

## ORIGINAL ARTICLE

## Association Between Outdoor Activity and Myopia Progression

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## ABSTRACT

**Background:** Myopia is a refractive defect that is on a rising trend of prevalence in children and adolescents all over the world. Poor environmental conditions especially less outdoor activities and more exposure to near work have been associated with the speed up of myopia. There is dearth of local information on this association in Pakistani children.**Objective:** To identify the relationship between outdoor activity and the development of myopia among school-aged children who visit a tertiary care hospital in DI Khan, Pakistan.**Methods:** The present analytical cross-sectional study was carried out in the Department of Ophthalmology Gomal Medical College, Dera Ismail Khan, from July 2022 to June 2023. One hundred eighty myopic children aged between 6 and 15 years were recruited by non-probability consecutive sampling. A structured proforma was to gather information on the data on daily outdoor activity, near-work duration, and family history. Spherical equivalent was determined by carrying out cycloplegic refraction. The progression of myopia was considered an improvement of 0.50 or more diopters in 12 months. The SPSS version 26 was employed to analyze data. Associations were evaluated using chi-square test and p 0.05 was taken as statistically significant.**Results:** The age of the subjects was  $10.8 \pm 2.4$  years, 54.4% of the males and 45.6% of the females. The development of myopia was found in 73 (40.6) children. Rates of progression were greatest with children who were spending less than 1 hour/day outside (63.3) and lowest with children who were spending more than 2 hours/day outside (20.0) ( $p = 0.001$ ). No meaningful results were also observed between myopia progression and positive family history ( $p = 0.018$ ) and high near-work exposure ( $>3$  hours/day) ( $p = 0.004$ ).**Conclusion:** Lack of outdoor exercise is closely linked to the development of myopia among school-going children. Outdoor exposure could be promoted as a simple low-cost intervention in order to decrease the problem of progressive myopia among the pediatric population of DI Khan.**Keywords:** Myopia; Exercise; Near work; Pediatric ophthalmology; Near work; Refractive error; Pakistan.

## INTRODUCTION

Nearsightedness (myopia) has become a significant public health problem in the global community, with an ever-growing rate of occurrence in children and adolescents. This is no longer believed to be a refractive error to be corrected optically but a disease that is related to an increased risk of ocular complications, over the long term, including detached retina, myopic maculopathy, glaucoma, and premature cataract. This increases the prevalence of myopia especially among urban dwellers and school-going children have led to increased interest in finding modifiable environmental and behavioral risk factors that can be used to curb the prevalence<sup>1</sup>.

Out of the different environmental determinants that have been studied, the time spent outside has been found to be protective with the incidence and advancement of myopia. Epidemiological research in other parts of the world has established that children who have more outdoor activities are less prone to myopia as opposed to their counterparts with an indoor lifestyle<sup>2,3</sup>. Interventional studies in schools have also proposed that a higher exposure to the outdoors during school days could be a major measure to prevent the occurrence of myopia in the one-three-year follow-up<sup>4</sup>. These results point to the validity of outdoor activity as a non-complicated and inexpensive preventive intervention.

The biological processes of the protective effect of outdoor exposure are also being investigated. Sunlight has been found to trigger the release of retinal dopamine which is instrumental in the suppression of axial elongation of the eye; one of the most important structural changes in myopia progression<sup>5</sup>. Secondly, outdoors settings also promote distance viewing and avoid near

work continuously, which can also help slow refractive changes. These mechanistic understandings provide some evidence to the epidemiological associations that we see.

On the other hand, the overload of near work, the long duration of screen time, and academic stressors have been seen as the factors of the escalating incidence of myopia. The policies of urbanization and changing the lifestyle pattern have greatly diminished the chances of outdoor play of children especially in developing nations. The combination of less outdoor physical exertion and more near work can lead to a compounded threat of faster myopia development in vulnerable persons<sup>6</sup>.

The inverse association between outdoor time and myopia development has also been supported by systematic reviews and meta-analyses but variations are found in the results between different populations and study designs<sup>7</sup>. Notably, the majority of the existing data are based on East Asian and Western nations, and the sociocultural and environmental factors can vary significantly in South Asia. Thus, one should be careful in generalising findings on international population to the population in Pakistan.

Little local information on environmental effects on the development of myopia is known in Pakistan, particularly in tertiary care. Majority of regional studies have been on prevalence estimates but excluding longitudinal progression or modifiable risk factors. The fast urbanization, rising educational needs, and rising screen time among children in DI Khan requires locally created evidence to guide preventive interventions<sup>8</sup>.

The tertiary care hospitals are the referral centers of a broad range of refractive disorders and an occasion to assess clinical progress and environmental exposure in a systematic manner. The analysis of the relationship between outdoor activities and the development of myopia in this context could provide useful information to clinicians, parents, and policymakers who might wish to minimize the clinical impact of progressive myopia among the population.

