**Progression of Myopia and Associated Risk Factors Among Pediatric Patients at a Tertiary Hospital in Northern Tanzania: A Cross-Sectional Study**

**Abstract**

**Objective:** To determine the proportion and factors associated with myopia progression among pediatric patients attending the Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania.

**Methods:** A hospital-based analytical cross-sectional study was conducted at the Pediatric Eye Clinic of KCMC from January 2022 to April 2024. Pediatric patients aged 4–18 years diagnosed with myopia (spherical equivalent ≤ –0.50D) and with follow-up refraction 11–13 months after baseline were included. Data were collected through clinical assessments and structured face-to-face interviews. Myopia progression was defined as an increase in spherical equivalent between visits. Generalized linear models with Poisson distribution and robust standard errors were used to estimate crude and adjusted prevalence ratios (PRs) with 95% confidence intervals (CIs).

**Results:** Of 201 eligible participants, 63.2% (n=127) demonstrated myopia progression. In unadjusted analyses, significant associations with progression were observed for male sex (PR=0.79; 95% CI: 0.63–0.98), non-spectacle wear (PR=1.37; 95% CI: 1.12–1.69), mobile device use (PR=1.49; 95% CI: 1.22–1.82), viewing television at ≤2 meters (PR=1.65; 95% CI: 1.33–2.06), prolonged near work (>2 hours/day) (PR=1.74; 95% CI: 1.42–2.14), reduced outdoor time (<1 hour/day) (PR=0.65; 95% CI: 0.45–0.92), and a positive family history of myopia (PR=1.80; 95% CI: 1.42–2.29). In adjusted analysis, four factors remained independently associated with progression: older age >13 years was protective (PR=0.64; 95% CI: 0.43–0.96), while near work >2 hours/day (PR=1.55; 95% CI: 1.23–1.94), television viewing distance ≤2 meters (PR=1.31; 95% CI: 1.07–1.62), and a positive family history (PR=1.53; 95% CI: 1.23–1.91) were associated with increased risk.

**Conclusion:** Myopia progression was notably prevalent. Younger age, prolonged near work, close television viewing, and a positive family history emerged as independent risk factors. These findings highlight the urgent need for early screening, behavior-focused education, and targeted interventions to address modifiable risk factors and mitigate the rising burden of myopia among pediatric populations in African settings.

**Keywords:** Myopia progression, children, near work, screen time, spectacle use, Tanzania

**INTRODUCTION**

Globally, uncorrected myopia is the leading cause of blindness (Fricke and Flanagan, 2019). Nearly 2 billion people worldwide approximately 28.3% of the global population are affected by myopia, and of these, 277 million (4.0%) suffer from high myopia (Holden *et al.*, 2016). The prevalence of myopia among schoolchildren is reported to be 42% in North America and 40% in Europe, reflecting a growing global concern (Grzybowski *et al.*, 2020). The burden is most pronounced in East and Southeast Asia, where myopia prevalence among students completing secondary education reaches 80–90% (Graddipneurosci, 2018)

In Africa, although the overall prevalence is comparatively lower, it has been steadily rising. A systematic review showed that the prevalence of myopia between 2011 and 2021 was nearly double that reported from 2000 to 2010. The highest prevalence is found in North Africa (6.8%), followed by Southern Africa (6.3%), East Africa (4.7%), and West Africa (3.5%) (Kobia-Acquah *et al.*, 2022) .In Tanzania, the most recent study, conducted in Mwanza City in 2002, reported a prevalence of 5.6% among secondary school students, identifying myopia as the most common refractive error in this group (Wedner *et al.*, 2002).

Myopia development and progression are influenced by a combination of genetic predisposition and environmental exposures. The mechanical stretching of the eye, coupled with biochemical forces related to axial elongation, leads to thinning and structural alterations in ocular tissues including the retina, choroid, and sclera (Wicaksana and Rachman, 2018). A strong familial component has been observed, with children of myopic parents more likely to develop and experience faster progression of the condition.

Environmental risk factors significantly contribute to myopia onset and progression. These include prolonged near work, increased screen time, high academic demands, reduced outdoor activity, urban living, and longer reading hours (Ip *et al.*, 2008; Saxena *et al.*, 2017; Nouraeinejad, 2022). However, the protective role of outdoor activity remains inconclusive, with some studies showing no consistent association (Jones-Jordan *et al.*, 2012; Wu *et al.*, 2013; Hsu *et al.*, 2017)

An earlier age of onset is associated with faster progression of myopia, possibly due to increased responsiveness of younger eyes to environmental stimuli during critical developmental periods (Hsu *et al.*, 2016) .Gender has also emerged as a contributing factor, with females especially school-aged girls being more prone to faster myopia progression (Tricard *et al.*, 2022).

Additionally, the degree of myopia at baseline, often quantified using the spherical equivalent, has been linked to progression with higher baseline myopia being hypothesized to progress more rapidly (Kumar *et al.*, 2020).

