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Original Article

The Impact of Excessive Digital Screen use on Refractive Error Progression Over 1 Year Among Schoolchildren in Northwest Algeria

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Abstract

Objectives: The shift from outdoor play to prolonged use of electronic devices among children, exacerbated by the COVID-19 pandemic, has raised concerns about its impact on visual health. This study explores the relationship between the excessive use of digital devices and the development of various refractive errors in children. This study aims to investigate the association between excessive screen time (including smartphones, tablets, computers, and televisions) with different types of refractive errors and axial length (AL) elongation in a cohort of school-aged children in North-West Algeria. It is a cross-sectional analysis focused on a representative sample from this region.

Methods: Over a 1-year period, 208 schoolchildren (416 eyes), aged 6–18 years (mean age: 6.21±3 years), underwent comprehensive eye examinations at the ophthalmic service of the pediatric hospital EHS Canastel, Oran. Cycloplegic measurements assessed the refractive errors, while A-scan ultrasonography measured the ocular biometry. The study also evaluated children's technology usage patterns, including daily screen time, types of devices used, and time spent outdoors.

Results: The study revealed a significant decrease in mean spherical equivalence (SE) in both eyes over the 1-year period. In the right eye (RE), SE dropped from −0.96 D to −1.48 D, and in the left eye (LE) from −0.70 D to −1.39 D. Myopic astigmatism was the most prevalent condition, affecting 51% of children, especially younger screen users ($p<0.001$). Axial length (AL) increased in both eyes, with an average elongation of 0.54 mm in the RE and 0.57 mm in the LE. There was a strong correlation between excessive screen use and the progression of myopic astigmatism, along with changes in spherical equivalence. Factors such as device type, screen time, and reduced outdoor activity were significantly associated with the progression of refractive errors and AL elongation ($p<0.005$).

Conclusion: Prolonged use of digital screens is significantly correlated with increased risks of myopic astigmatism, AL elongation, and changes in spherical equivalent values. These findings emphasize the urgent need for further research and public health measures to address the impact of prolonged digital device use on children's vision.

Keywords: Astigmatism, digital devices, myopia, ocular biometry, refractive errors, time-outdoor

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Introduction

Today, children are constantly surrounded by digital devices such as televisions, smartphones, tablets, and computers, extensively used at home and school. Concerns arise regarding behavioral and health implications, including reduced social interaction, instant gratification, and potential impacts on eye health (1). Numerous studies (2-4) have associated excessive screen time with various visual issues such as asthenopia, myopia, and low vision (5). Further highlighted that refractive errors and visual discomfort surged amid the COVID-19 pandemic, attributing this increase to elevated screen exposure, limited outdoor activities, and reduced screening efforts.

Many studies have reported an increase in screen time during the pandemic. A recent Turkish research study found that, in the emmetropic group, screen time increased by an average of 5.98±2.13 hours per day, while in the myopic group, it increased by 6.25±2.36 hours per day (6).

Duch et al. found that 68% of U.S. children under 2 years old were exposed to screen media, averaging 2.05 h daily (7).

This study represents the first of its kind in Algeria to explore the correlation between excessive screen exposure and refractive errors, with a particular focus on myopia and astigmatism. It specifically examines a cohort of school-age children in the northwest region of the country, offering a novel contribution to this area of research.

Methods

In this research, a comprehensive survey was conducted in the Algerian northwest, analyzing the vision of 208 schoolchildren and adolescents aged 6–18, spanning different educational stages: Primary (6–11 years), secondary (11–15 years), and high school (15–18 years). The study took place at the ophthalmic unit of the Pediatric Hospital EHS Canastel, Oran1, Algeria, spanning from October 2021 to October 2022. This collaborative effort between the University Oran and Pediatric Hospital EHS Canastel, Oran, Algeria, adhered to ethical guidelines. Written consent, following the Declaration of Helsinki, was obtained from both children and their parents or guardians after a thorough explanation of the study's nature and objectives.

Inclusion Criteria

- Age between 6 and 18 years
- Children with emmetropia or other refractive errors, including myopia, hyperopia, or astigmatism
- Regular digital device use (minimum 1 h/day)
- Sign informed consent from parents or guardians.

Exclusion Criteria

- Presence of ocular anomalies or systemic illnesses that impact vision
- History of intraocular surgery or significant ocular trauma
- Diagnosed with amblyopia or strabismus
- Severe accommodative dysfunction or binocular vision disorders
- Neurological conditions, such as epileptic seizures

Collection Data

The study was initiated with a survey specifically designed to assess the following variables, as outlined in Table 1.

Visual Examination

All children underwent comprehensive visual examinations, including tests for the Hirschberg corneal reflex, extraocular movement, cover test, and papillary responses. Visual acuity was measured with and without correction, using the Snellen visual scale, with letters that get progressively smaller. Refraction for each eye was measured three times, averaged for analysis after a 30-min interval between measurements. Pupil dilation was achieved using three drops of 0.5% Skiacol administered 5 min apart. The TOPCON KR-8900 autorefractor and keratometer were utilized for assessments. Ocular biometry of the anteroposterior segment was assessed using an A-scan ultrasound (ALCON surgical imaging system); for each measurement, three individual A-scan readings were obtained, and the mean value was computed to ensure accuracy. Consistently performed by the same experienced optometrist to ensure uniformity and reliability across all examinations.

Data Analysis

The data interpretation and analysis were conducted utilizing the Statistical Package for the Social Sciences version 20 in Chicago, Illinois, USA. Continuous variables were reported in the form of mean±standard deviation (SD) or median (range), quantitative data were assessed using the Pearson Chi-square test, and subsequent calculations included the determination of odds ratios (OR) along with their respective 95% confidence intervals (CI). Factors exhibiting an OR below 1 were identified as protective against various refractive errors and associated parameters, while those with an OR above 1 were considered potential risk factors. In addition, the statistical significance of continuous variables, expressed as values of $P \leq 0.005$, was assessed. Notably, the mean spherical equivalent was also considered within the analysis to provide further insights into refractive trends among the studied population.

