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The association between smartphone use and myopia progression in children: a prospective cohort study

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Abstract

Background The increasing myopia of children has sparked speculations on whether the use of smartphones can accelerate this rate. This study aims to identify possible predictors for myopic progression in children with smartphones over a period of two years.

Methods This prospective cohort study recruited 523 children aged 6 to 14 years. A comprehensive eye examination was performed at baseline and at 6, 12, and 24 months, which included spherical equivalent refractive error (with cycloplegia) and axial length. Smartphones usage patterns were traced using mobile usage monitoring app. Outdoor activities, sleep duration, and parental history of myopia were documented with structured questionnaires. Data on myopic progression associated with smartphone use are presented with multivariate regression analyses.

Results It demonstrated that daily usage of smartphones was positively associated with the progression of myopia (5.1 ± 1.2 vs. 3.4 ± 1.0 h, $p < 0.001$). Increased time of outdoor activity (1.2 ± 0.6 vs. 2.1 ± 0.8 h/day, $p < 0.001$) and longer distances of screens (25.8 ± 5.4 vs. 31.4 ± 6.2 cm, $p < 0.001$) were inversely related to myopic progression. Of importance is that children whose parents experienced myopia exhibited higher progression rates compared to those who did not (65.5% vs. 44.4%, $p < 0.001$).

Conclusion This study indicated that daily duration of smartphones use, time of outdoor activity, distance of screen, and parental myopia are predictors of childhood myopic progression.

Keywords Myopia, Children, Predictor, Myopic progression, Childhood, Smartphone, Digital screen

Introduction

Myopia, or nearsightedness, is the most prevalent childhood refractive error [1]; its onset usually begins during this period and may continue well into adolescence [2]. Over the past two decades, the prevalence of myopia among children worldwide has surged [3]; in many East Asian countries, myopia has reached epidemic proportions among children [4]. This sudden increase has challenged healthcare professionals and researchers alike, as the progression of myopia culminates in severe visual impairments related to high myopia with complications such as retinal detachment, glaucoma, and myopic maculopathy [5]. Since childhood myopia develops and progresses during ocular growth, it is relevant to understand the various factors that lead to its development and progression for developing preventive strategies [6].

Lifestyle changes, especially those regarding near-work activities, have been implicated as significant

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contributors to the increasing rates of childhood myopia [7]. A large amount of time spent reading, studying, and working on digital devices increases the risk for myopia through excessive accommodative strain [8]. At the same time, outdoor activities that have been proven to protect against myopia are now less frequently practiced in today's societies [9]. The transition from traditional outdoor play to indoor, screen-based activities among children has become a focus of attention in the understanding of environmental influences on myopia development [10].

Among all digital devices, the smartphone has become ubiquitous in the child's daily life [11]. More children are using smartphones for prolonged periods for both educational and recreational uses at very near viewing distances [12]. Interactively provided content by smartphones tends to promote extended use, and due to their portable nature with small screen dimensions, they thus possess a risk unique to myopia progression. Several cross-sectional studies have indicated that excessive smartphone use in children is related to increased myopia prevalence, though the prospective studies with respect to its long-term effects on the progression of myopia are still underexplored.

This may happen through the many different mechanisms by which the use of smartphones contributes to the advancement of myopia [13]. One such hypothetical mechanism is prolonged near work, wherein the continuous engagement of the eyes in focusing on objects within near proximity induces accommodative stress, leading to the elongation of the axial length of the eye, which is the key structural change associated with myopia progression [14]. Typical short viewing distances and continuous exposure to the screen may enhance accommodative lag and other visual symptoms like digital eye strain [15]. Furthermore, the use of smartphones could also reduce time outdoors-an activity that may further increase the risk for myopia- since it has been proven that natural daylight exposure slows the progression of myopia [16].

Despite the growing concern about the possible risks associated with the use of smartphones, there are few longitudinal studies that have presented evidence to investigate the relationship between smartphone use and the progression of myopia among children. Most of the studies have been cross-sectional and have looked at general near-work activities without isolating smartphone use as a specific risk factor [17]. In addition, there is limited data regarding other modifiable risk factors that may be associated with smartphone use, including screen distance, outdoor activity, and parental myopia. Given the pervasive use of smartphones among children, comprehensive, prospective studies of these variables are urgently needed. Thus, this research was a prospective cohort study to these ends, studying predictors of myopic progression associated with smartphones in a two-year cohort of children.