Myopia control strategies include behavioral and optical interventions. Behavioral approaches such as increased outdoor activity, longer recess, maintaining reading distances over 30 cm, and taking breaks every 30 minutes during near work help slow progression (Ip *et al.*, 2008; Wu *et al.*, 2018; Yao *et al.*, 2019). Optical methods like spectacles and contact lenses are commonly used. Advanced options include orthokeratology and low-dose atropine eye drops, which are effective but face challenges like side effects and adherence (Cooper and Tkatchenko, 2018). These treatments are often inaccessible in low-resource settings due to high costs and limited availability of specialized services.

Complications associated with high or pathological myopia are severe and may include irreversible visual impairment due to glaucoma, myopic macular degeneration, and retinal detachment (Wong *et al.*, 2014) .These outcomes emphasize the importance of early identification and management of progressive myopia, particularly in pediatric populations.

Despite the growing global burden of myopia, there remains a significant gap in data from Africa, particularly from Tanzania. Compared to other regions where multiple studies and meta-analyses have been conducted, Africa is underrepresented in myopia research. This lack of localized data hampers efforts to design effective prevention and control strategies tailored to the region.

To address this gap, the present study was conducted at the Eye Clinic of Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania to assess the rate of myopia progression and identify associated risk factors among the pediatric myopic population. The findings aim to enhance understanding and inform targeted interventions for myopia management in Tanzania and similar low-resource settings.

**METHODOLOGY**

**Study Design and Setting**

This analytical hospital-based cross sectional study, was conducted at the Pediatric Eye Clinic of Kilimanjaro Christian Medical Centre (KCMC) in Moshi, Tanzania, from January 2022 to April 2024. KCMC is one of four zonal referral hospitals in northeastern Tanzania, serving a population of over 15 million across the northern, eastern, and central regions, in addition to international patients. The hospital houses more than 450 beds and handles hundreds of outpatient visits daily. The Eye Department, which serves as the primary ophthalmic referral center in the region, attends to approximately 38,000 patients annually including around 3,000 refractive error cases and accommodates 49 inpatient beds. It also functions as a key training center for ophthalmologists, pediatric ophthalmologists, vitreoretinal surgeons, optometrists, ophthalmic nurses, assistants, and medical students.

**Study Population and Eligibility Criteria**

The study included pediatric patients aged 4 to 18 years who were diagnosed with myopia and attended the KCMC Eye Clinic during the study period. The lower age limit of 4 years was selected due to the low prevalence of myopia in younger children, as well as practical challenges in obtaining accurate refractive measurements and assessing associated risk factors. While KCMC typically classifies pediatric patients as those aged 15 years and younger, the upper limit of 18 years was used to align with the World Health Organization (WHO) definition of a child.

Eligible participants were those who had a documented spherical equivalent (SE) refractive error of at least -0.50 diopters (Flitcroft *et al.*, 2019) in the least myopic eye at their initial visit during the study period. To be included in the analysis, participants were also required to have undergone a second refraction between 11 and 13 months after the initial assessment, with both visits falling within the study period. Only the least myopic eye was analyzed to minimize the risk of overestimating the severity and progression of myopia, as well as to avoid anisometropic bias. Written informed consent (or assent, where applicable) was obtained from all participants or their guardians. Patients were excluded if they had ocular anomalies such as cataract or keratoconus, or a history of ocular surgery, including cataract extraction, corneal procedures, or refractive surgery.

**Data Collection Methods**

Data were extracted from the hospital’s Electronic Health Management System (EHMS) based on the inclusion criteria. Baseline SE values and degree of myopia were recorded and categorized as low (-0.50D to -3.00D), moderate (-3.25D to -4.75D), or high (-5.00D and above). Additional sociodemographic data such as age, sex, residence, and parental contact information were also documented.

This study involved clinical refractive assessments and face-to-face interviews with participants and/or their parents or caregivers. Appointments were scheduled via telephone, and all assessments were conducted in private to maintain confidentiality.

**Refractive Assessment**

For children under 6 years of age, and for older children who were uncooperative during standard testing, cycloplegic refraction was performed by an experienced optometrist using two drops of 1% cyclopentolate administered five minutes apart. Refraction was assessed 30 minutes after the final instillation. If pupillary light response persisted, an additional 20 minute wait was observed before conducting cycloplegic refraction with a retinoscope. For cooperative participants aged 6 years and above, standard (non-cycloplegic) refraction was performed. Objective refraction results from the least myopic eye were recorded. Myopia progression was defined as an increase in SE between the baseline and follow-up visits.