Ethics Committee Approval

The Ethics and Professional Conduct Committee certifies the adherence of the research protocol for the doctoral thesis project in optometry to the scientific and ethical standards outlined in Ministerial Decree No. 991 dated May 12, 2023.

Table 1. Questionnaire on demographics, gadget usage patterns, and time- outdoors

Section	Question	Response options
Children's demographic data	1. State:	[……………….]
	2. Age:	[……………….]
	3. Gender:	☐ Male ☐ Female
	4. School Level:	☐ Primary School ☐ Secondary School ☐ High School
Use of electrical gadgets	6. What was the earliest age at which you began using digital displays (e.g., smartphones, tablets, computers, etc.)?	[……………….]
	7. How much time do you spend per day on digital devices?	☐ Low (≤60 min/day) ☐ Moderate (2–3 h/day) ☐ High (5–10 h/day) ☐ Very high (> 10 h/day)
	8. How many digital devices do you use per day (e.g., smartphones, tablets, computers)?	[……………………]
	9. When do you typically use digital devices during the day? (Select all that apply):	☐ Morning ☐ 12 p.m. to 2 p.m. ☐ 5 p.m. to 8 p.m. ☐ After 9 p.m.
Nighttime gadget usage	10. Do you use digital devices during nighttime?	☐ Yes ☐ No
	11. If yes, what are the ambient lighting conditions during nighttime device use?	☐ Dark ☐ Light
	12. Is your nighttime device usage continuous or intermittent?	☐ Continuous ☐ Intermittent
	13. Do you use protective filters (e.g., blue light filter) during device usage at night?	☐ Yes ☐ No
Discomfort during gadget use	14. Do you experience any discomfort or strain while using digital gadgets? (e.g., eye strain, headaches, etc.)	☐ Yes ☐ No
	15. If yes, please describe the type of discomfort:	[………………]
Ownership of digital devices	16. Do you personally own any digital devices? (e.g., smartphone, tablet, computer)	☐ Yes ☐ No
	17. If yes, how many devices do you own?	[………………..]
Time-outdoors	18. How much time do you spend outdoors during daylight hours?	☐ Low (≤60 min/day) ☐ High (2–3 h/day)

Written consent, following the Declaration of Helsinki, was obtained from both children and their parents or guardians after a thorough explanation of the study's nature and objectives.

Results

Participant Demographics

A comprehensive screening of 208 children, 416 eyes aged between 6 and 18 years, was conducted, with a mean age of 6.21 years (±3, range 12). Further participant demographics are detailed in Table 2.

Refractive Status at Initial Examination (October 2021)

In the initial vision assessment conducted in October 2021, we identified various vision issues among the 208 participants, encompassing a total of 416 eyes. Myopia was present in 4 individuals (2%), hyperopia was observed in 8 participants (4%), anisometropia was found in 13 participants (6%), mixed astigmatism was noted in 8 participants (4%), and hyperopic astigmatism was identified in 69 participants (33%). Notably, myopic astigmatism was the most prevalent condition, affecting 106 participants (51%). The findings revealed an average degree of spherical myopia in the right eye (RE) of −2.15 (SD 0.41) and in the left eye (LE) of −2.75 (SD 0.64). The average degree of spherical hyperopia was 1.28 (SD 0.96) in the RE and 1.54 (SD 0.26) in the LE. The average cylinder measurement was −1.25 (SD 0.30) in the RE and −1.86 (SD 0.53) in the LE. The mean axial length (AL) was 24.38 mm (±0.32 mm SD 0.24) for the RE and 24.19 mm (±0.29 mm SD 0.21) for the LE.

Table 2. Summary of demographic, familial, and environmental characteristics among study participants (n=208)

Category	Subcategory	Details	Number of participants (n=208)	Percentage
Demographic information	Gender	Girls	123	59
		Boys	85	41
	School level	Primary school	104	50
		Secondary school	75	36
		High school	29	14
Corrective lenses and ocular conditions	Corrective lenses	Children under correction	94	45
		Children without correction	114	55
		Glasses with anti-reflective coating	79	38
		Glasses with white glass	15	7
	Ocular conditions in the family	Yes	85	41
		No	123	59
	Fathers	Myopic astigmatism	8	4
		Hyperopic astigmatism	6	3
		Mixed astigmatism	6	3
	Mothers	Myopia	10	5
		Hyperopia	2	1
		Astigmatism	2	1
	Sisters	Hyperopia	4	2
		Myopic astigmatism	17	8
		Hyperopic astigmatism	15	7
	Brothers	Anisometropia	2	1
		Myopia	8	4
		Hyperopia	2	1
Environmental Factors	Screen time per day	Low (<1 h)	17	8
		Moderate (2–3 h)	56	27
		High (5–10 h)	125	60
		Very high (>10 h)	10	5
	Nighttime gadget usage	In the dark	162	78
		In the light	46	22
	Outdoor activity (daylight)	Low (60 min per day)	166	80
		High (2–3 h per day)	42	20

Refractive Changes after 1 Year (October 2022)

In the follow-up refractive assessment a year later (October 2022), we noticed significant changes likely influenced by increased screen time. Myopic astigmatism rose to 65%, while hyperopic astigmatism decreased to 28%. Both eyes showed increased myopia and cylinder measurements, with reduced hyperopia. Specifically, the average spherical myopia in the RE (−3.01 SD 0.82) and in LE (−3.36 SD 0.90), and the notable increased in the AL RE (24.92±0.63 mm) and the LE (24.76±0.59 mm), while spherical hyperopia was reduced in the RE (0.98 SD 0.71) and in the LE (1.12 SD 1.02). In addition, cylinder measurements decreased in both eyes: RE (−1.81 SD 0.59) and LE (−2.22 SD 0.13). The study's analysis of myopic astigmatism over the 1-year period revealed significant and concerning changes in spherical equivalence (SE) for both eyes. In the RE, the mean SE decreased from −0.96 diopter (D) (SD: 0.66) at the initial assessment to −1.48 D (SD: 0.54) at the follow-up, representing a critical reduced of −0.52 D. Similarly, the LE showed significant worsening in myopic astigmatism, with the mean SE decreasing from −0.70 D (SD: 0.98) at the first control to −1.39 D (SD: 0.68) at the second control, marking a significant change of −0.69 D. The statistically significant correlation between these decreases in both eyes (p<0.001) underscores the severity and consistency of the progression in myopic astigmatism.

