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ORIGINAL ARTICLE

Progression of Myopia Among Age Groups: A Retrospective Study

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Abstract:

Objective: To scrutinize the annual progression of myopia among individuals from an urban setting of Pakistan across age demographics and ascertain its correlation with the myopia severity.

Methods: The study design of this report is retrospective, and the patients were recruited from Sindh Government Qatar Hospital, Karachi, from 2016 to 2022. Data was collected through a consecutive sampling technique; subjects were stratified into two age groups: <15 years and ≥15 years. The spherical equivalent (SE) was calculated at baseline and at follow-up after 300–415 days (approximately one year). The univariate Mann–Whitney U test, chi-square test, and multivariate logistic regression analyses were used for statistical analysis in SPSS 26.

Results: The participants' median age was 16 years (IQR: 12–20 years). The median spherical equivalent for the right eye was −3.5 diopters (D) (IQR: −5.4 to −2.0), and for the left eye was −3.6 D (IQR: −5.5 to −1.9). Most participants had mild myopia (41%), followed by moderate myopia (32%), while 27% had high or severe myopia. Baseline and one-year SE values were significantly higher in patients aged <15 years (−4.0 [−5.5 to −2.8] D and −4.5 [−6.25 to −3.2] D, respectively; $p < 0.001$). Younger patients showed significantly higher myopia progression contrasted with those aged ≥15 years ($p < 0.001$).

Conclusion: The progression of myopia among pediatric and teenage individuals in Karachi is substantial, particularly among individuals younger than 15 years. The findings of this study highlight the requirement for early identification and strategies for prevention and mitigation of the increasing incidence of myopia in Pakistan. *Al-Shifa Journal of Ophthalmology 2026; 22(1): 23-32.*

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Introduction:

Myopia is among the prevalent refractive errors affecting children. Several reports have projected that by the middle of this century, nearly one billion individuals globally may be at risk of developing complications related to myopia [1-3]. The development and myopia progression are impacted by multiple characteristics, for instance, age, age at diagnosis, severity of myopia (mild, moderate, high, or severe), ethnicity, and geographic location [4, 5]. Myopia has transform more prevalent in the United States, from approximately 25% to 42% among young adults and older individuals over the past thirty years, while in Australia, it is around 31% among adolescents [6, 7]. The populations from East Asian countries are demonstrated to be approximately two-fold as susceptible to

myopia compared with European, American, and Australian populations [8]. Notably, myopia prevalence rates are as high as 97% in South Korea have [9], and rates of 70–80% have been observed among young adults in East Asia [10].

Over the past years, myopia has been identified as a public health concern 8, 11-13, particularly in Asian populations. The estimated myopia prevalence in individuals age less than 20 years in Asia is approximately 24%, rising to 30% among adults older than 40 years 8. Vision loss resulting from pathological myopia is irreversible and contributes significantly to visual impairment worldwide 14. Visual impairment caused by pathologic myopia is approximately 5.8-7.8% in Europeans, 4.5% in South Americans, and 12.2-32.7% in East Asian 15. In Pakistan, a study at an institute in Lahore reported 83.6% of myopia prevalence among 118 medical students. Out of these, 56.4% exhibited a refractive error of less than -3.00 D, while 22.7% had a refractive error characterized as moderate myopia (-3.00 D and -6.00 D), and only 1.8% had a refractive error exceeding -6.00 D 16. In the Islamabad Institute, a cross-sectional study reported myopia prevalence of 23.4%, ranking second-highest among 2,138 patients 17. A study reported the strong association of glaucoma and Myopia in older age. In this multi-center cross-sectional study, two hundred fifty individuals aged between 40 and 65 were recruited 18.

There is a literature gap regarding the myopia progression in Pakistan, specifically the association of myopia severity with different age groups. The studies on the myopia progression and its relationship with various risk factors like age, ethnicity, heredity, etc., can help clinicians provide suitable treatment to patients. In this study, our objective is to scrutinize the annual progression of myopia among individuals from an urban setting in Pakistan across age demographics and ascertain its correlation with myopia severity.

