Original Article

Exposure to electronic gadgets and refractive errors among adolescents: A case–control study

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Abstract

Introduction: The increasing use of electronic gadgets (e-gadgets) has dramatically changed the adolescent lifestyle. There are rising concerns about the ill effects of the high usage of illuminated screens on vision, especially in adolescents.

Objectives: The objective was to explore the pattern of e-gadget use and its association with refractive errors (REs) among adolescents.

Methods: A case–control study was carried out among adolescents attending a tertiary care hospital. Adolescents with REs (cases) were compared with those without REs (controls) based on the inclusion and exclusion criteria. Two hundred matched adolescents (case-to-control ratio 1:1) were interviewed for exposure history to e-gadget use and pattern. The Chi-square test and odds ratio (OR) were calculated to find the association between e-gadget use and REs.

Results: Age (17.3 ± 3.4 vs. 16.8 ± 3.3 years) and gender distribution between cases and controls were comparable. The e-gadget exposure among cases was higher than in controls (OR 1.4 $P > 0.05$); however, it is the duration of e-gadget exposure for >5 years was significantly higher among the cases (OR 4.6 $P < 0.05$). During e-gadget usage, sitting posture (OR 7.5 $P < 0.05$), poor lighting, indoor activity, and irregular sleep patterns were higher among cases. The purpose of using e-gadgets was predominantly for social media and browsing in cases and the educational or reading purpose among controls.

Conclusion: Lesser duration, correct posture, and proper purpose of exposure to e-gadget are associated with lesser risk for REs. Results highlight the collective role of adolescents, parents, teachers, and doctors in education and lifestyle modification on e-gadget use.

Keywords: Adolescents, case–control study, electronic gadgets, refractive errors, screen time, visual impairment

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INTRODUCTION

Refractive errors (REs) are the most common ocular problem affecting all age groups. As per the World Health Organization (WHO) report, REs are the first cause of visual impairment accounting for 43%, and the second cause of visual loss worldwide.[1] These are one of the

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leading causes of avoidable blindness and important public health problems worldwide.[2] The prevalence of myopia is currently attracting worldwide attention as many recent studies report dramatic increases over the past 20 years. Myopia may be due to genetic predisposition and environmental risk factors, including early age exposure to close work mainly and excessive use of electronic gadgets (e-gadgets).[3-5] Longer distance near work, discontinuing near work every 30 min, and more outdoor time from parent self-report are protective behaviors in myopia prevalence and progression.[6,7]

In the present scenario, technological advances have dramatically changed the adolescent lifestyle. The use of computers and other screen gadgets is increasing among adolescents. In recent times, the use of computers, mobile, tablets, and the internet has become a part of one's daily activity, and most educational institutions use e-gadgets as an additional modality for teaching purposes. Due to the vast amount of options and availability of data from all over the world, these gadgets are used inadvertently for learning or social media. On the other side, there are also rising concerns about the ill effects of the high usage of illuminated screens on vision.[7]

However, it is the role of an ophthalmologist with good social intentions to provide the necessary information on the probability of REs being caused due to such modern educational practices. Moreover, planning a youth's career depends on visual acuity, especially in the navy, military, railways, and aviation jobs. Diagnosis and treatment of these errors are relatively simple and are one of the easiest ways to reduce impaired vision. This warrants early detection and treatment to prevent permanent disabilities like amblyopia and improving the chance for a successful visual outcome.

The present study aimed to determine the pattern of e-gadget use and its association with REs among adolescents.

METHODS

Study design and setting

This was a hospital-based case–control study.

Study population

This study was conducted in adolescents attending a tertiary care teaching hospital between September and December 2018.

Sample size and Sampling technique

Assuming 50% exposure to e-gadgets in the control group with an expected odds ratio (OR) of three in the cases at a 95% confidence level sample required in each group is 68. However, 100 cases and 100 controls (1:1) were included using nonprobability sampling.

Inclusion criteria

All adolescents of either gender aged between 10 and 19 years were included in the study. The WHO defines "Adolescents" as individuals in the 10–19 years age group.[7]

Exclusion criteria

Adolescents with previous ocular surgery and structural abnormalities like corneal and lenticular opacity, congenital abnormality, family history of REs, and pathological myopia were excluded from the study.

Data collection and tools

Adolescent patients attending a tertiary care teaching hospital in South India were recruited for this study and were categorized into two groups, each with 100 subjects. Based on the eligibility criteria, 100 adolescents with REs who attended the ophthalmology outpatient department were considered cases, and 100 matched individuals without REs (who attended the hospital for other than REs) were taken as controls. After informed consent, using a pretested questionnaire, subjects were interviewed for exposure to e-gadgets (pattern of use and duration) and other risk behaviors for REs. General ophthalmic examinations such as slit-lamp examination, visual acuity testing, auto refractometer, retinoscopy (dry) if needed, and wet retinoscopy (postmydriatic test) were done to establish the REs among the cases and controls.