Moreover, a significant increase in AL was observed, with the RE exhibiting an average elongation of 0.54±0.34 mm and the LE showing a mean increase of 0.57±0.27 mm. This substantial elongation of the eye is critically important, as it correlates strongly with the progression of myopia and highlights the direct impact of myopic astigmatism on ocular growth, as shown in Figures 1 and 2.

Digital Screen Users

In our study, we rigorously examined the impact of early screen exposure on children's refractive errors, revealing a concerning trend. Among the 208 participants, a significant 86% (179 children) who were exposed to screens at an early age exhibited notable vision impairments. Myopic astigmatism emerged as the most prevalent condition, affecting 51% (106 children) of the simple. In addition, hyperopic astigmatism was present in 29% (50 children), with smaller groups experiencing other refractive errors, such as anisometropia, mixed astigmatism, hyperopia, and myopia. Crucially, our data established a robust link between screen exposure before the age of 5 and the onset of myopic astigmatism. The Findings showed a statistically significant association, with an OR of 5.32 (95% CI: 1.97–11.56) and p=0.003, indicating that early screen exposure increases the likelihood of developing myopic astigmatism by more than fivefold. These results underscore the critical need to monitor and manage screen time in young children to mitigate the risk of vision-related issues later in life. For a detailed visual representation, please refer to Figure 3.

Among commonly used digital devices, smartphones, tablets, and computers were found to be heavily utilized by youngsters, with a significant correlation to the development of myopic astigmatism. The data indicated strong associations with smartphones (p<0.001; OR = 4.06 [1.70–9.66]), tablets (p=0.004; OR = 2.44 [1.21–4.90]), and computers (p=0.001; OR = 4.02 [1.89–8.56]). However, this association was not observed with other vision issues or with television viewing. For further details, refer to Figure 4 (Table 3).

In this study, 17 children (8%) spend less than an hour daily on screens, while 52 children (25%) spend 2–3 h, a duration strongly linked to myopic astigmatism (p<0.001; OR = 4.36 [2.03–9.36]). The most common screen usage, 5–10 h/day, was observed in 125 cases (60%) and significantly increased the risk of myopic astigmatism (p<0.001; OR = 4.80 [2.24–10.29]). Interestingly, 10 children (5%) exceed 10 h of daily screen time, yet no clear correlation was found between <1 h and more than 10 h of usage.

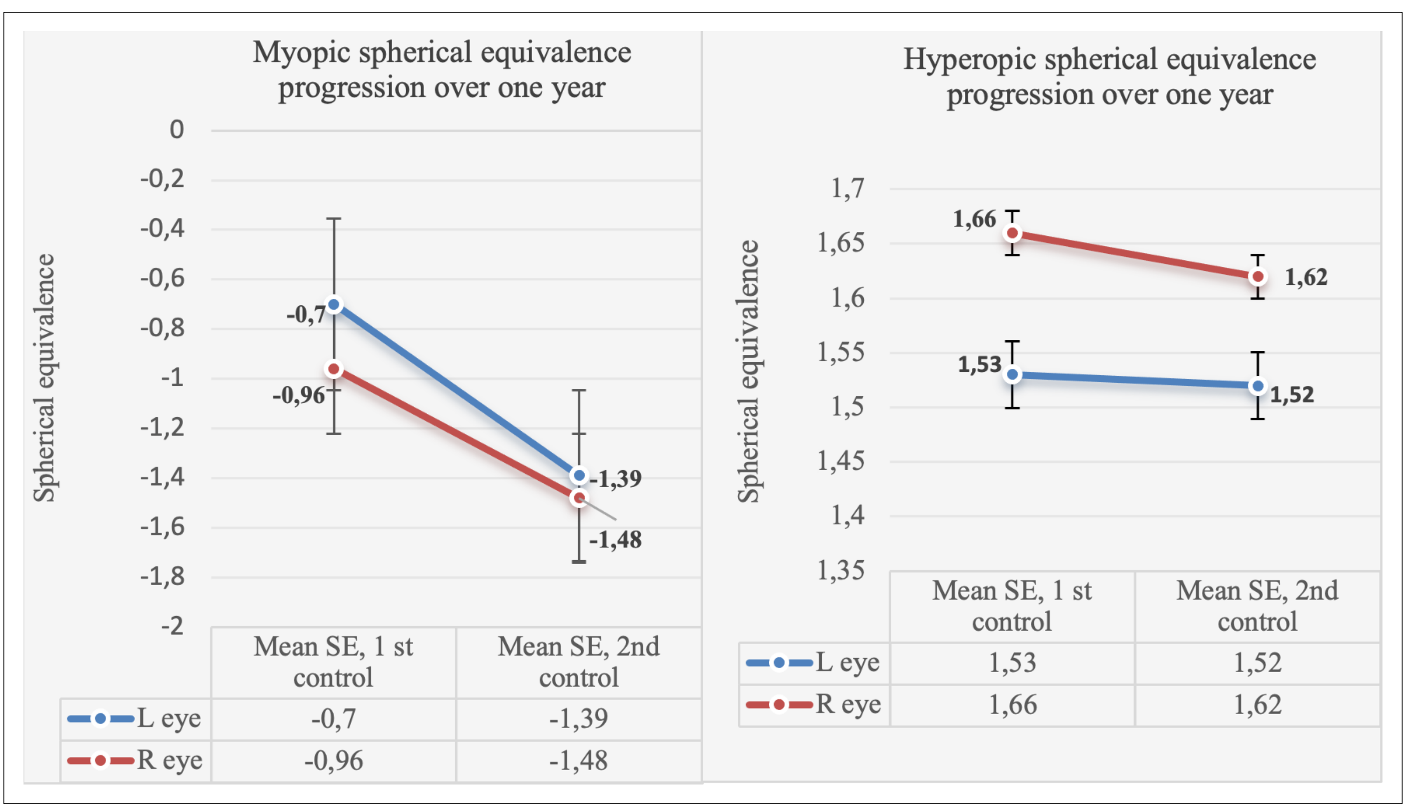

Figure 1. Yearly changes in mean spherical equivalence for myopia and hyperopia: A comparison of initial and subsequent measurements.