Methodology:

The study design of this report is retrospective, and the patients were recruited from Sindh Qatar Hospital, Karachi, Pakistan. Between 2016 and 2022, a total of 13,563 patients diagnosed with myopia attended the hospital. Among them, 3,853 patients returned for follow-up ophthalmic examinations. After applying strict data-quality criteria and excluding records without complete longitudinal follow-up, 3,434 patients were included in the final analysis. Ethical approval was obtained from the hospital's Ethics Review Committee (ERC/15/082023).

Inclusion criteria were patients aged 10–25 years diagnosed with myopia who attended follow-up visits approximately one year after baseline assessment. Any patient with a history of ocular pathology or surgery was not included. In this study, 3434 patients were recruited, while 419 patients with incomplete data were excluded. The patients were stratified according to age; there were 1,572 patients aged under 15 years who were categorized into the "<15 years" age group. The remaining age group comprised 1,862 patients aged over 15 years, categorized into the ">15 years" age group, refer to Figure 1.

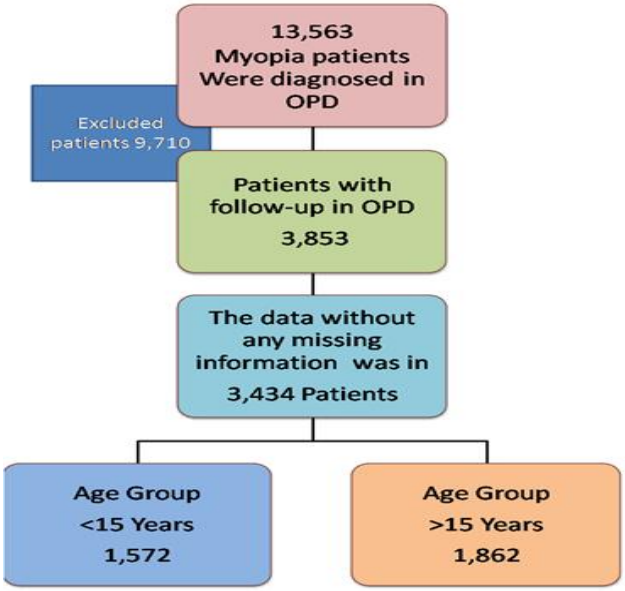

Fig 1: Flow Diagram of Participant Selection and Inclusion in the Study of Myopia Patients Attending the Ophthalmology Outpatient Department (OPD).

At baseline, demographic data (age and gender) and refractive error measurements were recorded. Spherical equivalent values were documented at baseline and during follow-up visits conducted 330–415 days later. The patients have visited the OPD twice, and the refractive examination was cycloplegic for patients younger than 16 years. The age cutoff of 15 years was selected based on evidence indicating stabilization of axial length and slowing of myopia progression toward the end of puberty 1. Mild myopia was characterized as a spherical equivalent of (−0.5 to −3.0 D), moderate myopia as (>−3.0 to −6.0 D), high myopia as (>−6.0 to −9.0 D), or severe myopia as (<−9.0 D) 1. The difference between the spherical equivalent at baseline and after one year was defined as Myopia progression.

SPSS version 27 was used for the statistical analysis. Categorical variables were reported as frequencies and percentages, while continuous variables were reported as medians and interquartile ranges. The Shapiro–Wilk test was utilized to assess the normality of quantitative variables. The evaluation of quantitative variables was estimated by the univariate Mann–Whitney U test, and for categorical variables, the chi-square test was utilized.

Hosmer et al., have described the purposeful selection of covariates. We follow these criteria for the selection of variables for multivariate analysis 19. This criterion recommends a screening threshold of p-value <0.25 or p-value <0.1 to make sure that the marginal insignificant variables can be significant confounders when compared in multivariate analysis. The statistical significance of a variable was considered if any variable had a p-value <0.05.

Results:

The participants' median age was 16 years (IQR: 12–20 years). No significant differences were observed between right and left eye spherical equivalent values; therefore, the analysis focused on the right eye. Male participants accounted for 53% (n = 1,818) of the sample, while females comprised 47% (n = 1,616). At baseline, 41% of participants were characterized with mild myopia, 32% were characterized with moderate myopia, and 27% were characterized with high or severe myopia (Table 1).