Methods

Study design

This was a prospective cohort study designed to investigate the predictors of myopic progression in children with frequent smartphone use. The study was conducted over a 24-month period, with baseline measurements taken at the start and follow-up assessments at 6-month intervals. Both ocular measurements and the amount of smartphone use data were collected during each visit. The primary outcome was myopic progression, defined as a change in spherical equivalent refractive error or axial length over time.

Study population

This study targeted children between the ages of 6 to 14 years from local primary and secondary schools. The criteria for the selection of children would include: those who used smartphones for more than an hour daily, and had never been affected with ocular disorders. Such children who suffered from amblyopia, strabismus, previous ocular surgery, or any systemic conditions affecting visual development would be excluded from the research. Informed consent in writing was obtained from their parents or guardians, and 523 children were registered for the study.

Ethical approval

The ethical approval was granted by the Institutional Review Board (Approval number: CT-23-116), complying with principles laid down in the Declaration of Helsinki. The aims, risks, and benefits of this research study were explained to all participants and their parents. Informed consent in writing was obtained from the parents/guardians, and assent was obtained from the children above 10 years of age.

Data collection

Ocular measurements at each visit were done under standardized procedures by trained optometrists. Refractive errors were measured using cycloplegic autorefraction with Topcon KR-800; axial length was measured by optical biometry with the use of IOLMaster 700. Corneal curvature and intraocular pressure were also recorded for controlling the potential confounders. Smartphones usage patterns were traced using self-reporting questionnaire and mobile usage monitoring app (Screen Time Labs Ltd®, United Kingdom). These ranged from detailed screen time to average viewing distance and various kinds of activities considered onscreen, such as gaming and reading.

Data was also collected through standard questionnaires validated in the Sydney Myopia Study (Supplementary 1) [18]. Factors recorded were parental history of myopia, parental control on screen time use, and home lighting condition during the use of smartphones. The demographic data at baseline included age, gender, and socio-economic status.

Outcome measures

The primary outcome measure was change in spherical equivalent refractive error and axial length over the 24-month study period. Symptoms of eye strain, blurred vision, dry eye and near point of accommodation and convergence are secondary measures of outcome. The pattern of smartphone use and other life style factors is measured as a potential predictor for the above said outcomes.

Statistical analysis

Descriptive statistics were used to summarize demographic and baseline characteristics of study participants. Continuous variables were presented by mean ± SD, while categorical data were reported as frequency and percentage. Associations of smartphone use with myopic progression were determined using multivariate linear regression analysis, which was adjusted for potential confounders including age, gender, baseline refractive error, outdoor activity, and parental myopia. The associations between continuous variables were determined by Pearson's correlation coefficients.

Multivariate logistic regression models were conducted to identify the independent predictors of clinically significant myopic progression, which was defined as a change in spherical equivalent ≥ 0.50 diopters per year. To further evaluate potential interactions between smartphone use, genetic predisposition, and outdoor activity, we conducted a stratified analysis. Participants were categorized based on parental myopia (yes/no) and outdoor activity levels (< 1 vs. ≥1 h/day), and myopia progression rates were compared across different smartphone usage groups within each stratum. This approach allowed us to assess whether the effects of smartphone use on myopia progression varied according to genetic and environmental factors. To assess whether baseline myopia severity influenced the relationship between smartphone usage and myopia progression, participants were stratified into three groups: low myopia (≥ -0.50 D), moderate myopia (-0.50 to -3.00 D), and high myopia (< -3.00 D). Myopia progression rates (D/year) were compared across different smartphone usage durations (< 2 h, 2–4 h, > 4 h) within each myopia group using ANOVA to determine statistical significance. The level of statistical significance was set at $p < 0.05$. All analyses were performed by using SPSS version 26 (IBM Corp., Armonk, NY, USA).

Sample size calculation

The sample size calculation was thus done based on previous studies in childhood myopia progression, at an assumed effect size of 0.4 diopters/year at a significance level of 0.05 and 80% statistical power. Thus, 440 subjects would be the least required to ensure the results be statistically significant to determine the relation between smartphone addiction and myopic progression. Considering dropouts, 523 participants were enrolled.

Results

Study flow

A total of 523 children aged between 6 and 14 years (mean age 10.6 ± 2.1 years) participated in the study. During the follow-up period, assessments were conducted at 6, 12, and 24 months (Fig. 1). Of the initially recruited children, 487 (93.1%) completed the 6-month visit, 462 (88.3%) completed the 12-month visit, and 439 (83.9%) remained in the study through the 24-month follow-up. Attrition was primarily due to relocation ($n = 42$), withdrawal of consent ($n = 23$), and loss to follow-up ($n = 19$).

