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# Matched Case Control Study on Association of Excessive Screen Time and Refractive Error Among Children in a Tertiary Hospital of South India

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## ABSTRACT

**Purpose:** This study aimed to determine refractive errors among the children attending tertiary care hospital and its association with excessive screen time.
**Design:** The matched case-control study was conducted among school aged children aged 6 to 18 years.
**Methods:** A total of 141 cases of any refractive error were selected from the children of 6 to 18 years of age from tertiary medical college in Perambalur district of Tamil Nadu, attending ophthalmology OPD and 141 children attending other OPDs of same hospital were selected as controls. Main outcome variable was refractive error. Exposure variables were screen time exposure, duration of outdoor activities, near work, participation in sports activities and parental myopia.
**Results:** Mean duration of near work per day that is spent on reading, drawing, handicraft, homework is 128.7±84.27 minutes. Mean duration of screen time per day that is the time spent on television, computers, smart phones, laptops, tabs, television is 147.5±103.7 minutes. Mean duration of duration of outdoor activities per day such as sports, walking, exercise is 44.5±38.2 minutes. Binary multivariate logistic regression analysis showed that increased duration of screen exposure was significantly associated with higher risk of refractive error among children.
**Conclusion:** The findings of this study indicate that increased screen exposure is significantly associated with refractive error among children. Greater duration of daily screen exposure appears to increase the likelihood of refractive error. It is recommended that parents of young children be encouraged to watch appropriate media content with them in order to facilitate learning and avoid excessive screen exposure.
***Keywords:*** Refractive error, Children eye sight, Vision, Myopia

## INTRODUCTION

Uncorrected refractive error is one of the leading causes of vision impairment. Globally, at least 2.2 billion people have a near or distance vision impairment half of which could have been prevented. Over 88 million of these include those with moderate or severe distance vision impairment or

blindness due to unaddressed refractive error. Most of this distance vision impairment is in low-and middle-income regions [1].

Increased digital screen time could be a potential modifiable environmental risk factor for refractive error such as myopia. In the past few years, world including India have witnessed an increase in usage of smart phone, tablets, laptops, computers and other digital devices. This has been facilitated by improved access to high speed and cheaper internet. COVID-19 pandemic has further aggravated the situation where children are forced to stay indoors and engage more with digital devices for educational, gaming and entertainment purposes. Even in post pandemic period a significant part of learning at school and home are happening through digital devices like smart board, computer, smart television, mobile, laptop and tablets etc. This increase in screen exposure have led to children complaining of various eye symptoms such as blurred vision, headache, redness and watering from eyes [2].

Studies have found a significant association between the increase in the screen time on digital devices and the development of symptoms of computer vision syndrome and myopia [2-4]. Studies have also found that children with increased use of electronic devices, such as mobile phones and tablets had higher risk of myopia progression as compared to those using television and projectors for online or e-learning [4,5]. Some studies have also found that progression of myopia to be affected by the reduced time spent outdoors [3,4]. Thus, preventing these environmental risk factors for refractive errors such as myopia among children like increased screen time, reduced outdoor activities or sunlight exposure is very critical to prevent the onset of myopia or slow down myopic progression [3].

Although there are few cross-sectional studies which generated contrasting hypothesis regarding the association of increased screen exposure and refractive errors (mostly for myopia) but none has tested such association using analytical studies to prove such association [6]. Further studies with quantification of screen time measurements are necessary to assess evidence of an association between screen time and refractive errors. Establishing such an association may help in designing interventions for children to prevent or delay the progression of refractive errors. Provision of evidence-based facts about refractive errors to children and parents as well as to those in charge of initiating and achieving lifestyle changes among children is very essential for addressing one of important cause of visual impairment among children. Therefore, we intend to test this hypothesis that increase in screen time could be cause of refractive error among children. The present study aimed to determine the association of excessive screen time exposure and refractive error in children aged less than 18 years in child attending tertiary care hospital.

## MATERIALS & METHODS

This hospital based case control study conducted on children with the age group of 6 to 18 years attending a tertiary medical college in Perambalur district of Tamil Nadu from April to September 2023.

### Selection of case and controls

Selection of cases: Patients in the age group of 6 - 18 years who are diagnosed with refractive error such as Myopia (short-sightedness), Hypermetropia (Far-sightedness) or Astigmatism. Cases attending the ophthalmology department of the medical college were selected as cases.

Selection of Control: Patients in the age group of 6-18 years without any refractive error. Controls attending other OPDs of hospital were selected as controls. For every case one control was selected.