Statistical analysis

The data were entered into MS Excel 2019 and analyzed by Epi Info for Windows 7.2 (CDC, Atlanta, Georgia). For descriptive statistics, the categorical variables were analyzed using percentages and the continuous variables by calculating mean and standard deviation. For inferential statistics, the ORs and Chi-square test were applied to find the association between the factors, including e-gadget use and REs.

Ethics approval and informed consent

Ethics approval was obtained from the institutional ethics committee, and informed written consent was taken from the participants.

RESULTS

A hospital-based case–control study where 200 adolescents were included in the final analysis, with a response rate of 100%. Cases and controls were matched with respect to age and gender. Accordingly, the mean age of cases and controls was 17.3 ± 3.4 years and 16.8 ± 3.3 years, respectively ($P = 0.292$). Gender distribution showed that males were 53% and 44% among cases and controls, respectively ($P = 0.202$).

E-gadget exposure among cases was slightly higher than in controls, with an ORs of 1.4; however, this was not statistically significant. Duration of e-gadget exposure for more than 5 years was significantly higher among the cases, with an odds of 4.6 ($P < 0.05$) [Table 1].

Sitting posture during e-gadget usage was significantly higher among the cases, with an OR of 7.5. Other factors such as poor lighting of the surroundings during gadget usage, seldom playing outdoor games, and irregular sleep patterns were slightly higher among cases; however, they were not statistically significant [Tables 2 and 3].

The pattern of e-gadget usage showed that predominant smartphone usage was seen more among cases, usage of both smartphones and computers, and purpose of usage being social media browsing were more among cases. Similarly, predominant computer usage and purpose of usage being either for learning or watching videos were more among controls [Figure 1].

DISCUSSION

In the past decade, increased exposure to electronic screen equipment, mainly due to the excessive use of computers and smartphones for occupational, learning, and communication purposes, urging the need to know the adverse effects caused, especially on ocular health. Several environmental factors and lifestyle adaptations were developed to add to the magnitude of the ocular problem.[7]

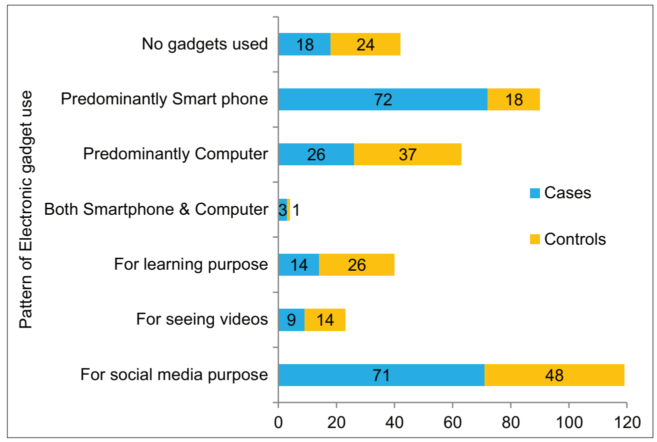

Figure 1: Electronic gadget usage among the cases and controls ($n = 200$)

Table 1: Electronic gadget exposure among cases and controls (n=200)

Variable	Cases (n=100), n (%)	Controls (n=100), n (%)	Total (n=200)	OR (95% CI)	P
E-gadget exposure					
Present	82 (82.0)	76 (76.0)	158	1.4 (0.7–2.8)	0.298
Absent	18 (18.0)	24 (24.0)	42	1	
	Cases (n=82), n (%)	Controls (n=76), v (%)	Total (n=158)	OR (95% CI)	P
Exposure for >5 years					
Present	13 (15.9)	3 (3.9)	16	4.6 (1.3–16.8)	0.021*
Absent	69 (84.1)	73 (96.1)	142	1	

*P<0.05 is statistically significant. OR: Odds ratio CI: Confidence interval

Table 2: Associated factors for electronic gadget usage among cases and controls (n=158)

Variable	Cases (n=82), n (%)	Controls (n=76), n (%)	Total (n=158)	OR (95% CI)	P
The posture of gadget usage					
Sitting	80 (97.6)	64 (84.2)	144	7.5 (1.7–34.7)	0.010*
Supine	2 (2.4)	12 (15.8)	14	1	
Surrounding light					
Poor	43 (52.4)	32 (42.1)	75	1.5 (0.8–2.8)	0.194
Good	39 (47.6)	44 (57.9)	83	1	