Baseline characteristics and study flow

In the participants, 280 (53.5%) were male, and 243 (46.5%) were female. At baseline, the average spherical equivalent refractive error was − 0.85 ± 0.50 diopters, with an average axial length of 23.48 ± 1.25 mm. Parental myopia was present in 302 children (57.7%). The mean time spent using smartphones per day was 4.3 ± 1.2 h, and the mean time spent participating in outdoor activities was 1.7 ± 0.8 h per day. The average hours of sleep were 8.2 ± 0.9 per night (Table 1).

Smartphone usage patterns and visual symptoms

Mean average screen distance at baseline was 28.4 ± 6.2 cm, while children spent an average of 1.8 ± 0.5 h in continuous smartphone use sessions. Mean time use spent gaming was 1.2 ± 0.7 h/day, and time spent on reading activities was 0.9 ± 0.5 h/day. A big percentage of children complained about visual symptoms. So, accordingly, 164 (31.3%) showed eye strain, 133 (25.4%) had complaints for dry eye symptoms, 105 (20.1%) reported blurred vision, and 98 (18.7%) suffered from headaches (Table 2).

Changes in ocular parameters over time

The spherical equivalent refractive error became more myopic during this 24-month study period. The mean refractive error, -0.93 ± 0.52 diopters at 6 months, increased to -1.32 ± 0.65 diopters at 24 months (Fig. 2). Axial length correspondingly increased from 23.48 ± 1.25 mm at baseline to 24.00 ± 1.35 mm at the end of the study (Fig. 3). Near point of accommodation and near point of convergence showed only small variations at different times, the near point of accommodation