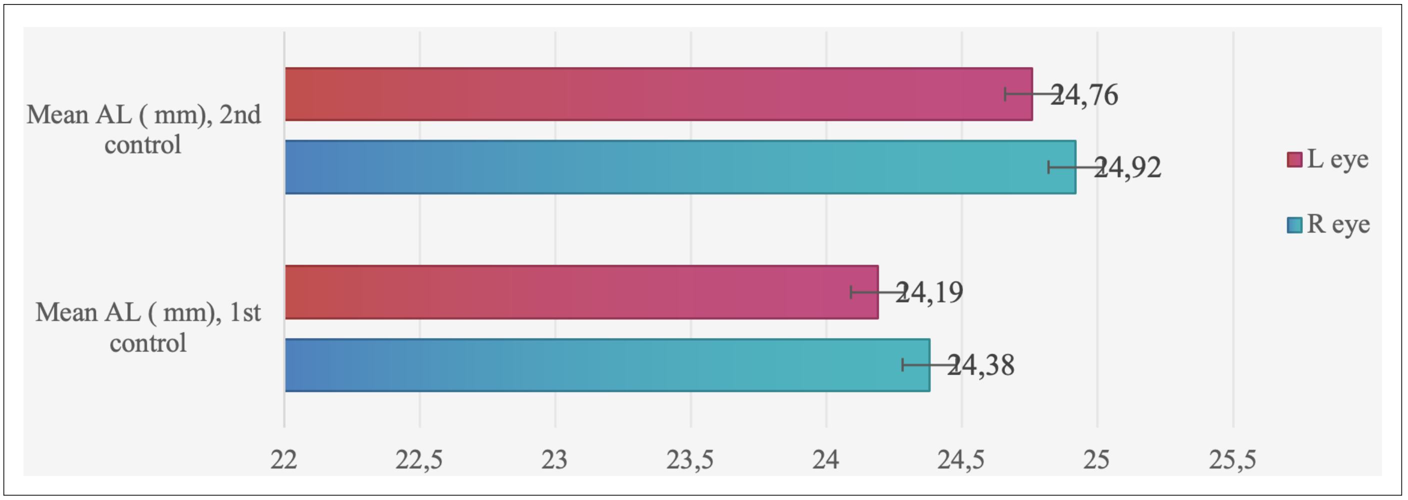

Figure 2. 1 year evolution of mean axial length in left and right eyes.

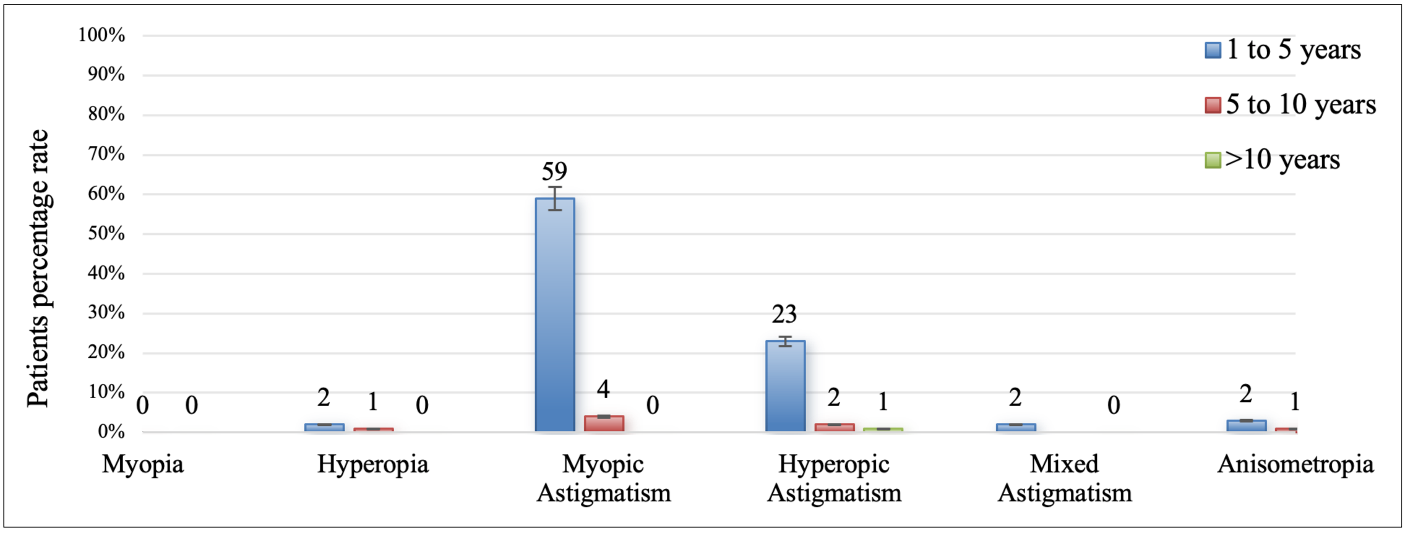

Figure 3. Early screen exposure in children and its association with different refractive errors.