**Matching:** Cases and controls were matched for age and sex.

**Inclusion criteria:** Study participants meeting the case and control definition and

whose parents provides consent for study was included.

**Exclusion criteria:** Study participants with serious disease or eye conditions including eye injury requiring hospitalisation were excluded from study.

**Sample size calculation:** OpenEpi, Version 3 (OpenSource.org, USA) was used for Sample size estimation [7]. The current study sample size was calculated using the proportion of high screen exposure among control as 55.2 percent [8] and odds ratio of 2 with 95% confidence interval and power of 80 percent. The minimum sample required for the study is 141 cases of refractive error and 141 controls.

**Sampling technique:** All patients meeting the case definition of cases and control were selected from ophthalmology department and other OPDs from the hospital.

**Study Tools:** The objective was assessed using a semi-structured interview schedule. The schedule included questions related to general characteristics of the participants such as age, gender, religion, family income, class of study, anthropometric measurements, and parental history of refractive error. Assessment of screen exposure, time spent on near work, outdoor activities and participation in sports activities and assessment of refractive error through eye examination.

**Data collection:** The data collection was interview-based and clinical examination. Interview was done by investigator of study himself. Participant or their parents was enquired about the age of child, gender, class of study and parental history of refractive error. They were also asked about the time spent on near work, outdoor activities and screen exposure and their participation in sports activities. This was followed by eye examination of patients. Written informed consent of parent and assent of child was obtained for every participant before data collection. The data collection was maintained anonymous without collecting any personal details like the respondents' name, email or any other personal details and participants confidentiality maintained.

**Examination protocol:** Clinical data was be extracted from the patient outpatient card. Clinical examinations including eye examination was conducted at ophthalmology department of medical college for both case and control.

All children have undergone the following procedures: visual acuity testing for near and distant vision, non-cycloplegia autorefraction, slit-lamp examination. In addition, those with refractive error on initial examination have undergone cycloplegia and cycloplegia autorefraction and ophthalmoscopy to further confirm the diagnosis. The vision examinations and autorefractometry were performed by professionals in a well-lighted classroom. Visual acuity for distance vision was measured at a distance of 6 meters, using Snellen's chart. We measured cycloplegic refraction 30 minutes after the instillation of a drop of cyclopentolate 1% twice. Cycloplegia was considered complete if the pupils are dilated 6 mm or greater and the pupillary light reflex was absent. The pupil size was determined roughly with the help of a regular ruler. If needed, a third drop was instilled. Children were asked to keep their eyes closed, for the duration of cycloplegia. Autorefraction with an average of three measurements will be taken. The autorefractor was calibrated at the beginning of each working day. Examination of the lens, vitreous, and fundus was performed by an ophthalmologist with a slit lamp and indirect ophthalmoscope.

## Statistical Analysis

Collected data were entered into MS Excel, and data analysis was done using SPSS version 25.0 (IBM). Continuous variables such as time spent in near work, duration of

screen exposure, and outdoor activities were summarized by mean and standard deviations. For categorical variables presented as percentage distribution and frequency.

The association between categorical variables among cases and controls was assessed using the chi-square test. Odds ratios and 95% CI were calculated to estimate the strength of association between potential risk factors and refractive error.

To determine the independent predictors of refractive error, binary multivariate logistic regression analysis was performed, including variables such as duration of screen exposure, outdoor activity, place of stay, duration of near work, and participation in sports activities. P values less than 0.05 were considered statistically significant.

**Operational definition:**

**A. Outcome variable:** Criteria of diagnosis of refractive errors: Refractive errors are determined by the spherical equivalent refraction (SER) calculated as sphere plus the half of the cylindrical error in accordance with international recommendations [9,10]. Myopia: SER of less than 0.50 D. Myopia will be further divided into three refractive error groups: Low myopia (-3.0 D < SER < -0.50 D), Moderate myopia (-6.0 < D SER < -3.0 D D) and High myopia (SER < -6.0 D). Hypermetropia: SER more than +1.00 D Astigmatism: Clinically significant astigmatism (CSA) is defined as a cylindrical error as > 1.0 D, regardless of sign Spherical equivalent from the worse eye will used for analysis. The worse eye is defined as the eye with the greater absolute value of the SER.

**B. Exposure Variable:**

1. **Screen time exposure:** Hours spent with gadgets such as computers, smartphones, laptops, tabs, etc. daily? High screen time is defined as > 2 hours per day of screen time [11].
2. **Outdoor activities:** Hours spent in the outdoor activities daily.
3. **Sports activities:** Participation in sports activities or club.
4. **Near work:** Hours spent on the near work such as reading, drawing, handicraft, homework, etc. daily (time spent at school is not considered).
5. **Parental Myopia:** Whether either of the parents were ever prescribed with glasses for refractive error.