Table 1: Demographic and clinical characteristics at baseline

Variables	Median (IQR)
Baseline SE Right Eye Left Eye	 -3.5 (-5.375--2) D -3.6 (-5.5- -1.9) D
Follow up SE Right Eye Left Eye	 -4 (-5.875--2.375) D -3.8 (-5.875--2.375) D
SE Difference	-0.25 (-0.75-0.125) D
Variables	N (%)
Gender Male Female	 1,616 (47) 1,818 (53)
Age <15 years >15 years	 1572(46) 1862(54)
Myopia Severity Severe High Moderate Mild	 273(8) 663(19) 1085(32) 1413(41)
SE: Spherical Equivalent, IQR: Inter-quartile range, D: Diopter	

Females exhibited significantly higher baseline spherical equivalent values than males (median −4.0 D vs. −3.25 D; $p < 0.001$) (Table 2). Both genders demonstrated significant progression in myopia over one year ($p < 0.001$) (Figure 2).

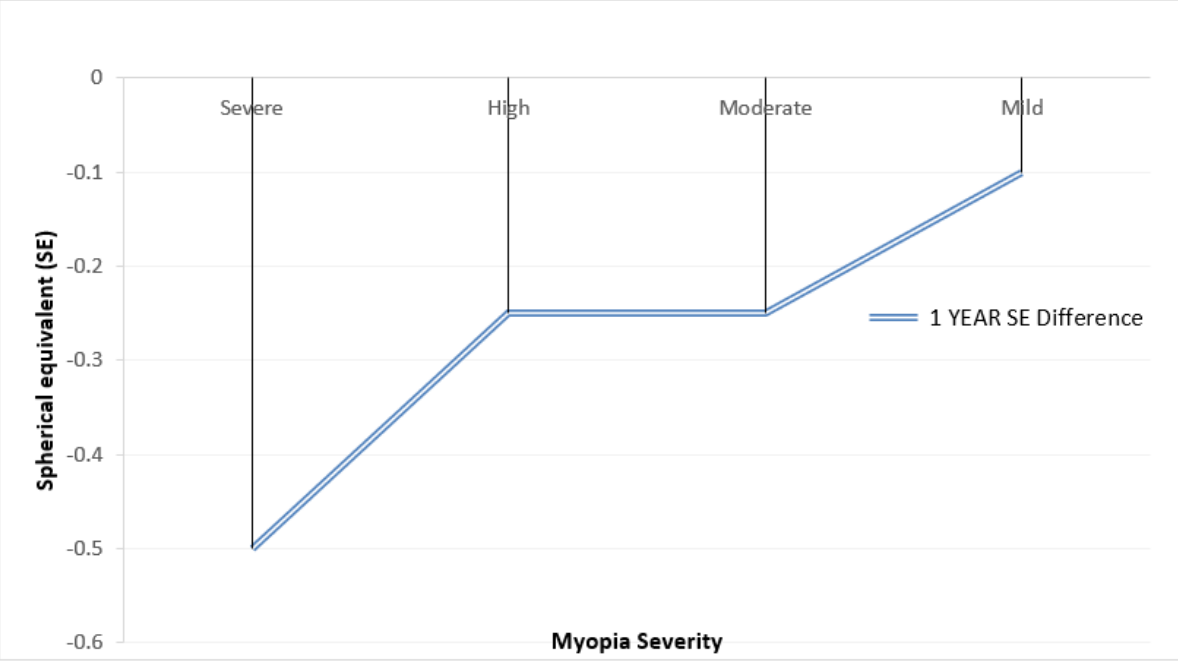

Figure. 2: The Spherical equivalent difference according to the Myopia severity:

Table 2: Univariate analyses of age group with clinical and demographic characteristics