Daily usage patterns revealed a clear increase in digital device usage as the day progressed. While only 21 participants (10%) used devices in the morning, usage surged in the afternoon with 69 participants (33%) and peaked during the evening hours, with 177 participants (85%) engaging in screen time. Critically, our findings show that children with myopic astigmatism are significantly more likely to be exposed to digital devices after 9 PM, with 190 participants (91%) reporting nighttime use. This overexposure during late hours presents a highly significant risk factor for myopic astigmatism ($p<0.001$; OR = 5.24 [2.02–13.62]). Refer to Figure 5 for visual representation.

Most children (181/208, 87%) are exposed to screens before bedtime, with the majority (162/208, 78%) using screens in darkness. Notably, significant associations were found between screen exposure at bedtime in darkness and the development of myopic astigmatism: 51% (54/106) of children with myopic astigmatism were exposed to screens at bedtime ($p=0.005$; OR = 3.01 [1.18–7.66]), and 52% (65/106) used screens in darkness ($p=0.001$; OR = 3.56 [1.64–7.71]). These findings reveal a strong and concerning link between screen use under these conditions and the prevalence of myopic astigmatism.

Screen exposure is prevalent throughout the day, with most instances being discontinuous; only 46 (22%) children used screens continuously. In terms of habits, 114 (55%) used devices while lying down, and 94 (45%) used them while eating, practices that may contribute to childhood obesity.

Our study also highlights that outside of school, most children spend their time at home. A significant portion, 166 (80%), spend 60 min or less outdoors daily, while only 42 (20%) spend over 2 h outside. Importantly, children who spend minimal time outdoors and more than an hour on screens daily are at a higher risk of visual impairments, particularly myopic astigmatism ($p=0.001$; OR = 4.50 [1.71–12.63]).

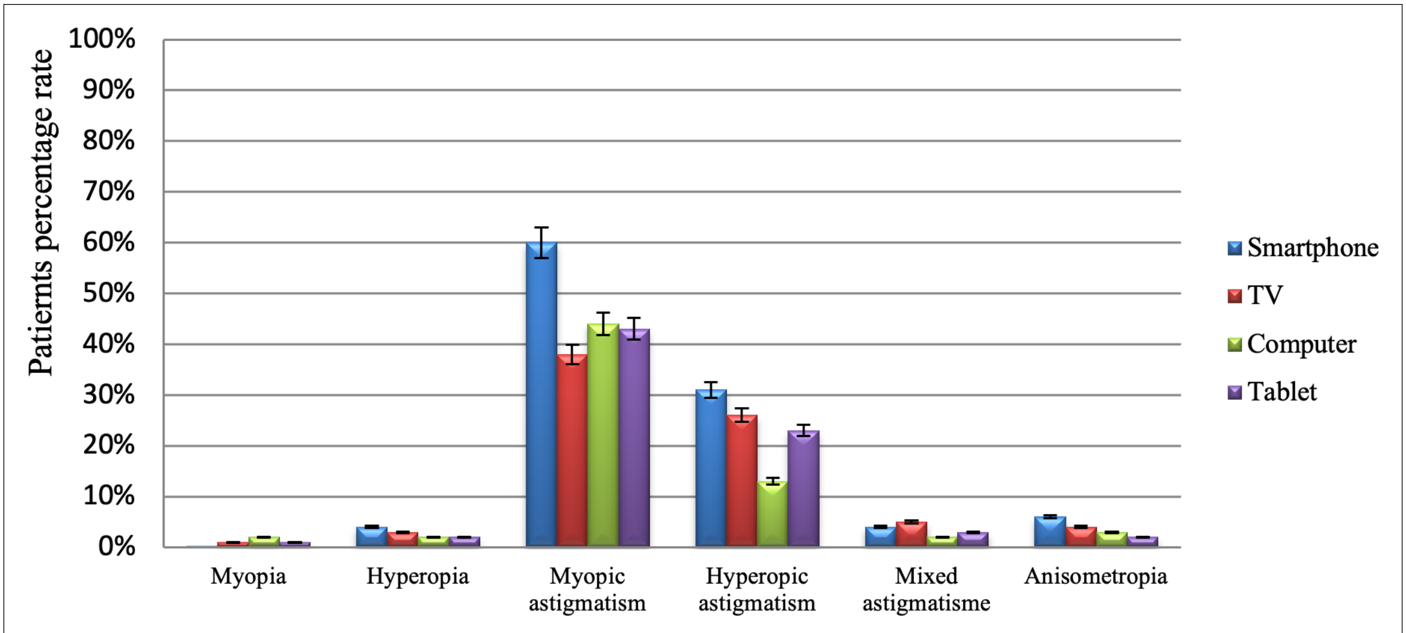

Figure 4. Prevalence of electronic device usage in children and its link to refractive errors.

