours outdoor.

Mean outdoor time was found to be lesser in astigmatics (1.46 hours) and myopes (1.88 hours) as compared to emmetropes (2.24 hours) and hypermetropes (2.41 hours).

Prevalence of both astigmatism and myopia were found to be less with an increase in the daily outdoor time whereas prevalence of hypermetropia did not follow such trend.

		Refractive errors				Total	Test statistics
		Emmetropia	Myopia	Hypermetropia	Astigmatism		
Outdoor Time	<= 2 Hours	19	14	21	53	107	Pearson Chi-square p value= 0.122
		17.8%	13.1%	19.6%	49.5%	100.0%	
	> 2 hours	15	6	14	16	51	
		29.4%	11.8%	27.5%	31.4%	100.0%	
Total		34	20	35	69	158	

Table 4: Distribution of refractive errors in different group of outdoor time

V. DISCUSSION

Our study population was composed of 64.56% males and 35.44% females with almost similar average daily screentime use. Uncorrected refractive error was found to be more common in females (80.3%) than in males (77.4%). This trend is similar to the study carried out in West Bengal by Saha et al.[7], where prevalence of refractive error was found to be higher in females (17.3%) than in males (10.9%) in 2017.

The study showed that mean duration of use of illuminated screens was 5 hours/day with mean near screen use of 3.36 hours/day. This finding is quite higher than as found by Basnet et al.[8] (average 2 hours daily in 2019) but in similar range as found by McCrann et al.[6] and Moore et al.[9] in 2020.. Moore et al.[9] reported average daily screentime usage of 5.1 hours in children aged between 5 to 11 years in Canada.

We found that 75.3% children of the study population were using daily illuminated screens for more than the proposed recommended duration of 2 hours[10,] which is much greater than that reported by Simonato et al.[11] and LeBlanc et al.[12]. In 2015, LeBlanc found 54.2% of children of age-group 9-11 years using daily digital screens for more than 2 hours with more screentime in boys as compared to girls. So currently, the amount of screentime has increased in children than before as it may be difficult for parents to control their children's screentime in recent pandemic of refractive error.

The study revealed that, among our study population with mean daily screentime of 5 hours, 78.5% had uncorrected refractive error. This is quite higher compared to what was found by Sheeladevi et al.[13] ,Paudel P et al.[14,] Mayro B A et al.[15] and Saha et al.[7]. A study conducted in Pakistan in 2019 by Iqbal F et al[16] found prevalence of 63.3% refractive error in school-going children

aged between 4 and 15 years. In the same year, Basnet et al.[8] found prevalence of refractive error to be 43.9% in children of 6 to 15 years age-group who were using illuminated screen for approximately 2 hours on a daily basis. The rise in refractive error in paediatric age group in last few years is pointing towards its association with increased digital screen use in children during this period with literature proving screentime as potential risk for refractive error[14, 17, 18, 19, 20, 21]

The most common refractive error found in our study population was astigmatism (43.67%), followed by hypermetropia (22.1%) and myopia (12.6%). Basnet A et al.[8] found commonest refractive error to be astigmatism (24.7%) followed by myopia (15.1%) and hypermetropia (4.2%) among digital screen users. But in contrast, Saha M et al.[7] and Das A et al.[22] found the most common refractive error to be myopia followed by hypermetropia and astigmatism.

Our finding resonated with the study of McCrann et al.[23] and Guan et al.[18] who found positive correlation of presence of myopia and screentime. Guan et al.[18] reported that more than 60 minutes/day computer and smart-phone usage (near illuminated screen) was significantly associated with greater refractive error where television viewing (distant illuminated screen) was not. We also found that the increase in prevalence of myopia is rising even more with increase in near screen exposure. We could not find the effect of distant screen usage exclusively, as in this era of mobile phones and smartphones, all children were using near screens in our study population with or without distant screen. Basnet et al.[8] didn't find any such correlation between screentime and prevalence of refractive error.

In our study, we found that there is a visibly distinct lowering pattern of prevalence of astigmatism and myopia with increase in daily average outdoor time. Prevalence of myopia and astigmatism were 13.1% and 49.5% respectively in children with less than 2 hours daily outdoor time, whereas they were 11.8 % and 31.4% respectively among children with more than 2 hours of daily outdoor time. Guan et al.[18] also reported the significant association between outdoor time and reduced myopia, where myopia prevalence was the highest among those who spent the least outdoor time. Harrington et al.[24] and Lin Z et al.[25] also found positive correlation between more outdoor time and lower myopic prevalence.

The findings of our study obtained after thorough evaluation of the data strongly indicate that the usage of digital screens, in particular the near-screens, is associated with increased prevalence of refractive errors among children who otherwise do not have any history of parental high refractive errors. We believe that the clinical significance demonstrated with the current sample size, specifically in the group of higher screen exposure, is a key to warrant future conclusive research in this area. That the duration of outdoor activities exhibits an association with less prevalence of the refractive error, is perhaps due to the minimal accommodative requirement for focus beyond 6 meters. On the other hand; spending more time with near screen strains the eyes to focus at short distance. So, more research is necessary to draw a conclusion on this matter. Meanwhile, to avoid ill-effects of near screentime; it is advisable to have increased outdoor time as well.

VI. CONCLUSION

Clinically, the prevalence of uncorrected refractive error was positively associated with the screentime and negatively associated with outdoor time. The pattern could not meet the statistically significant level, though the clinical trend was pointing towards a strong association

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