Patient Characteristics:		Age Group		P-value:
		<15 years	>15 years	
Baseline SE (Median (IQR))		-4 (-5.5--2.8)	-3 (-5.25--1.8)	<0.001
Follow up SE (Median (IQR))		-4.5 (-6.25--3.2)	-3.25 (-5.5--1.9)	<0.001
SE Difference (Median (IQR))		-0.5 (-1-0)	0 (-0.5-0.25)	<0.001
Gender (N (%))	Female	737 (46.9)	942 (51)	0.02
	Male	835 (53)	920 (49)	
Severity of Myopia (N (%))	Severe	149 (9.5)	124 (6.7)	<0.001
	High	312 (19.8)	351 (19)	
	Moderate	635 (40)	450 (24)	
	Mild	476 (30)	937 (50)	
SE: Spherical Equivalent: IQR: Inter-quartile range D: Diopter				

Patients younger than 15 years had significantly higher baseline and follow-up spherical equivalent values compared with those aged 15 years or older ($p < 0.001$). Myopia progression was greater in the younger age group, with a median SE change of −0.5 D compared with 0.0 D in older patients ($p < 0.001$). Multivariate analysis revealed that age <15 years was independently associated with increased odds of myopia progression (OR: 2.14; 95% CI: 1.91–2.40; $p < 0.001$). Male gender was also associated with higher odds of progression compared with females (OR: 1.41; 95% CI: 1.16–1.71; $p < 0.001$) (Table 3).

Table 3: Multivariate analysis of age association with other factors

	Reference Category (Categorical Data)	Beta coefficient	Standard Error	P-value	Odds Ratio	95% C. I.	
						Lower	Upper
SE Difference		.761	.058	<0.001	2.141	1.912	2.397
Baseline SE		-0.738	0.07	<0.001	0.478	0.4	0.5
Follow up SE		0.766	0.06	<0.001	2.2	1.9	2.4
Severity of Myopia Severe	Mild	-0.650	0.38	0.08	0.5	0.25	1.1
Severity of Myopia High	Mild	-0.663	0.19	0.001	0.5	0.353	0.753
Severity of Myopia Moderate	Mild	-1.085	0.12	<0.001	0.34	0.269	0.424
Gender (Female)	Male	0.342	0.1	<0.001	1.41	1.158	1.713
Constant		0.92	0.08	<0.001	2.51		
Omnibus Tests of Model Coefficients			Step, lock, Model		Chi-square 378.2	<0.001	
Hosmer and Lemeshow Test					Chi-square 9.3	0.32	
Nagelkerke R Square			0.139				
SE: Spherical Equivalent: IQR: Inter-quartile range D: Diopter.							

Discussion:

This retrospective study evaluated myopia progression among children and young adults in an urban population of Karachi, Pakistan, and identified age, gender, and baseline myopia severity as significant factors associated with refractive progression. These findings provide important longitudinal evidence from a South Asian context, where data on myopia progression remain limited.

A key finding was the significantly greater progression of myopia observed in patients younger than 15 years compared with older individuals. Younger participants demonstrated larger negative shifts in spherical equivalent over the one-year follow-up period, consistent with Verkicharla et al., 2020, Chen et al., 2018, and Ducloux et al., 2023 showing that myopia progression is most rapid during childhood and early adolescence. This period corresponds to active ocular growth and axial elongation, which typically stabilize in late adolescence, explaining the slower progression observed in older patients 1, 20, 21.

Age is a major characteristic in the evaluation of myopia progression. In this study, results confirmed that progression of myopia is significantly higher among patients with an age less than 15 years of age as compared to older patients. However, the myopia progression is

different among the age groups, as Chua et al., 2016, Jensen 1995, and Saw et al., 2005 report the progression faster in the age group of 7-9 years or 9 to 12 4, 22,23.

Multivariate analysis confirmed younger age as an independent predictor of myopia progression, with patients under 15 years having more than twice the odds of progression compared with those aged 15 years and above. This highlights the importance of early identification and monitoring of myopia, as preventive and control strategies are likely to be most effective when implemented during childhood.