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**Objective:** To establish the relationship between outdoor activities and the development of myopia in school-aged children who attend a tertiary care hospital in DI Khan, Pakistan.

**METHODOLOGY**

**Study Design and Setting:** This cross-sectional study is analytical and was carried out at the Department of Ophthalmology Gomal Medical College, Dera Ismail Khan. This was conducted in a span of one Year that is from July 2022 to June 2023. The hospital is a tertiary care referral center serving a high number of pediatric and adolescent patients within and beyond the city and the districts.

**Population and Sampling of the study:** The sample consisted of school-aged children with myopia (615 years) referred to the outpatient department of the study. The children had to have a refractive error of at least 0.50 diopters (D) in one eye and limited to a spherical refractive error. Patients with a history of ocular pathology (e.g., keratoconus, congenital cataract, glaucoma, retinal disease), who had undergone ocular surgery, had a systemic disease that affected vision, or who were subjected to drug therapy as a myopia control method (e.g. atropine therapy) were excluded. The sampling method used was a non-probability consecutive sampling. All the potential patients that appeared throughout the study, and fulfilled the inclusion criteria in addition to whose parents/guardians signed an informed consent were recruited into the study.

**Data Collection Procedure:** Demographic and clinical data were coded using a structured proforma after informed consent was written and given by the parents or guardians. The data gathered pertained to age, sex, grade education, years of being myopic, history of myopia in the family, and the average number of hours a day spent in outdoor pursuits and near work (reading, homework, and screen activities). Parental reporting was used to measure outdoor activity and the activities were divided into less than 1 hour/day, 1 2 hours/day and more than 2 hours/day. Near work was measured as hours per day.

Each participant was subjected to the comprehensive ophthalmic examination. Snellen chart was used to evaluate the best-corrected and uncorrected visual acuity. Autorefraction and retinoscopy were used to determine the spherical equivalent (SE) using 1% cyclopentolate to perform cycloplegic refraction. Where axial length was obtained, non-contact optical biometry was used to measure axial length. The progress of myopia was evaluated by the comparison of the current cycloplegic refraction against the previously recorded refractive data within the last 12 months (where possible). Progression was considered to be an increment of 0.50 or more in myopic spherical equivalent in a period of one year.

**Variables and Operational Definitions:** Myopia progression (yes/no) was used as the main outcome variable. Outside activity (average hours daily) was taken as the key independent variable. Age, gender, family history of myopia, baseline refractive error, and the duration of near work were taken as secondary variables. Myopia was determined as a 0.50 D (spherical equivalent) or less. Significant progression was determined as a 0.50 D or more in the last year.

**Data Analysis:** Statistical Package for Social Sciences (SPSS) version 26 was used to input data and analyze them. The quantitative variables (age and spherical equivalent) were in the form of mean and standard deviation. The qualitative variables like gender, type of outdoor activities and progression status were displayed in form of frequencies and percentages. The Chi-square test was used to determine the relationship between outdoor activity and progression of myopia. Mean changes in refractions were compared by using independent sample t-test to compare the groups. When the p-value was equal to or less than 0.05, it was taken to be statistically significant.

**Ethical Considerations:** Before the start of the study, ethical approval was taken from the Institutional Review Board. Parents or legal guardians of all the participants provided written informed

consent. Patient confidentiality was kept in strict confidence and all the procedures were followed in accordance with the principles provided in the Declaration of Helsinki.

**RESULTS**

The sample size was 180 myopic children who were 6-15 years old. The average age of the participants was 10.8/ 2.4 years. There were 98 (54.4%) males and 82 (45.6%) females. Seventy two (40.0) children had a positive family history of myopia. The average baseline spherical equivalent refractive error was -2.10 +/- 1.15 diopters.

All in all, 73 (40.6%) of the participants demonstrated the onset of the myopia progression (defined as the increase of 0.50 D in 12 months).

Individual children that spent less than 1 hour/day outdoors demonstrated the greatest progression rate (63.3%), and those who spent more than 2 hours/day outdoors demonstrated the lowest progression rate (20.0%). The relationship between low levels of outdoor activity and the progression of myopia was statistically significant ( p = 0.001).

Myopia progression was also significantly related to family history of myopia and extended near work (>3 hours/day) (p = 0.018 and p = 0.004 respectively).