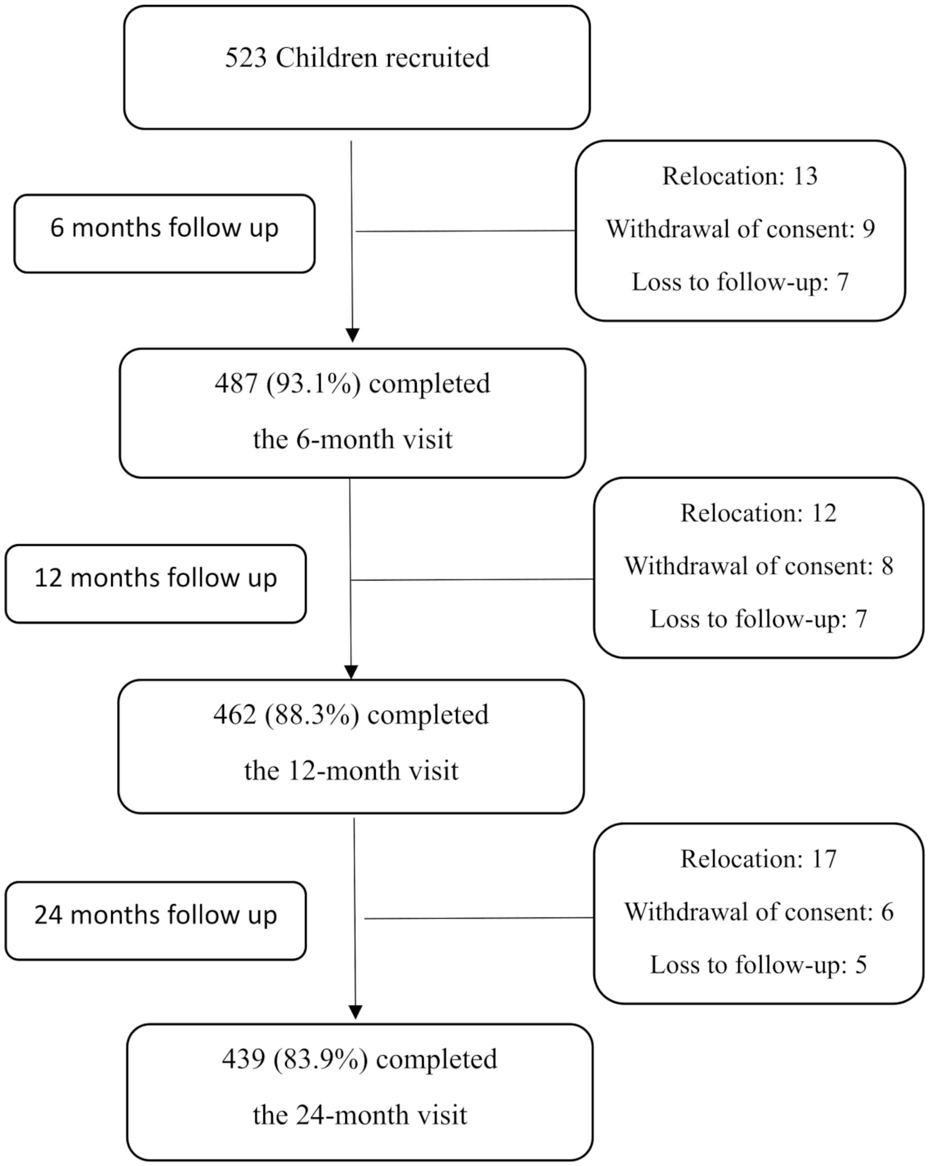

Fig. 1 Study flow diagram demonstrating the participants recruitment and follow up

Table 1 Baseline characteristics of study participants

Characteristic	Mean ± SD / *N* (%)
Age (years)	10.6 ± 2.1
Gender (Male/Female)	280 (53.5%) / 243 (46.5%)
Baseline Refractive Error (Diopters)	-0.85 ± 0.50
Baseline Axial Length (mm)	23.48 ± 1.25
Corneal Curvature (D)	43.10 ± 1.45
Parental Myopia (Yes/No)	302 (57.7%) / 221 (42.3%)
Daily Smartphone Usage (Hours)	4.3 ± 1.2
Outdoor Activity Time (Hours)	1.7 ± 0.8
Sleep Duration (Hours)	8.2 ± 0.9

Table 2 Smartphone usage patterns and visual symptoms

Smartphone Usage and Symptoms	Mean ± SD / *N* (%)
Average Screen Distance (cm)	28.4 ± 6.2
Continuous Usage Duration (Hours)	1.8 ± 0.5
Gaming Time (Hours/Day)	1.2 ± 0.7
Reading Time (Hours/Day)	0.9 ± 0.5
Eye Strain	164 (31.3%)
Dry Eye Symptoms	133 (25.4%)
Blurred Vision	105 (20.1%)
Headaches	98 (18.7%)