In contrast, a study reported that in children from Australia, the annual progression was reported as -0.31 to -0.4 D. In Europe, the UK, the USA, China, Japan, and Singapore, it ranged from -0.55 D to -0.34 D to -0.5 D and -0.31 to -1.2 D, respectively 5, 24,25. Chua et al., 2016 from India reports a lesser progression of myopia at -0.24 ± 0.42 D (4). The severity of myopia demonstrated a correlation with its progression based on our dataset. This observation is consistent with findings from Saw et al., 2005, and Zhou et al., 2016 conducted in East Asia 23,26. Upon stratification by age, females under 15 years old exhibited a higher inclination for progression of myopia compared to males in the same age group. Furthermore, in a report by Hsu et al., 2017, gender is reported as a risk factor for the progression of Myopia, with females displaying a higher inclination for progression compared to males, at ages of 7 and 12 27. Gender differences were also observed, with female participants demonstrating higher baseline myopia and greater progression than males. Although the mechanisms underlying this difference remain unclear, similar trends have been reported in previous studies and may be influenced by biological or behavioral factors. Baseline myopia severity was significantly associated with progression, with moderate to severe myopia showing greater refractive worsening, emphasizing the need for closer follow-up in these patients due to the risk of vision-threatening complications, consistent with findings from studies conducted in Europe and Asia Tricard et al., 2022, demonstrates that a small difference of 0.03 D or a difference of 9% was observed between males and females. Several studies have indicated a greater progression of myopia in females compared to males 28. For instance, Hymen et al., 2005 documented a disparity of 0.16 diopters in spherical equivalent over three years 29.

Donovan et al., 2012, in his meta-analysis revealed a statistically significant disparity in the annual progression of myopia between genders. Specifically, females exhibited a mean difference of -0.8 diopters, whereas males showed a mean difference of -0.7 diopters (p-value <0.001) 5. This gender-based discrepancy persisted across prospective studies conducted by Saxena et al., 2017 in the subcontinent 30 and East Asia by Saxena et al., 2022 25 as well as in several other longitudinal investigations from North America reported by COMET group 2013, (31).

Donovan et al., 2012, reported that the progression rate of myopia was found to be higher in Asian patients (-0.82D), while in European patients it was lower (0.5D) 5. Verkicharla et al., 2020, have done a study on 10000 school children aged 5 to 15 years reported an annual progression of -0.27 ± 0.42 D. A hospital-originated study from South Asia was carried out on kids and adolescents; it reported 4.3% participants had myopia associated with pathologies comparable to European and East Asians 1).

A study by Younan et al., 2002, reported the severity of myopia is a risk factor for various conditions that cause the loss of vision, and Myopia equal to or higher than 5.00 D is documented as a vital reason for complete vision loss. Patients with myopia 6.00D or more have 14.4 times greater odds of glaucoma, Cataract is 3.3 times, and retinal detachment is 7.8 times higher in patients having myopia 8.00D or higher 32.

The consistent findings across by Yu et al., 2023 suggest a potential correlation. However, the specific cause remains speculative. One plausible explanation could be the variance in outdoor exposure between genders, potentially contributing to the pronounced myopic progression observed in females 33.

Our study has few limitations worth noting. Firstly, its retrospective nature limits the scope of data collection to a specific timeframe, spanning from 2016 to 2022. Additionally, the study's single-center design may restrict the generalizability of our findings to broader populations. Furthermore, certain significant risk factors potentially linked to myopia, such as outdoor activity or exposure, near work, screen time, and hereditary predispositions, were not incorporated into our analysis. Moreover, data regarding the onset of myopia and the age at which individuals first received corrective glasses were unavailable, further constraining our comprehensive understanding of the condition.

This investigation adopted a Cohort study design, incorporating longitudinal follow-up assessments, which facilitated a more comprehensive understanding of the observed progressions. To the best of current knowledge, this represents the inaugural examination into the progression dynamics of Myopia. The sample size has been deemed adequate to undertake a rigorous analysis of the progression patterns.

Conclusion:

Myopia progression among children and young adults in Karachi is substantial and comparable to rates reported in East Asian and European populations. Younger age and greater baseline severity are key predictors of progression. Early diagnosis and timely preventive interventions may help slow progression and reduce the long-term burden of myopia-related visual impairment. Further prospective and interventional studies are needed to establish causal relationships and evaluate preventive strategies.

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