Table 1: Demographic and Baseline Characteristics (n = 180)

Variable	Value
Age (Mean ± SD)	10.8 ± 2.4 years
Gender – Male	98 (54.4%)
Gender – Female	82 (45.6%)
Family History of Myopia – Yes	72 (40.0%)
Family History of Myopia – No	108 (60.0%)
Baseline Spherical Equivalent (Mean ± SD)	-2.10 ± 1.15 D

Table 2: Distribution of Outdoor Activity and Myopia Progression (n = 180)

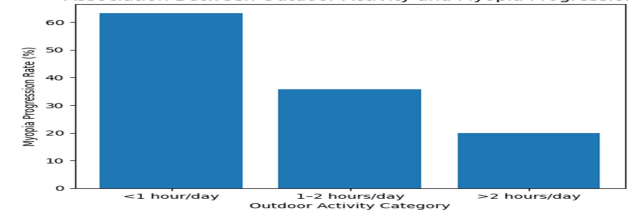
Outdoor Activity	Total (n)	Progression (n)	No Progression (n)	Progression Rate (%)
<1 hour/day	60	38	22	63.3%
1–2 hours/day	70	25	45	35.7%
>2 hours/day	50	10	40	20.0%
Total	180	73	107	40.6%

Chi-square test: p = 0.001

Table 3: Association of Selected Variables with Myopia Progression

Variable	Progression Present (n=73)	Progression Absent (n=107)	p-value
Outdoor Activity <1 hr	38	22	0.001
Outdoor Activity 1–2 hr	25	45	
Outdoor Activity >2 hr	10	40	
Family History – Yes	40	32	0.018
Family History – No	33	75	
Near Work >3 hrs/day	50	28	0.004
Near Work ≤3 hrs/day	23	79	

Figure 1: Association Between Outdoor Activity and Myopia Progression



## DISCUSSION

The current research showed that outdoor activity is highly negatively related to the development of myopia in school-aged children in a tertiary care hospital in DI Khan. The children who spent less than one hour per day outdoors had the highest rates of progression, and children that spent more than two hours daily outdoors had significantly lower progression. These results are in line with already reported evidence internationally showing the protective effect of outdoor exposure in the decreasing refractive progression [9,10].

A dose response relationship between outdoor time and lower incidence or progression of myopia has been supported by several epidemiological investigations performed on different populations<sup>11,12</sup>. Excessive amounts of natural light have been linked with a reduced rate of axial elongation and a delayed refractive error. The fact that these results are applicable in various geographic locations lends additional weight to the external validity of our findings and places the possibility of the existence of similar protective mechanisms in Pakistani children.

Experimental studies which have shown that exposure to bright light stimulates release of retinal dopamine which suppresses excessive ocular growth has helped in supporting the biological plausibility of this association<sup>13,14</sup>. The protective effect of the outdoors activity in the clinical and population-based studies can be explained by this mechanism as credible. There is also the added benefit that outdoor settings are associated with distance viewing and less accommodative strain than indoor near tasks which also may lead to increased deceleration of refractive progression.

In the current literature, having myopic history of the family was a significant predictor of the progression. This observation is consistent with the past reports that have suggested that children whose parents have myopic are more likely to experience accelerated refractive changes<sup>15,16</sup>. It seems that genetic predisposition is affected by environmental exposure, meaning that children with hereditary vulnerability might respond to preventive measures like spending more time outdoors.

Also of great significance in myopia progression in our cohort was near-work exposure. Previous research has shown that reading, homework, and screen time have an increased number of refractive shifts, particularly when there is insufficient physical activity in the outdoors<sup>17,18</sup>. The lifestyles of children have changed significantly with the influence of urbanization, education pressure, and the use of digital devices that would likely be the cause of the increasing prevalence of pediatric myopia in developing nations.

The rate of progression detected in the study indicates the increasing health cost of myopia to the society in urban centers. The same issues have been brought up in regional and global analyses, which focus on the importance of environmental factors subject to change in the process of shaping disease trajectories<sup>19</sup>. Simple behavior interventions, (enhancing outdoor exposure daily) could help reduce long term complications in high myopia when identified in high risk children at an early age.

On the whole, the results of this research confirm the hypothesis that outdoor activity is a protective factor in preventing the development of myopia among school going children. The observed opposite correlation in this study, which is the same as the existing published data, supports the significance of lifestyle change as a component of myopia management interventions<sup>20</sup>. Since upsurge outdoor exposure is simple and cost-effective, school and community-based public health efforts can be crucial to the mitigation of the rising childhood burden of myopia pediatric in Pakistan.

**LIMITATIONS:** There are some weaknesses to this study. The cross sectional type of design restricts causal inference between outdoor activity and the progression of myopia. Parental reporting was used to get outdoor exposure and near work duration, which can be subject to recall bias. It was definitely a research study in a single tertiary care hospital, which probably cannot be generalized to the broader community. Measurements of axial length were not

consistently available making structural measurement of progression constrained. It is suggested that future longitudinal, multicenter studies that objectively measure light exposure and have longer follow-up can help in better clarifying causal relationship as well as establish optimal outdoor exposure limits.

## CONCLUSION

This paper shows that there is a significant negative correlation between outdoor activity and the development of myopia among school-going children referred to a tertiary care hospital in DI Khan. Reduced daily outdoor exposure to children was associated with increased rates of refractive progression with more outdoor time being protective. Other contributing factors were family history of myopia and long-term exposure to near-work. These results endorse the use of regular outdoor exercise as a low-cost and less complex intervention to reduce the pace of myopia and lessen the load of high myopia in the pediatric population of Pakistan.

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