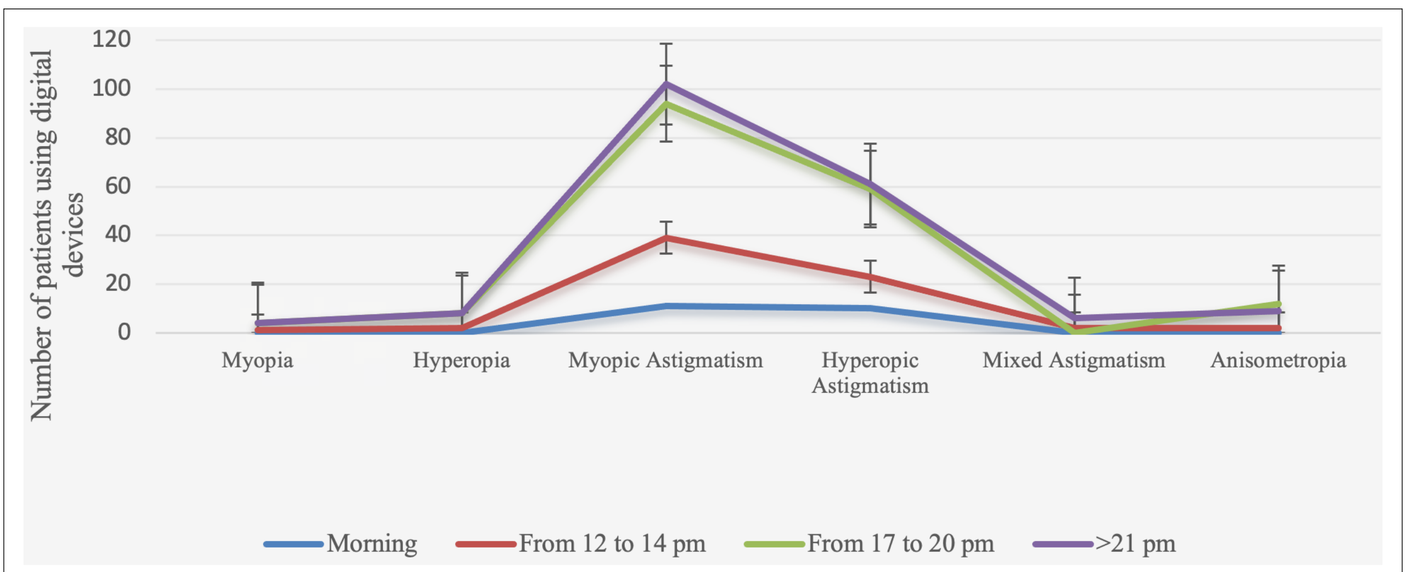

Figure 5. Daytime digital usage among patients with refractive errors.

Moreover, of the 183 participants, 155 found protective filters ineffective, and the absence of such filters was significantly linked to myopic astigmatism (p=0.004; OR = 3.67 [1.32–12.45]). These findings underscore the urgent need for interventions to mitigate the harmful effects of screen exposure on children's vision.

Ocular Biometry

The analysis of ocular biometry in this study provides robust evidence that digital device overuse is a critical factor in AL elongation, a key driver of myopia progression. Initial measurements revealed a mean AL of 24.38 mm (±0.55) in the RE and 24.19 mm (±0.49) in the LE. However, by the second control, these values had significantly increased to 24.92 mm (±0.47) for the RE and 24.76 mm (±0.38) for the LE, underscoring a clear and measurable progression in axial elongation. Crucially, the study identified a strong, statistically significant correlation between excessive smartphone use and AL elongation, particularly within the critical ranges of (24–25 mm) and (25–26 mm). The association was profound, with smartphone use linked to myopic shifts (RE [24–25 mm]: p=0.005, OR = 4.40; LE [25–26 mm]: p=0.003, OR = 11.45), indicating a high likelihood that device overuse directly accelerates the progression of myopia. Furthermore, the data unequivocally demonstrates that overuse of computers and frequent tablet exposure is positively associated with AL elongation within these same ranges. For instance, AL measurements in the RE (25–26 mm) range were significantly impacted by prolonged screen time (p=0.005, OR = 2.50), and even more so in the LE (p<0.001, OR = 3.36). Contrastingly, television use showed no significant impact on AL. Moreover, the study delves into lifestyle factors, revealing a compelling link between screen time duration and nighttime device use in darkness with increased AL (OR = 2.98; p=0.002). Children with 2–3 h of daily screen exposure exhibited a strong association with AL elongation to (25–26 mm) in both eyes (RE: p=0.004, OR = 3.58; LE: p=0.005, OR = 3.76). Alarmingly, those with 5–10 h of screen time per day showed even stronger correlations (RE: P = 0.001, OR = 3.88; LE: p=0.004, OR=4.03), underscoring the cumulative effect of prolonged exposure.

Night-time screen use in darkness presented another alarming finding, exacerbating AL elongation significantly (RE: p=0.003, OR = 3.65; LE: p=0.005, OR = 4.61).

Discussion

This study offers crucial insights into the relationship between prolonged screen exposure and visual impairment among Algerian schoolchildren, marking a pioneering investigation in the region. By examining the progression of refractive errors over time, we sought to identify the risks associated with the excessive use of digital devices. Our findings revealed a significant prevalence of astigmatism among the children, particularly its strong association with myopia, leading us to explore the connection between extensive screen time and specific refractive errors.

The data demonstrate a significant correlation between increased screen exposure and a rise in myopic mean SE, accompanied by a reduction in hyperopic mean SE, as depicted in Figure 1. This suggests that prolonged screen time is closely linked to the progression of myopia.

We hypothesize that the visual demands of close-range device use, which involve processes of accommodation and convergence, may underlie this association. Accommodation involves the adjustment of the lens to focus on nearby objects, requiring contraction of the ciliary muscles. Simultaneously, convergence ensures proper alignment of both eyes to maintain a clear focus on a screen. Prolonged engagement in these activities imposes considerable strain on the visual system, potentially leading to eye fatigue and discomfort.

Furthermore, continuous digital device use may influence ocular development, particularly through axial elongation, which exacerbates myopic refractive errors (8). This structural change in the eye could also contribute to the onset or progression of astigmatism, possibly due to sustained pressure on the cornea or lens. These findings highlight the importance of further research and public health strategies aimed at mitigating the detrimental effects of excessive screen exposure on children's vision.

In line with previous pediatric studies, our findings confirm that astigmatism and myopia are among the most common vision impairments in preschool and school-age children. The literature consistently shows that astigmatism demonstrates significant stability from an early age, often persisting throughout the emmetropization process, a trend our study similarly found (9-11). Recent research has shown that prolonged screen exposure is associated with an increase in myopic SE refraction and a decrease in hyperopic SE among children and adolescents under 18. Our findings align with these results, confirming the significant impact of extended screen time on the progression of myopia in young individuals (12-14).

Other contributing factors influenced the association between astigmatism and myopia in our sample. Various elements can impact retinal image quality, including extended near work during digital device use. Prolonged near work is associated with increased accommodative lag, as evidenced by research models. This accommodative lag may contribute to myopia progression by inducing hyperopic retinal defocus, which, in turn, can lead to axial elongation (5,9,10). This correlation underscores the significant impact of modern digital habits on the progression of myopia, as observed in our study.