## RESULT

Mean age of the study participants is 14.3 years. Males were 90 (31.9%), females were 192 (68.1%). Table 1 shows the socio-economic class (Modified B.G. Prasad classification 2023), religion and class of study of cases and controls.

**Table 1: Distribution of socio demographic details among the study participants**

| Characteristics | Catageory | Cases n=141 (%) | Controls n=141 (%) | Chi sq | P-value |
|---|---|---|---|---|---|
| **Socio economic class** | Class 2 | 19 (13.5) | 17 (12.1) | 0.609 | 0.894 |
| | Class 3 | 77 (54.6) | 73 (51.8) | | |
| | Class 4 | 43 (30.5) | 49 (34.8) | | |
| | Class 5 | 2 (1.4) | 2 (1.4) | | |
| **Religion** | Hindu | 112 (79.4) | 125 (88.7) | 4.902 | 0.086 |
| | Muslim | 21 (14.9) | 10 (7.1) | | |
| | Christian | 8 (5.7) | 6 (4.3) | | |
| **Education** | Primary School | 11 (7.8) | 6 (4.3) | 8.770 | **0.033*** |
| | Middle School | 37 (26.2) | 47 (33.3) | | |
| | Secondary School | 26 (18.4) | 40 (28.4) | | |
| | High Secondary School | 67 (47.5) | 48 (34) | | |

Most common refractive error among cases was Myopia 130 cases (92.9%), followed by hypermetropia 6 cases (3.6%) and astigmatism 5 cases (3.5%).

Mean duration of near work per day that is spent on reading, drawing, handicraft, homework is 128.7+ 84.27 minutes. Mean duration of screen time per day that is the time spent on television, computers, smart phones, laptops, tabs, television is 147.5+ 103.7 minutes. Mean duration of duration of outdoor activities per day such as sports, walking, exercise is 44.5+ 38.2 minutes.

**Table 2: Distribution of characteristics contributing to refractive error**

| Characteristics | Categeory | Cases n=141 (%) | Controls n=141 (%) | OR (95%CI) | P-value |
|---|---|---|---|---|---|
| **Place of Stay** | Day Scholar | 124 (87.9) | 130 (92.2) | 0.617 (0.27 – 1.37) | 0.232 |
| | Hostellar | 17 (12.1) | 11 (7.8) | | |
| **Duration of screen time (computers, smartphones, laptops, tabs, television)** | >147 minutes (>2.45 hours) | 93 (66) | 37 (26.2) | 5.446 (3.26- 9.08) | **0.000*** |
| | ≤ 147 minutes (≤2.45 hours) | 48 (34) | 104 (73.8) | | |
| **Duration of outdoor activities (sports, walking, exercise)** | ≤45 minutes | 106 (75.2) | 48 (34) | 5.868 (3.499-9.841) | 0.000* |
| | > 45 minutes | 35 (24.8) | 93 (66) | | |
| **Participation in sports activity or sports club** | Yes | 31 (22) | 58 (41.1) | 0.403 (0.24-0.67) | 0.001* |
| | No | 110 (78) | 83 (58.9) | | |
| **Duration of near work (reading, drawing, handicraft, homework)** | >130 minutes | 82 (58.2) | 17 (12.1) | 10.138 (5.523 - 18.609) | 0.000* |
| | ≤130 minutes | 59 (41.8) | 124 (87.9) | | |
| **Parental Myopia** | Absent | 128 (90.8) | 133 (94.3) | 0.592 (0.238 - 1.477) | 0.257 |
| | Present | 13 (9.2) | 8 (5.7) | | |

Table 2 shows distribution of characteristics contributing to refractive error such as place of stay, parental myopia duration of screen time, outdoor activities and near work. About 66% of the cases with screentime more than >2.45 hours were affected by refractive errors as compared to controls (OR=5.446, CI=3.26-9.08). Also, the odds of developing refractive error (OR=10.138, CI=5.523-18.609) was more among those with longer duration of engaging in near work like reading, drawing, handicraft, homework. Similar finding was observed with those with lesser duration of outdoor activities (OR=5.868, CI=3.499-9.841) and their association was statistically significant.

