Rate of myopia progression among Ethiopian myopic children: An observational cohort study

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ABSTRACT

Objective: The study aims to determine the rate of myopia progression in children and its associated factors, from November 2021 to August 2023.
Methodology: An observational cohort study was conducted at Saint Paul's Hospital Millennium Medical College (SPHMMC) on 66 children aged 6 to 15 years. Consecutive sampling technique was used. Data was collected with face-to-face interview using structured questionnaires and measurements were taken at the beginning of the study and one year after the initial examination. Data was entered and analyzed using Statistical Package for Social Sciences (SPSS) software version 26. Rate of progression was determined by using paired sample student T- test. The factors associated with progression rate were explored using multivariable binary logistic regression. A P value < 0.05 was used to declare significance in the study.
Results: The mean difference in spherical equivalent between the last and the first visit of 66 children was - 0.41 Diopters (P < 0.001). Fast progression was shown in 18.2% of children; 28.8% showed moderate progression and 53% showed slow progression. Prolonged reading time (AOR = 5.00 (95% CI: 1.10, 25.00), P = 0.04)) and longer television watching time (AOR = 3.85 (95% CI:1.16, 12.50), P = 0.03) were factors associated with a moderate/fast rate of progression.
Conclusion: The mean change in spherical equivalent among myopic children after 1 year of follow up was – 0.41 Diopters. Longer reading time per day and longer time spent watching television were factors associated with higher risk of moderate to fast rate of myopia progression.

Key words: Myopia, Progression rate, Ethiopia

INTRODUCTION

Myopia is a common refractive error in the literate countries and there is a hereditary influence on the different components of the refractive elements of the eye[1,2]. Myopia results from an eye having excessive refractive power for its axial length. This may be due either to the eye having a relatively long axial length or to increased dioptric power of one or more of the refractive elements[3].

Myopia is defined by a refractive error of −0.50 diopters (D) or less, and high myopia by refractive errors of −5.00 D or less, and in 2020 they affect 2.6 billion and 300 million people, respectively, world- wide. Myopia frequently appears in childhood, with a peak incidence occurring between 8 and 10 years of age[4].

Myopia has become a significant global public health and socioeconomic problem. East Asia, and other parts of the world to a lesser extent, has been faced with an increasing prevalence of myopia. The prevalence of myopia and High Myopia (HM) (the definition of myopia and HM is spherical equivalence (SE) of −0.50 diopters (D) or less and SE −5.00 D or −6.00 D, respectively) in young adults in urban areas of East Asian countries has risen to 80–90% and around 20%, respectively. Myopia impairs many aspects of life including educational and occupational activities. High myopes have greater risk of developing several vision-threatening conditions including myopic macular degeneration, retinal detachment, glaucoma, and cataract[5].

Interplay between genetic and environmental factors has been shown to influence the onset and progression of myopia; however, environmental influences are considered to play a significant role. With an onset commonly found in school-age children between the ages of 6 and 12 years, myopia progresses before commonly stabilizing during adolescence; although in a few eyes, progression continues well beyond teenage years and into adulthood[6].

Though there are many studies done about the rate of myopia progression and the factors affecting it worldwide; literature is scarce in Ethiopia and Africa in general. Most of the studies conducted in Ethiopia previously were cross-sectional prevalence studies and hadn't tried to assess the rate of progression of myopia[7-10]. Thus, this study tried to determine the rate of myopia progression over a year period and identified the factors associated with progression of myopia among children aged 6 to 15 years.

MATERIALS AND METHODS

Study design: An observational cohort study was conducted from November 2021 to August 2023 at Saint Paul's Hospital Millennium Medical College, Ethiopia, on children with myopia.

Inclusion criteria: All children aged 6 to 15 years with a spherical equivalent of at least – 0.50 D on either eye and Uncorrected Visual Acuity (UVA) of 6/9 or less on either eye and whose parents consent to be in the study. The age range was used because most progressions of myopia occur during this age group.

Exclusion criteria: Children with corneal opacities, intraocular masses, ocular trauma, previous ocular surgery, cardiovascular or nervous system diseases, history of untreated closed angle glaucoma and cyclopentolate allergy were excluded.

Sampling technique: Consecutive sampling technique was used; all eligible children during the study period were included in the study.

Variables of the study

Dependent variables: Rate of myopia progression.