Several theories remain to be fully validated regarding the impact of extended close-up screen time on visual development. One prominent theory suggests that prolonged screen use may overstrain children's ciliary muscles, leading to excessive accommodation. This theory posits that continuous near work could disrupt the natural development and structural integrity of the crystalline lens (15,16). Alternatively, according to Collins et al., close screen viewing could potentially alter children's corneal curvature due to changes in palpebral aperture and associated eye movements during task execution (17). Moreover, downward screen gaze might elevate eyelid pressure on the cornea, potentially resulting in heightened corneal astigmatism (18). This theory aligns with our findings, which also indicate a significant rise in astigmatism. The increase in astigmatism observed in our study may be influenced by the additional corneal pressure resulting from prolonged downward gaze during screen use.

In our study, 49% of the sample demonstrated significant engagement with handheld electronic devices, particularly smartphones. We observed that early exposure to various electronic screens, especially before the age of 5, was associated with an increase in visual impairments, notably myopic astigmatism, as illustrated in Figure 3. The risk of developing myopic astigmatism at an early age was significantly higher with greater daily screen time and longer duration of exposure (p=0.003; OR = 5.32 [1.97–11.56]). This finding is consistent with numerous studies that have reported a higher incidence of astigmatism and myopia associated with early and prolonged screen exposure. Our results reinforce the evidence suggesting that early screen exposure is a critical factor in the development of these refractive errors (3,4,15,19,20). Yang et al. identified a strong and positive relationship between screen exposure and myopia in preschool-aged children (21). Which is consistent with the findings of another cohort study, (22) Huang et al. reported that children exposed to screens within the first 3 years of life had a significantly higher risk of developing astigmatism, with the highest risk observed among those exposed during their 1st year (15). Our study corroborates these findings by revealing a significant association between daily screen exposure exceeding 2 h and an increased incidence of myopic astigmatism (p<0.001). This is consistent with global research on excessive screen usage and its impact on myopia and astigmatism in similar age groups. For example, a study conducted across primary and middle school students in six Chinese provinces found a higher risk of myopia among children whose screen time was not regulated by their parents. These findings collectively highlight the detrimental effects of prolonged screen exposure on visual development in children (23). Our results align with a recent Turkish study that found increased screen time during the COVID-19 pandemic caused myopic shifts in emmetropic children and worsened myopia in myopic children, highlighting the impact of excessive screen use on myopia (24). Guan et al. identified a significant association between increased myopia and extended daily usage of smartphones and computers exceeding 60 min, (25) Huang et al. found that astigmatism risk increased with both total years of exposure and average daily screen time (15). In two large Taiwanese studies, each extra hour of near-vision activities—such as using a smartphone, computer, or watching television, or reading books—was associated with a 1% increase in the risk of developing myopia (26), and a 26% increase in the odds of severe myopia (27), Two studies in north India involved individuals aged 5–15 years and reported that exceeding 2 h of daily screen use increased the odds of myopia by 8.33 times among children attending private schools in that age group.

Alvarez-Peregrina et al. found a correlation between increased electronic device use and higher myopia prevalence in Spanish children aged 5–7 (OR: 1.10 [1.07–1.13]; p≤0.001) (28).

Increased screen time led to a notable rise in myopia among Irish children across both age groups (p<0.001). In children aged 6–7, myopia prevalence escalated fivefold, from 3.0% (1-h screen time group) to 15.5% (>3 h of screen time) (29). Italian children who played video games for 30 min or more and used digital devices for 3 h or more daily had a 68% prevalence of myopia compared to 0% among non-participants. However, no statistical correlations have been identified yet (30). In Danish youths, myopia affected 37–44% of those using screens over 6 h daily, while only 0–06% were affected using screens <5 h daily (31). Two studies in Qatar involving older children aged 6–18 revealed a robust link between prolonged screen use (over 3 h daily) and visual issues (1,32). A study among Saudi Arabian university students found no correlation between myopia and using electronic devices for learning. Interestingly, its prevalence in Riyadh differed from reports in other countries Nations (33).

Sadly, 82% of children use screens before bedtime and after 9 p.m. in dim lighting, correlating significantly with myopic astigmatism at p=0.005 and p=0.001, respectively. This disrupts their sleep, hindering the vital production of retinal pigment essential for eye recovery. Compared to a prospective trial investigation, a study found that going to bed late increased the chances of nearsightedness in 6–9

Table 3. Analyzing the effect of smartphone, television, computer, and tablet on refractive errors: Statistical overview of odds ratios, confidence intervals, and P-values

Refractive error	Smartphone OR (CI 95%)	p	Television OR (CI 95%)	p	Computer OR (CI 95%)	p	Tablet OR (CI 95%)	p
Myopia	0.99 (0.98–1.00)	0.65	1.03 (0.96–1.14)	0.018	1.00 (0.99–1.02)	0.55	—	—
Hyperopia	0.31 (0.07–1.40)	0.11	0.27 (0.06–1.23)	0.07	1.78 (0.41–7.78)	0.43	0.38 (0.04–3.24)	0.36
Myopic Astigmatism	4.06 (1.70–9.66)	<0.001	1.15 (0.51–2.57)	0.72	4.02 (1.89–8.56)	0.001	2.44 (1.21–4.90)	0.004
Hyperopic Astigmatism	1.52 (1.36–3.75)	0.02	1.07 (0.46–2.49)	0.86	1.26 (1.11–1.59)	0.08	0.54 (0.26–1.11)	0.09
Mixed astigmatism	1.44 (0.17–12.21)	0.73	0.94 (0.91–0.98)	0.21	1.06 (1.01–1.10)	0.08	0.38 (0.04–3.24)	0.36
Anisometropia	1.21 (1.13–1.30)	0.16	0.61 (0.12–3.12)	0.55	1.47 (0.35–6.15)	0.59	1.43 (0.34–5.97)	0.61