**Table 3: Binary multivariate logistic regression of refractive error with predictors (duration of outdoor activities, near work, screen time, place of stay and participation in sports).**

| Predictors | B | S.E. | Wald | df | Sig. | Exp (B) |
|---|---|---|---|---|---|---|
| **Outdoor activities (min)** | -0.020 | .006 | 9.923 | 1 | **.002*** | 1.020 |
| **Duration of Near work (min)** | 0.024 | .004 | 33.225 | 1 | **.000*** | .976 |
| **Duration of Screen time (min)** | 0.028 | .004 | 46.727 | 1 | **.000*** | .973 |
| **Place of stay (Day scholar)** | 0.922 | .693 | 1.768 | 1 | .184 | 2.514 |
| **Participation in sports (Yes)** | -0.062 | .436 | .020 | 1 | .888 | 0.940 |
| **Constant** | 4.807 | 0.984 | 23.888 | 1 | .000 | 122.355 |

***(*p < 0.05 - significante)***

Table 3 shows the result binary multivariate logistic regression analysis examining the association between refractive error and selected predictors. Increased duration of screen exposure and time spent in near work were found to be significantly associated with refractive error. Children who spent longer duration on digital screens and near vision activities had higher odds of developing refractive error. In contrast, increased time spent in outdoor activities was associated with lower odds of refractive error. These associations were statically significant ($p < 0.05$).

## DISCUSSION

In the current study mean age of the study participants is 14.3 years while which is higher compared to the similar studies among the children in various other places such as 9.9 years in study done by Ma M et al, 10.3 years in a study done by Agrawal D et al in Raipur, 9 years in a study done by Madigan S et al. 10.5 years in a study done by Panda L et al. [5,12-14].

Female students were predominant in this study (68.1%) which is higher compared to other studies where males gender was predominant such as in study by Ma M et al male students were 48%, Tewari R et al male students were 44% [5,15]. Whereas in another study conducted by Panda L et al showed that there were near equal number of boys and girls [14].

This study showed majority of those with myopia (92.9%) followed by hypermetropia (3.5%) and astigmatism (3.4%). Whereas in a study done by done by Agrawal D et al myopia was reported in maximum followed by astigmatism and hyperopia [13]. Study by Saara K et al showed that the overall prevalence of refractive errors was found to be 21.51% with myopia, hyperopia, and other refractive errors was found to be 19.53% (n = 752), 6 (0.16%), and 70 (1.82%), respectively which is comparatively less compared to our study [16].

In this study the screen time usage assessed among the children, in which the mean duration of screentime was 2 hours 45 minutes which was lesser when compared with the screen time of the adults in a study conducted among 200 people of age 18 to 27 years in which the average screentime was 3 to 5 hours per day, also majority (84%) of them suffered from myopia [17].

A study done by Ma M et al at reported that students of 7 to 12 years with myopia were reported to have spent more time on digital devices for online learning ($P < 0.001$) and less time on outdoor activities ($P < 0.001$) [5]. This result is similar to those found in our study where cases of refractive error had more screen time and more duration of near work. Contrastingly in systematic review conducted by Carla Lanca et al. showed that was no association of screen time with prevalent and incident myopia [6].

In the present study increase in the outdoor activities did not result in absence of refractive error. However, no association between reduced outdoor time and faster myopia progression was observed in many other studies [15].

However, the types of gadgets used which contributed to the screen time were not assessed in our study. Further detailed evaluation of the type of gadget which contributed to screentime and thereby refractive error would provide even more clear depiction of the underlying problem.

Since the study was conducted in a single tertiary care hospital, the findings may not be generalizable to the wider population. However multicentre and large-sample research would be helpful to our understanding of the overall impact of the screen time on refractive error.

## CONCLUSION

Study proves that high screen time is significantly associated with risk of refractive error, every additional hour spent on digital screen would increase the risk. Refractive error affects not only the educational outcomes of children but also affects the quality of life, personal and psychological wellbeing. It is recommended that parents of young children be

encouraged to watch appropriate media content with them in order to facilitate learning. Using interactive media alongside a parent or adult increases its educational value and ensures that children are not only using it for enjoyment. Co-viewing also enables parents to maximize the main lessons through parent-child interaction and question-asking.

### *Declaration by Authors*

**Ethical Approval:** Institutional Review Board approval was obtained prospectively, prior to commencement of the study, from the Institutional Ethics Committee, Dhanalakshmi Srinivasan Medical College and Hospital, Tamil Nadu, India Project/IEC No.: IECHS/IRCHS/No. 441, The Ethics Committee approved the study protocol, including the study design, selection of cases and controls, data collection procedures, ophthalmic examination methods, and confidentiality safeguards. Written informed consent was obtained from the parents or legal guardians of all participants, and assent was obtained from children wherever appropriate. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (1975), as revised in 2000.

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**Conflict of Interest:** The authors declare no conflict of interest.

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