Independent variables

Socio-demographic variables: Age, sex, residence, maternal level of education, paternal level of education.

Genetic, behavioral and myopia related factors: Family history of myopia, duration of eyeglass use, eyeglass hours per day, time spent reading per day, class break, time spent outdoors per day, television (TV) watching hours, computer use hours, sport activities, sleeping hours per day, initial spherical equivalent.

Operational definitions

Myopia: A refractive error that affects visual acuity (UVA ≤6/9) and with a spherical equivalent of at least – 0.50 D in one or both eyes.

Low myopia: Myopia between – 0.50 D and – 3.00 D.

Moderate myopia: Myopia between – 3.00 D and – 6.00 D.

High myopia: Myopia of at least -6.00 D in one or both eyes.

Spherical equivalent: Sphere power plus half of the cylindrical power of a spectacle.

Myopic progression: Difference between mean spherical equivalent at the final and initial visits.

Slow progression: Change in spherical equivalent over a year period of > - 0.50 D.

Moderate progression: Change in a spherical equivalent over a year period ≤ - 0.50 D but > -1.00 D.

Fast progression: Change in spherical equivalent over a year period ≤ - 1.00 D.

Data collection tools and techniques

Data was collected with face-to-face interview using structured questionnaire; optometrists and ophthalmic nurses were the informants. Measurements were taken during initial presentation and after one year. Objective refraction after cycloplegia (with cyclopentolate 1% eye drop) was taken with autorefractors (Zeiss, Carl Zeiss meditec AG); Axial Length (AL), Anterior Chamber (AC) depth, lens thickness and vitreous depth were measured using A scan ultrasound (Quantum medical).

Data analysis

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 26. Rate of progression was determined by using paired sample student T- test by comparing the means of Spherical Equivalent (SE) of myopia at the initial exam and final one-year examinations. The factors associated with progression rate were explored using multivariable binary logistic regression. A P value of less than 0.05 was used to declare significance of the association.

Ethics approval and consent to participate: The study was conducted after ethical clearance letter was obtained from the Institutional Review Board (IRB) of Saint Paul's Hospital Millennium Medical College (SPHMMC) with approval number of 533/ 2021. Informed written consent was taken from the parents or guardians of the children. Assent was also taken for children aged between 13 and 15 years.

RESULTS

Socio - demographic characteristics

A total of 66 children with a diagnosis of myopia were followed for one year. The mean age was 11.02 years (range, 6-15 years). Forty-three (65.2%) of the study subjects were females. Sixty-two (93.9%) of children were from the urban residence (Table 1).

Table 1: Socio – demographic characteristics of the study population, SPHMMC, 2023

Variables	Frequency	(%)
Age (years)		
6-10	26	39.4
11-15	40	60.6
Sex		
Male	23	34.8
Female	43	65.2
Residence		
Urban	62	93.9
Rural	4	6.1
Maternal education		
No formal education/primary education	22	33.8
Secondary level and above	43	66.2
Paternal education		
No formal education/ primary education	18	27.3
Secondary education and above	48	72.7

Genetic, behavioral and myopia related factors

Thirteen (19.7 %) children had history of myopia either in the parents or siblings. The mean duration of eyeglass use was 1.98 years ± 1.19 and the average time of eyeglass use was 12.85 ± 1. 44 hours. The average time the children spend reading per day was 2.21 hours (Range from 0.3 – 6hrs) ± 1. 41 hours.

The mean time outdoors was 2.54 ± 1.98 hours while the average TV watching time per day was 2.34 ± 1.76 hours. On average, the time the children spend using computers or mobile phones was 1.37 ± 1. 91 hours while the mean time the children enrolled in the study spent in sporting activities was 0.66 ± 1.06 hours. Based on the initial SE, 29 (43.9%) of the children had low myopia; 15 (22.7 %) had moderate myopia and 22 (%) had high myopia at the beginning of the study (Table 2).