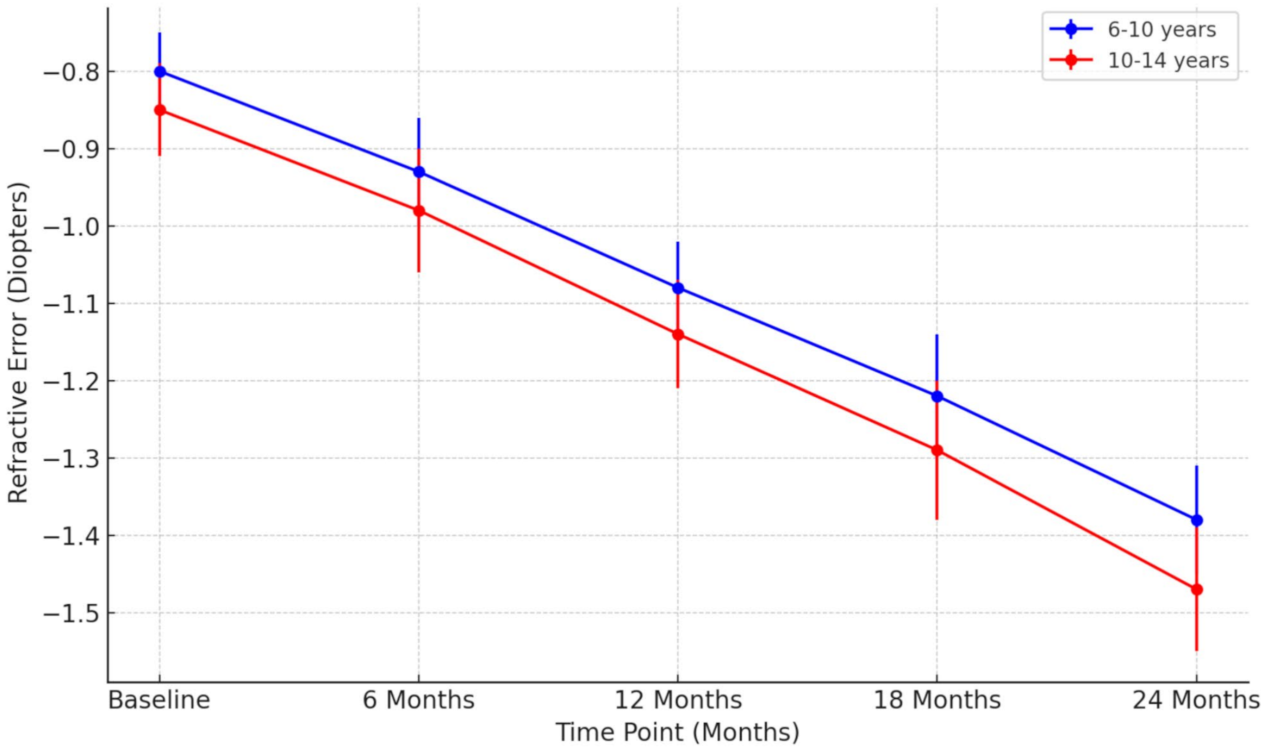

Fig. 2 Changes in refractive error of the study participants over the study period in different bassline age groups

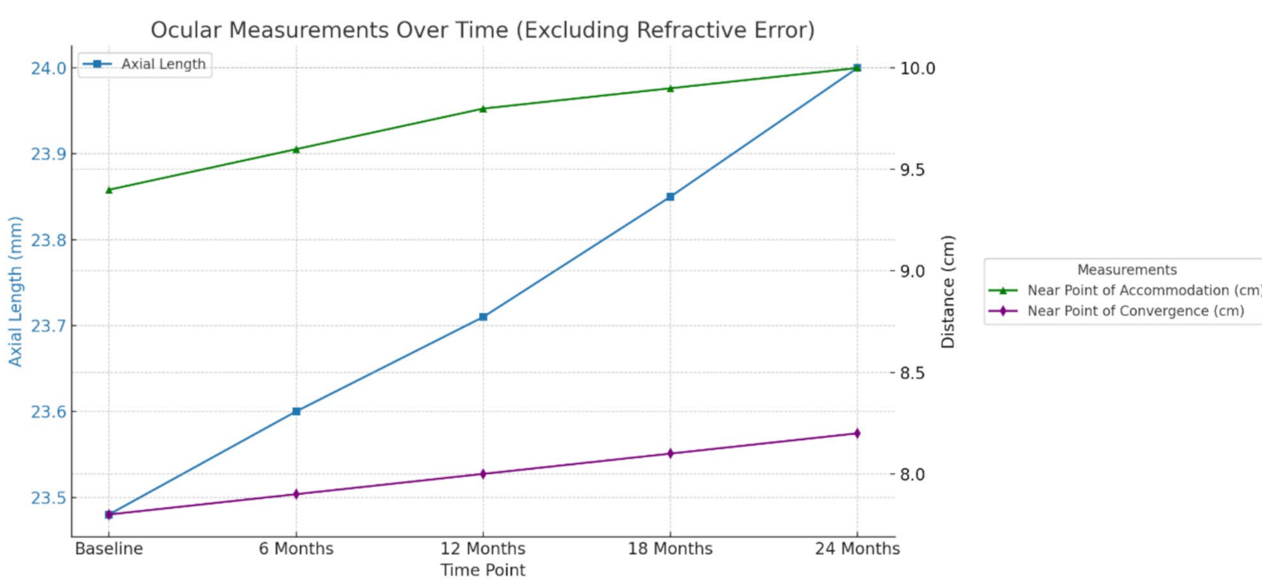

Fig. 3 Changes in ocular indices of the study participants over the study period

increased from 9.4 ± 1.2 cm at baseline to 10.0 ± 1.3 cm at 24 months and the near point of convergence increased from 7.8 ± 1.1 to 8.2 ± 1.2 cm over the same period.

Predictors of myopic progression

Multiple regression analyses uncovered several significant predictors for myopic progression. Myopic progression was positively related to daily smartphone use: β = 0.28, 95% CI: from 0.19 to 0.37, $p < 0.001$. Myopic progression was negatively associated with time of outdoor activity: β = -0.22, 95% CI: from −0.34 to -0.10, $p < 0.001$, which denotes that longer time outdoors decreased the risk of myopia progression. It was also observed that screen distance acted as an important

Table 3 Multivariate regression analysis of predictors of myopic progression

Predictor Variable	β (Regression Coefficient)	95% CI	*p*-value
Age (years)	-0.10 ± 0.03	-0.16 to -0.04	< 0.001
Daily Smartphone Usage (hrs)	0.28 ± 0.05	0.19 to 0.37	< 0.001
Outdoor Activity (hrs/day)	-0.22 ± 0.06	-0.34 to -0.10	< 0.001
Parental Myopia (Yes/No)	0.35 ± 0.09	0.17 to 0.53	< 0.001
Screen Distance (cm)	-0.15 ± 0.04	-0.23 to -0.07	0.002
Baseline Refractive Error (D)	-0.40 ± 0.07	-0.54 to -0.26	< 0.001