*P<0.05 is statistically significant. OR: Odds ratio, CI: Confidence interval

Table 3: Other behavioral factors among cases and controls (n=200)

Variable	Cases (n=100), n (%)	Controls (n=100), n (%)	Total (n=200)	OR (95% CI)	P
Playing outdoor games					
Not often	63 (63.0)	52 (52.0)	115	1.6 (0.9–2.8)	0.116*
Often	37 (37.0)	48 (48.0)	85	1	
Sleep pattern					
Irregular	12 (12.0)	07 (7.0)	19	1.8 (0.7–4.8)	0.233*
Regular	88 (88.0)	93 (93.0)	181	1	

*P>0.05 is statistically not significant. OR: Odds ratio, CI: Confidence interval

In our study, e-gadget exposure in both groups was almost equal; most of the subjects in the case group had used a smartphone, whereas those in the control group had used a computer and were found to have no RE. Computer, on the other hand, though e-gadget, has lesser impact probably due to the distance (more than 30 cm) at which the subject sits compared to the habit of adolescents where the phone is used within 15 cm.

Although the exposure in both groups did not show statistical significance, the duration of exposure in cases was significantly higher than controls with a $P < 0.05$, stressing that the prolonged use of gadgets for longer years will affect the refractive status.

In a study done by Fernández-Montero *et al.*, it was obtained that computer use is associated with myopia development or progression. However, the study did not include the criteria for smartphone use. Their study observed that more than 40 h a week of exposure had more significant RE progression compared to 10 h of use in the case of controls.[8] In our study, the screen time between controls and cases was not significantly different, but in cases, there was more smartphone use.

In a study by Guan *et al.*, prolonged (>60 min/day) computer usage and smartphone usage were significantly associated with higher RE with a $P = 0.01$, whereas television viewing and after-school study were not.[9]

Dixit *et al.* published a study that revealed the most common RE among schoolgoing children in the 12–15-year-old age group was myopia. However, no significant association was observed between myopia and prolonged usage of illuminated screens and myopia. This observation is against the common public thinking that increased usage of illuminated screens predisposes to REs.[6]

In a study by Enthoven *et al.*, they concluded that increased computer use is associated with myopia development within the sample of children. The combined effect of near work (computer use, reading time, and reading distance) showed an increased ORs for myopia at the age 9 years old. In contrast, outdoor exposure showed a decreased ORs, and the interaction term was significant ($P = 0.036$).[10]

In our study, around 87% of the REs were of myopia in the cases, similar to the above study. Lacunae are the study group not as large as the previous study.

In a study by Hansen *et al.*, lower physical activity and more use of screen devices contributed significantly to the observed 25% prevalence of myopia, with a roughly doubled risk of having myopia if physically active <3 h/week or if using screen devices >6 h/day. Results supported physical activity being a protective factor and near work as a risk factor for myopia in adolescents.[11]

Various research studies also show that the kind of near work, like reading, influences myopia development. During near work, eyeball is in accommodation. Accommodation raises intraocular pressure causing elongation of the eyeball that leads to myopia.[10-14]

Posture while using the gadget is an important lifestyle related to the risk of development of REs. Many authors in previous studies have attributed improper posture to excessive straining of eyes and hunching of the back, leading to pain in the neck and back muscles.[15-19] Although our study shows that most cases and controls preferred sitting posture, cases had statistically significant REs attributed to incorrect posture and excessive usage of digital devices.

In our study, it has been found that using e-gadgets for a longer duration and with improper posture adapted while using these aids led to the development of the RE. Furthermore, the fact that smartphone users are more affected than the use of large screen devices like the computer. This shows that the role of accommodation and the probability of developing REs are more due to the duration of usage of smaller screens compared to laptops and improper postures adopted while using these.

The environmental settings and other cocurricular activities in both groups statistically could not establish any relation to the development of ocular abnormalities. The participants' recall and socially desirable bias may limit the study's results.

CONCLUSION

Using e-gadgets (either computers or smartphones) with a duration of <2 h/day and for a lesser number of years and the device appropriately placed at the level of the eyes with proper musculoskeletal posture has a lesser risk for developing vision problems. Using mobile phones (lesser screen sizes) for reading e-books or educational purposes is a bad option, and it is preferable to use laptops or computers instead whenever possible.

Furthermore, in the study, it has been found that most adolescents have used e-gadgets for social media platforms which may affect their eyes and subsequently impact their careers in the long run. The results help us counsel adolescents and provide health education on the sensible way of using gadgets and other good practices, which helps prevent visual problems and promote eye health. Adolescents, parents, teachers, and doctors have a collective role in education and lifestyle modification.