Table 2: Genetic, behavioral and myopia related factors, SPHMMC, 2023

Variables		Frequency	(%)
Family history	Yes	13	19.7
	No	53	80.3
Duration of eye glass use (years)	≤ 3	61	92.4
	>3	5	7.6
Eye glass hours per day (hours)	≤12	29	43.9
	>12	37	56.1
Reading time per day (hours)	≤ 3	52	78.8
	>3	14	21.2
Class break	Indoors	20	30.8
	Outdoors	45	69.2
Time spent outdoors (hours)	≤ 2	43	65.2
	>2	23	34.8
TV watching hours	≤ 2	42	63.6
	>2	24	36.4
Computer use hours	≤ 1	42	63.6
	>1	24	36.4
Sport activities	Yes	29	43.9
	No	37	56.1
Sleeping hours	< 8	4	6.1
	≥ 8	62	93.9 %
Initial spherical equivalent	Low myopia	29	43.9 %
	Moderate myopia	15	22.7 %
	High myopia	22	33.3 %

Progression of myopia

The mean SE, measured by cycloplegic autorefraction, of the right eyes of 66 children participated in the initial examination was -5.35 D (SD, 4.63D) with a range of -20 D to -0.5 D. There was no significant difference between the mean Spherical Equivalent Refraction (SER) of the left and the right eyes (P = 0.201) (Table 3).

The mean AL of the right eyes of the 64 children who had biometric measurements during initial examination was 24. 60 (SD, 1.42) mm with a range of 22. 24mm to 28.2mm, whereas that of the left eye of 61 children was 24.72 (SD, 1.68) mm and ranges from 22.05mm to 29.15 mm. Since there was no statistically significant difference on SERs and ALs between the right and the left eyes, the measurements from the right eye were chosen for statistical analysis. The mean change in spherical equivalent between the first visit and after 1 year of the right eye was - 0.41 D and was statistically significant (P < 0.001).

Table 3: Change in ocular measurements of the study population, SPHMMC, 2023

	Initial examination Mean (SD)	Examination after 1 year Mean (SD)	Mean difference	P-value
SE (D)	-5.35 (4.63)	-5.76 (4.54)	- 0.41	< 0.001
Anterior chamber depth (mm)	3.47 (0.29)	3.47 (0. 30)	0.00063	0.980
Lens thickness (mm)	3.60 (0.53)	3.63 (0.57)	0.02	0.540
Vitreous depth (mm)	17.54 (1.49)	17.74 (1.54)	0.20	< 0. 001
Axial length (mm)	24.60 (1.42)	24.82 (1.46)	0.22	< 0.001

Twelve children 12 (18.2%) showed fast progression; 19 (28.8%) showed moderate rate of progression and 35 (53%) showed slow progression based on SE measurement after cycloplegia. Upon binary logistic regression testing; age of the child (P=0.37), sex (P=0.92), place of residence (P=0.38), maternal (P=0.26) and paternal (P=0.42) educational level, family history of myopia (P=0.95), duration of eyeglass use (P=0.75), where they pass the class break (P=0.34), whether they participate in sports or not (P=0.49), hours spent outdoors (P=0.68) and sleeping hours per day (P=0.90) had no significant association with rate of myopia progression.

Table 4: Factors associated with myopia progression of the study population, SPHMMC, 2023

Variables		Progression		COR (95% CI)	AOR (95% CI)	P-value
Fast/moderate		Slow				
Age (years)	6-10	14	12	0.63 (0.24, 1.71)		0.37
	11-15	17	23	1.00		
Sex	Male	11	12	0.95 (0.34, 2.62)		0.92
	Female	20	23	1.00		
Family history	Yes	6	7	1.04 (0.30, 3.52)		0.95
	No	25	28	1.00		
Eye glass hours per day	≤ 12	10	19	2.50 (0.91, 6.81)	0.54 (0.18, 1.67)	0.29
	>12	21	16	1.00	1.00	
Reading time per day (hours)	≤ 3	21	31	1.00	1.00	
	>3	10	4	3.70 (1.02, 12.5)	5.00 (1.10, 25.00)	0.04*
Class break	Indoor	11	9	0.60 (0.21, 1.73)		0.34
	Outdoor	19	26	1.00		
Time spent outdoors (hours)	≤ 2	21	20	0.81 (0. 29, 2.23)		0.68
	>2	101	13	1.00		
TV watching hours	≤ 2	15	27	1.00	1.00	
	>2	16	8	3.57 (1.25, 10.00)	3.85 (1.16, 12.50)	0.03*
Computer use hours	≤ 1	17	25	0.49 (0. 18, 1.35)	1.07 (0.32, 3.64)	0.91
	>1	14	10	1.00	1.00	
Sleeping hours	< 8	2	2	0.88 (0.12, 6.64)		0.90
	≥ 8	29	33	1.00		
Initial spherical equivalent	Low myopia	16	13	0.55 (0.21, 1.48)	2.54 (0.81, 7.96)	0.11
	Moderate/ high myopia	15	22	1.00	1.00	