Table 4 Smartphone usage and myopic progression group comparison

Variable	Myopia Progression Group (≥ 0.50D/year)	Non-Progression Group (< 0.50D/year)	*p*-value
Daily Smartphone Usage (hrs)	5.1 ± 1.2	3.4 ± 1.0	< 0.001
Outdoor Activity (hrs/day)	1.2 ± 0.6	2.1 ± 0.8	< 0.001
Screen Distance (cm)	25.8 ± 5.4	31.4 ± 6.2	< 0.001
Parental Myopia (Yes/No)	186 (65.5%) / 98 (34.5%)	116 (44.4%) / 145 (55.6%)	< 0.001

Table 5 Ocular parameters and myopia progression in different smartphone usage groups

Parameter	< 2 h	2–4 h	> 4 h	*p*-value
Myopia progression (D/year, mean ± SD)	0.32 ± 0.16	0.43 ± 0.20	0.66 ± 0.27	< 0.001
Spherical equivalent at 24 months (D)	-1.13 ± 0.52	-1.32 ± 0.55	-1.54 ± 0.61	< 0.001
Axial length at 24 months (mm)	23.84 ± 1.33	23.95 ± 1.32	24.13 ± 1.38	0.023
Near point of accommodation (cm)	10.21 ± 1.33	10.11 ± 1.31	10.08 ± 1.24	0.135
Near point of convergence (cm)	8.15 ± 1.23	8.21 ± 1.27	8.38 ± 1.31	0.341

predictor. The smaller the screen distance, the larger the myopic progression is. It was β = -0.15 with 95% CI: -0.23, -0.07, $p = 0.002$. Parental myopia acted as a strong predictor because the children of myopic parents showed a higher rate of myopia progression: β = 0.35, 95% CI: 0.17, 0.53, and $p < 0.001$. Baseline refractive error was inversely related to myopic progression, with β = -0.40, 95% CI: -0.54 to -0.26, $p < 0.001$, indicating that the more myopic the baseline refraction is, the faster the progression (Table 3).

Comparison of myopia progression groups

When comparing children with significant myopic progression (≥ 0.50D/year) to their non-progressed counterparts, several key factors showed significant differences. Children in the progression group had used smartphones for longer periods of time each day (5.1 ± 1.2 h vs. 3.4 ± 1.0 h, $p < 0.001$), and their average distance from the screen was shorter (25.8 ± 5.4 cm vs. 31.4 ± 6.2 cm, $p < 0.001$). They also spent less time outdoors (1.2 ± 0.6 h/day vs. 2.1 ± 0.8 h/day, $p < 0.001$). Parental myopia was more frequent in the progression group (65.5% vs. 44.4%, $p < 0.001$) (Table 4).

Comparison smartphone usage groups

Myopia progression was significantly greater in children using smartphones for more than 4 h per day (0.66 ± 0.27 D/year) compared to those using smartphones for 2–4 h (0.43 ± 0.20 D/year) and less than 2 h (0.32 ± 0.16 D/year) ($p < 0.001$) (Table 5). Similarly, the spherical equivalent at 24 months was more myopic in the > 4-hour group (-1.54 ± 0.61 D) than in the 2–4-hour (-1.32 ± 0.55 D) and < 2-hour (-1.13 ± 0.52 D) groups ($p < 0.001$). Axial length also exhibited a significant increase with higher smartphone use, with the longest axial length observed in the > 4-hour group (24.13 ± 1.38 mm, $p = 0.023$). However, near point of accommodation and near point of convergence did not show significant differences between groups ($p = 0.135$ and $p = 0.341$, respectively). These findings suggest that increased smartphone usage is associated with greater myopic progression and axial elongation but has a limited impact on accommodative and convergence parameters.

Stratified analysis of smartphone use and myopia progression

Stratified analysis revealed that the association between smartphone use and myopia progression remained significant across all subgroups (Table 6). Among children with parental myopia, those using smartphones for more than 4 h per day had a higher myopia progression rate (0.72 ± 0.25 D/year) compared to those using smartphones for 2–4 h (0.48 ± 0.22 D/year) and less than 2 h (0.35 ± 0.18 D/year, $p < 0.026$). A similar trend was observed in children with lower outdoor activity levels, indicating that excessive smartphone use contributes to myopia progression regardless of genetic predisposition or time spent outdoors.