OR: Odds ratios; CI: Confidence intervals.

years old. Opinions differed on the amount of sleep needed (34,35). Cui et al. report that using screens, relying on desk or ceiling lamps for light, poor sleep, and inadequate night-time study lighting are all myopia risk factors (36). Recent research indicates conflicting findings regarding the link between using screens at night or in low light and myopia. Further investigation is needed for a clearer understanding. Based on the data in Table 4, there is a strong correlation between spending less time outdoors and myopic astigmatism. The significance of this relationship is reflected in p=0.001 and an OR of 4.50 [1.71–12.63] (2). In our society, 85% of electronic screens lack protective filters, and this absence is significantly associated with myopic astigmatism (p=0.004; OR = 3.67 [1.32–12.45]). Research indicates that prolonged exposure to blue light from screens can damage ocular tissues, increasing the risk of various eye disorders, including corneal issues, cataracts in the crystalline lens, and macular degeneration in the retina (37-39). Our study found a positive relationship between excessive screen use and AL progression, as shown in Figure 2, with ALs exceeding 24 mm corresponding to myopia. Significant associations were observed between the use of various electronic devices (smartphones, tablets, and computers) and both myopic astigmatism and AL growth. Specifically, screen use exceeding 2 h/day was linked to increased AL and a higher risk of myopia, similar to smartphone usage patterns observed in 13 years old in the Netherlands (40). Our study found that additional screen time was associated with a 0.54±0.34 mm and 0.57±0.27 mm increase in RE and LE, respectively (p<0.001). Moreover, our findings highlight a critical association between nighttime screen use in dim lighting and increased AL (RE: p=0.003, OR = 3.65; LE: p=0.005, OR = 4.61). This supports the concerns raised by research into the effects of blue light and narrow-band, short-wavelength light emitted by digital devices, which can exacerbate ocular growth and contribute to myopia progression (41). This correlation underscores the detrimental impact of nighttime screen exposure on eye health, as similar studies have found that blue light exposure can impair retinal recovery and accelerate the development of myopia (42).

The study has some limitations. The cross-sectional design limits causal inference, and self-reported screen time may introduce recall bias. In addition, the sample size and demographics could affect generalizability. Variations in measurement techniques or instruments could affect the consistency and accuracy of the data. Ensuring standardized measurement protocols in future studies could improve the reliability of the findings. Despite these factors, the study provides valuable insights into the association between screen time, myopic astigmatism, and AL progression.

Table 4. Correlations of refractive errors with screen time, daytime and bedtime use, light conditions, outdoor activity, and filter use

Duration of screen Use	Myopia (OR, CI 95%)	p	Hyperopia (OR, CI 95%)	p	Myopic Astigmatism (OR, CI 95%)	p	Hyperopic Astigmatism (OR, CI 95%)	p	Mixed Astigmatism (OR, CI 95%)	p	Anisometropia (OR, CI 95%)	p
2–3 h/day	0.99 (0.97–1.00)	0.56	0.68 (0.07–1.84)	0.01	4.36 (2.03–9.36)	<0.001	0.46 (0.23–1.93)	0.02	0.73 (0.09–1.87)	0.02	0.68 (0.09–1.50)	0.15
5–10 h/day	0.86 (0.08–1.46)	0.59	0.92 (0.06–1.79)	0.02	4.80 (2.24–10.29)	<0.001	0.67 (0.23–2.96)	0.03	0.91 (0.12–1.14)	0.07	0.84 (0.09–1.41)	0.12
Daytime screen use												
Evening	0.87 (0.57–1.54)	0.15	0.96 (0.12–1.02)	0.03	5.24 (2.02–13.62)	<0.001	0.78 (0.51–1.54)	0.12	0.83 (0.70–1.43)	0.09	0.75 (0.32–1.32)	0.15
Bedtime use	0.93 (0.01–0.42)	0.13	1.32 (0.73–1.32)	0.01	3.01 (1.18–7.66)	0.005	0.38 (0.11–1.34)	0.09	1.01 (0.76–1.54)	0.08	0.25 (0.01–1.04)	0.07
Use of screen in darkness	0.76 (0.19–0.52)	0.26	0.94 (0.11–1.13)	0.07	3.56 (1.64–7.71)	0.001	0.75 (0.15–1.84)	0.07	1.54 (0.32–1.15)	0.11	0.84 (0.23–1.83)	0.13
Outdoor time												
<60 min	0.78 (0.36–1.04)	0.11	1.03 (0.14–1.86)	0.08	4.50 (1.71–12.63)	0.001	1.63 (0.45–2.42)	0.07	0.98 (0.33–1.78)	0.15	1.54 (0.86–2.54)	0.04
Protective filter	0.97 (0.23–1.73)	0.09	1.13 (0.18–1.84)	0.07	3.67 (1.32–12.45)	0.004	1.97 (0.83–2.42)	0.01	0.87 (0.08–1.10)	0.17	0.99 (0.63–1.55)	0.10

Conclusion

The initial investigation conducted in Algeria uncovers a significant concern: A notable rise in myopic astigmatism, myopic SE, and AL progression among children, which appears to be linked to extensive digital screen use. This trend contrasts with findings from global studies, revealing a distinct pattern in the Algerian context. The pronounced early exposure and prolonged screen engagement among Algerian children represent an urgent need for targeted research to understand how technological exposure specifically impacts visual refractive errors. This evidence highlights the critical necessity for comprehensive and longitudinal studies to address this growing issue, ultimately guiding the development of effective preventive and corrective interventions tailored to the needs of affected populations.

Disclosures

Ethics Committee Approval: The Ethics and Professional Conduct Committee certifies the adherence of the research protocol for the doctoral thesis project in optometry to the scientific and ethical standards outlined in Ministerial Decree No. 991 dated May 12, 2023.

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