*- Clinically significant

After a multivariable binary logistic regression analysis of the factors associated with myopia progression, reading time per day (AOR: 5.00; CI: 1.10,0. 25.00; P = 0.04) and hours spent watching TV per day (AOR:3.85; CI:1.16, 12.50; P = 0.03) were significantly associated with fast/moderate rate of progression. Those children with reading time of more than three hours per day were five times more likely (80% higher risk) to have fast/moderate rate of progression in comparison to those who read less than three hours per day. Myopic children who spend more than 2 hours a day watching TV were 3.85 times (74% higher risk) more likely to have a moderate/fast myopia progression than those who spend 2 or less hours watching TV.

DISCUSSION

The mean change in SE after one year was - 0.41 D; consistent with studies in Taipei, Taiwan (- 0.42 ± 0.85 D); Western China (- 0.43 D), and Hong Kong (-0.44 D). There was a significant change in AL one year after the initial visit of 0.22 mm (P < 0.001) and change in vitreous depth of 0.20 mm (P < 0.001). These results are similar with the studies in Hong Kong which showed a significant mean annual change in axial length and vitreous depth of 0.34 mm and 0.28 mm respectively[11-13].

In this study 18.2% of children showed fast progression; 28.8% moderately progress and 53% progressed slowly. This differs from the study in Taipei which shows a 46.96%, 28.50% and 24.54% slow, moderate and fast progression, respectively. This may be due to the relatively young age of the study subjects in the study in Taipei (mean age; 7.49 years versus 11.02 years in this study) and difference in race of the study participants between the studies[12]. Similar to previous studies, reading time of three or more hours per day was significantly associated with moderate or fast rate of myopia progression in this study[1]. The increased incidence and rate of progression linked with reading is supposed to be related to the increased saccadic back-and-forth movements of the eye during reading, which cause repeated pressure and pulses of stretch on the eye[14].

Consistent with other studies, time spent outdoors was not significantly associated with rate of myopia progression[1,12,15]. Physical activity was also not significantly associated with rate of progression of myopia in one of the studies of a metanalysis similar to the results in our study; while six of the studies in the meta-analysis show reverse association between physical activity and rate of myopia progression[16].

Contrary to a Finnish study, there was a significantly higher risk of moderate to fast myopia progression among children who spent more than 2 hours watching TV per day. The fact that bifocal glasses were provided for the participants of the Finnish study and the shorter follow up period in our study may explain this difference[17]. In our study sleeping hours per day was not significantly associated with rate of myopia progression; consistent with a Chinese study[18].

CONCLUSION

While myopia is a growing global socioeconomic and public health problem, there were no studies which assess the rate of myopia progression among school children and determine the factors associated with faster rate of progression in Ethiopia. This study determined the rate of myopia progression based on changes in SE after cycloplegic autorefraction among children aged 6 to 15 years and tried to identify the factors associated with moderate/fast rate of myopia progression.

This study shows that the mean change in spherical equivalent among myopic children after one year of follow up was – 0.41 D. There were also significant changes in axial length (0.22 mm, P < 0.001) and vitreous depth (0.20mm, P < 0.001) after one year follow up. Prolonged reading time per day and longer time spent watching TV were factors associated with higher risk of moderate to fast rate of myopia progression.

RECOMMENDATION

Though our study is a pioneer in Ethiopia to determine the rate of myopia progression and tried to identify the factors associated with rate of myopia progression, it is not a complete set with no room for further recommendations. Further studies with larger sample size need to be done to better strengthen and identify other factors associated with rate of myopia progression.

Strengths and limitations

There are no similar studies done previously in Ethiopia as per the authors' information; the study will be used as a baseline for further studies in the future. Appropriate study designs and clear inclusion and exclusion criteria were used. The study has real world relevance; appropriate statistical analysis was used and was conducted after ethical approval and informed consent.

The study is limited by small sample size and being a single center study. Longer follow up periods would also have been appropriate. There were patients lost to follow up and tracking with phone calls was tried.

ACKNOWLEDGEMENTS

The authors would like to heartfully acknowledge the study subjects and their parents or guardians for their cooperation during the data collection process.

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