Table 6 Stratified analysis of myopia progression based on parental myopia and outdoor activity

Group	Myopia Progression (Diopter)			
	Smartphone Usage < 2 h	Smartphone Usage 2–4 h	Smartphone Usage > 4 h	*p*-value
Parental Myopia (Yes)	0.35 ± 0.18	0.48 ± 0.22	0.72 ± 0.25	< 0.026
Parental Myopia (No)	0.27 ± 0.12	0.36 ± 0.15	0.58 ± 0.22	< 0.011
Outdoor Activity < 1 h/day	0.41 ± 0.15	0.53 ± 0.19	0.79 ± 0.28	< 0.007
Outdoor Activity ≥ 1 h/day	0.29 ± 0.13	0.38 ± 0.16	0.56 ± 0.21	< 0.004

Table 7 Stratified analysis of myopia progression based on baseline myopia severity

Baseline Myopia Group	Myopia Progression (Diopter)			
	Smartphone Usage < 2 h	Smartphone Usage 2–4 h	Smartphone Usage > 4 h	*p*-value
Low Myopia (-0.50 D ≥)	0.28 ± 0.14	0.39 ± 0.18	0.61 ± 0.24	0.019
Moderate Myopia (-0.50 to -3.00 D)	0.34 ± 0.16	0.46 ± 0.21	0.70 ± 0.27	0.008
High Myopia (< -3.00 D)	0.42 ± 0.20	0.55 ± 0.23	0.82 ± 0.31	0.002

Stratified analysis of myopia progression by baseline myopia severity

Stratified analysis revealed that higher baseline myopia was associated with faster progression, with children in the high myopia group exhibiting the greatest annual progression across all smartphone usage durations (Table 7). In all myopia groups, increased smartphone usage was significantly correlated with greater progression, with the highest rates observed in children using smartphones for more than 4 h per day. The effect of smartphone use on myopia progression was most pronounced in the high myopia group ($p = 0.002$), indicating that children with greater baseline myopia may be more susceptible to excessive screen time.

Discussion

This prospective cohort study is of great importance for understanding predictors of myopic progression associated with smartphone use in a sample of 523 children aged 6–14 years. Significant myopia advancement was found within the participants over the 24-month study period, as evidenced by the remarkably diminished mean spherical equivalent refractive error toward the end of the study. The axial length has also shown an increase and further established the relation between smartphone use and ocular development. Our results indicated that daily use of smartphones, averaging several hours, is highly associated with the progression of myopia, while longer times of outdoor activities and longer screen distances are protective ones. Besides, the strong impact of parental myopia underlines the multifactorial pattern of myopia.

Several studies have been conducted to investigate the association of myopia with the use of smartphones among children, albeit different methodologies and populations than those presented here. Guan et al. analyzed a large cohort of almost 20,000 primary school children in China; they demonstrated that higher screen time of smartphones was associated with a gradual increase in the prevalence of myopia. Importantly, their data did suggest that exposure to more than 60 min of smartphone use daily was associated with a higher prevalence of myopia than no exposure. However, for lesser durations of exposure, the statistical association was not very strong; hence, p-values indicated little or no relation between limited smartphone use and myopia progression. In contrast, our study found a consistent and significant positive association between daily smartphone use and myopic progression over a two-year period, emphasizing the cumulative effect of screen time on ocular health [19].

Harrington et al. also found significant associations between smartphone screen time and myopia prevalence among school children in Ireland. Their survey showed that children who use smartphones for more than three hours a day had the highest myopia rate, while their prevalence was lower for those using it less than an hour. The described odds ratios indicated a clear trend of higher smartphone use associated with increased odds of myopia development. In fact, this conclusion is corroborated by our own findings that children in the group with myopia progression used smartphones for longer and had shorter average distances from the screen, further suggesting that extensive smartphone use is one of the major risk factors for myopia. These put together bring into focus the critical need to increase awareness of potential childhood myopia from screen time and balance digital device use with outdoor activities [20].