Giving information might not be in favor or against e-gadget use. However, it gives a person the necessary information to make an informed decision on their use, like a disclaimer before a horror movie.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob M. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. J Curr Ophthalmol 2018;30:3-22.
2. Prabha V, Stanly AM. A cross sectional study on refractive error among schoolchildren aged 6 to 17 years in Chennai, India. Int J Community Med Public Health 2016;3:71-3.
3. Jayaraman K, Iranmanesh M, Chin Liang C, Iranmanesh M. The determinants of early refractive error on school-going chinese children: An empirical study in Malaysia. SAGE Open 2016;6:1-8.
4. Hilkert SM, Parness-Yossifon R, Mets-Halgrimson R, Mets MB. Ocular biometry and determinants of refractive error in a founder population of European ancestry. Ophthalmic Genet 2018;39:11-6.
5. Chatterjee S. Use of Gadgets Leading to Myopia in the Very Young. Times of India Bangalore Edition; 11 Jun, 2017. Available form: https://timesofindia.indiatimes.com/city/bengaluru/use-of-gadgets-leading-to-myopia-in-the-very-young/articleshow/59090770.cms. [Last accessed on 2018 Oct 21].
6. Dixit R, Jindal M, Gupta P, Dubey A. Excessive usage of illuminated screen a risk factor for myopia in adolescent population. Int J Curr Med Appl Sci 2016;10:173-6.
7. World Health Organization. Adolescent Health and Development. Available from: http://www.searo.who.int/entity/child_adolescent/topics/adolescent_health/en/. [Last accessed on 2018 Jan 21].
8. Fernández-Montero A, Olmo-Jimenez JM, Olmo N, Bes-Rastrollo M, Moreno-Galarraga L, Moreno-Montañés J, *et al*. The impact of computer use in myopia progression: A cohort study in Spain. Prev Med 2015;71:67-71.
9. Guan H, Yu NN, Wang H, Boswell M, Shi Y, Rozelle S, *et al*. Impact of various types of near work and time spent outdoors at different times of day on visual acuity and refractive error among Chinese school-going children. PLoS One 2019;14:e0215827.
10. Enthoven CA, Polling JR, Verzijden T, Tideman JW, Al-Jaffar N, Jansen PW, *et al*. Smartphone use associated with refractive error in teenagers: The myopia app study. Ophthalmology 2021;128:1681-8.
11. Hansen MH, Laigaard PP, Olsen EM, Skovgaard AM, Larsen M, Kessel L, *et al*. Low physical activity and higher use of screen devices are associated with myopia at the age of 16-17 years in the CCC2000 Eye Study. Acta Ophthalmol 2020;98:315-21.
12. Torsheim T, Eriksson L, Schnohr CW, Hansen F, Bjarnason T, Välimaa R. Screen-based activities and physical complaints among adolescents from the Nordic countries. BMC Public Health 2010;10:324.
13. Breen R, Pyper S, Rusk Y, Dockrell S. An investigation of children's posture and discomfort during computer use. Ergonomics 2007;50:1582-92.
14. Hakala PT, Saarni LA, Punamäki RL, Wallenius MA, Nygård CH, Rimpelä AH. Musculoskeletal symptoms and computer use among Finnish adolescents pain intensity and inconvenience to everyday life: A cross-sectional study. BMC Musculoskelet Disord 2012;13:41.
15. Yasir ZH, Khandekar R, Al-Dhibi H, Banaeem AS, Al-Shangiti AK, Balous MA. Comparison of refractive error and related ocular morbidities between Saudi and Indian school children in Riyadh, Saudi Arabia. J Clin Ophthalmol Res 2020;8:56-61.
16. Ali Qasim MS, Ali Qasim MM, Qasim MB, Khan RA, Anwar N, Akram S, *et al*. Effects of electronic devices on vision in students age group 18-25. Ann Med Health Sci Res 2021;11:1572-7.
17. Mohammed F, Somasundaran S, Poothatta J. Digital eye strain among undergraduate medical students during the COVID-19 pandemic: A cross-sectional survey. Kerala J Ophthalmol 2021;33:284-90.
18. Sealza MJ, Zena Gulta Amora M, Salise-Oncog AA. Gadget use and visual acuity among school-age children in Tagbilaran city Central Elementary school: A correlational study. Chin J Med Res 2021;4:15-22.
19. Issa LF, Alqurashi KA, Althomali T, Alzahrani TA, Aljuaid AS, Alharthi TM. Smartphone use and its impact on ocular health among university students in Saudi Arabia. Int J Prev Med 2021;12:149.