While our study identified a significant association between increased smartphone use and myopia progression, it is important to consider that this relationship may be attributed to overall near work activities rather than smartphone use alone. Traditional near work, such as reading and writing, has long been recognized as a risk factor for myopia development. This distinction may explain the differences between our findings and those of Chua et al., who examined the effects of handheld device screen time on 925 three-year-old children in Singapore and found no significant relationship between screen exposure and axial length progression, particularly for lower levels of exposure [21]. Similarly, Toh et al. analyzed data from 1,691 adolescents aged 10 to 19 years in Singapore and reported no significant association between smartphone and tablet use and myopia prevalence [22]. Traditional near work, such as reading and writing, has long been recognized as a risk factor for myopia development [23]. However, some researchers argue that digital screens may have a more pronounced effect on myopia progression due to several factors. Children are introduced to digital devices at younger ages compared to traditional reading materials, leading to earlier onset of prolonged near work activities [24]. The immersive and interactive nature of digital content often results in children spending more time on screens than they would with books, increasing the duration of near work [24]. Digital devices are typically held at closer distances to the eyes compared to books, resulting in higher accommodative demand and increased strain on the visual system [25]. These factors suggest that while all forms of near work contribute to myopia progression, the unique characteristics of digital screen use may exacerbate the risk, highlighting the need for moderated screen time and regular visual breaks to protect children's visual health..

The underlying causes of myopia with the use of smartphones in children are complex and most likely involve physiological and behavioral factors [26]. Perhaps one of the main mechanisms underlying this is prolonged near work associated with the use of smartphones [27]. Children, during prolonged periods working at close distances on screens, stress their eyes excessively with excessive accommodative efforts [28]. This constant need for focusing may result in a lag of accommodation that causes an elongation of the eyeball-a critical structural change associated with myopia development. Extended near work can also reduce time outdoors spent by children in distant viewing activities necessary for normal eye development [29]. Such a shift of focus from distant to near could interfere with the normal development of vision, thus contributing to myopia onset.

Among the other mechanisms of myopic progression, apart from the sustained optical and physiological changes from near work, is reduced time outdoors [30]. There has been a noted protective effect against myopia with exposure to natural light, possibly partly because sunlight may affect the levels of dopamine in the retina, which in turn has an inhibitory effect on axial elongation, thus slowing down the rate of myopia progression [31]. Children who spend a lot of time on smartphones often have less time for outdoor playing, which increases the possibility of myopia. In addition, a predisposition toward using smartphones in poor lighting further adds to visual discomfort and strain and thus to the overall risk of myopia [32]. These mechanisms put together identify a need for a balanced screen time with outdoor activities to help children develop good vision.

Some limitations exist in the present study that need to be addressed while interpreting the results. Dependence on self-reported data about the use of outdoor activities may be subject to recall bias. Furthermore, the study does not account for total near work, including activities such as reading, writing, and tablet/computer use. Additionally, selection bias is a concern as all participants used smartphones for at least one hour daily, preventing a true control group with minimal or no smartphone exposure to assess the impact of excessive use on myopia progression. The small observational design used does not allow the establishment of a causal relationship between smartphone use and myopic progression, since there exist other confounding variables that predispose one to the disease, such as genetic predisposition and environmental ones. Additionally, the absence of data on other myopia control interventions, such as orthokeratology, atropine use, or bifocal lenses, limits our ability to fully assess smartphone use as an independent risk factor for myopia progression. Finally, the sample was recruited within a fixed geographic region, and thus generalizability to other populations and/or cultural backgrounds might be limited. Future studies preferably would include more objective measures of outdoor activity along with longitudinal designs and consider a broad near-work activity assessment.

Conclusion

In the present prospective cohort study, myopic progression associated significantly with the use of smartphones in children points to the role of extended screen time, shorter viewing distances, and reduced outdoor activity as part of the critical risk factors. These findings suggest that daily use of the smartphone may be associated with significant long-term deterioration of refractive error and axial elongation, hence proposing a possible influence brought about by the use of digital devices on the development of the eyes in children, hence calling for awareness among parents, educators, and health professionals. There is a need to balance screen time with multiple opportunities for being outdoors, playing, and developing good visual habits in children at an early stage. Due to the continuous rise in worldwide prevalence, interventions that target both environmental and behavioral factors will play a crucial role in halting this current public health threat.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12887-025-05715-4.

Supplementary Material 1

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Author contributions
Jing Li conceptualized and designed the study, led data collection, analysis, and interpretation, and drafted the manuscript. The author also coordinated the study team and approved the final version of the manuscript for submission.

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None.

Data availability
The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the institutional research ethics committee (Approval number: CT-23-116).

Consent for publication
Informed consent in writing was obtained from the parents/guardians, and assent was obtained from the children above 10 years of age.

Competing interests
The authors declare no competing interests.

Clinical trial number
Not applicable. The study is not a clinical trial.

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