**Interviews**

Structured face-to-face interviews lasting 10 to 15 minutes were conducted with participants and their parents or caregivers. Written and verbal informed consent (and assent, where appropriate) was obtained prior to participation. Data were collected using a structured, interviewer administered questionnaire adapted from existing literature (Wedner *et al.*, 2002; Sinshaw *et al.*, 2021) and pretested on 5% of the sample to ensure clarity and validity. The questionnaire was available in both English and Swahili; translation into Swahili was conducted by a language expert, and answers were recorded in English for analysis. Topics covered included participants’ and parents’ education levels, family history of refractive error, use of electronic devices (computer, tablet, or mobile phone), and spectacle-wearing patterns, which were categorized into three groups: full-time wearers (those who wore spectacles both during the day at school and at home, including at night), occasional wearers (those who wore spectacles only during school hours or during the day), and non-wearers (those who did not wear spectacles at all). Participants were asked to simulate the distance they sit from a television screen by sitting at a distance from a wall; distances were classified as less than or more than 2 meters. Estimated time spent on near work and outdoor activities after school hours was also assessed and categorized as either more than or less than two hours per day. To enhance data accuracy and reliability, parents or caregivers were involved in verifying participant responses

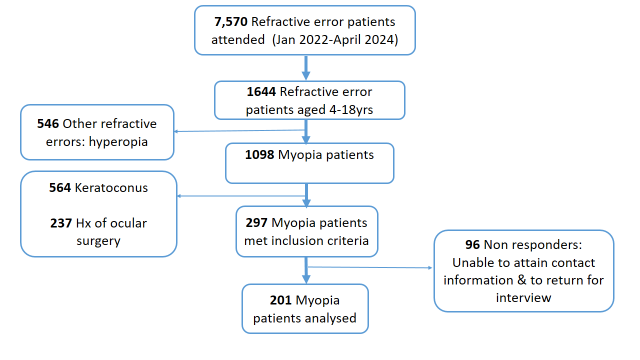
**Data analysis**

Data was cleaned and analyzed using STATA (Stata Corp LLC, College Station, Texas, USA) version 17. Categorical variables were summarized using frequency and percentages and numeric variables were summarized using mean with Standard deviation (SD). Generalized linear model with Poisson family and log link function was used to estimate prevalence ratio (PR) and the corresponding 95% confidence interval for factors associated with Myopia progression. Variables with a P-value of < 0.05 were considered statistically associated with myopia progression. Stepwise regression with lockterm option for participants age and sex was employed for model building and variable selection in adjusted analysis, while a pairwise correlations were examined to assess collinearity among the variables included in the analysis. A Variance Inflation Factor (VIF) of >10 was considered high multicollinearity.

**RESULTS**

Out of 1,098 myopic patients aged 4–18 years, 297 met the eligibility criteria after exclusions.

Of these, 201 patients completed the interview and were included in the final analysis. (Figure 1)



**Figure 1:** Flowchart of patient selection process

**Participants background characteristics**

A total of 201 participants were enrolled in the study. The mean age at both presentation and diagnosis was 12.9 years (SD = 3.11). Nearly half of the participants (46.3%) were aged between 9–13 years, while 44.7% were older than 13 years. Females constituted a slight majority (55.7%). Most participants (60.2%) were at the secondary education level, with a predominance of private school attendance (69.2%) and urban residency (72.6%). Over half of the mothers had completed secondary education (52.2%), while 50.7% of fathers had attained a college education or higher. Regarding spectacle use, majority (44.3%) wore spectacles occasionally. Most children reported viewing television at a distance of two meters or less (45.8%). Use of other electronic devices was reported by 35.3% of participants. A large proportion (78.6%) engaged in outdoor activities for less than one hour per day, while 39.8% reported more than two hours of near work daily.

Low myopia was the most common degree (65.2%), followed by high (21.4%) and moderate myopia (13.4%). Family history of myopia was reported in 50.2% of participants **(Table 1).** Spectacle-wearing patterns varied with the degree of myopia: the majority with low myopia were non-wearers (84.8%), while most with moderate (14.9%) and high myopia (23.8%) were spectacle wearers.

**Table 1 : Participants background characteristics (N=201)**

|  |  |  |
| --- | --- | --- |
| **Variable** | **Frequency** | **Percentage** |
| **Age at presentation (In years)** |  |  |
| ≤ 8 | 18 | 9 |
| 9-13 | 93 | 46.3 |
| >13 | 90 | 44.7 |
| *Mean (SD)* | *12.9(3.11)* |  |
| **Age at Diagnosis (in Years)** |  |  |
| >=8 | 65 | 32.3 |
| 9-13 | 100 | 49.8 |
| >13 | 36 | 17.9 |
| *Mean (SD)* | *12.9(3.11)* |  |
| **Sex of the participant** |  |  |
| Female | 112 | 55.7 |
| Male | 89 | 44.3 |
| **Participants education level** |  |  |
| Kindergarten/day care | 6 | 3 |
| Primary | 74 | 36.8 |
| Secondary | 121 | 60.2 |
| **Mother's education level** |  |  |
| No formal education | 1 | 0.5 |
| Primary education | 31 | 15.3 |
| Secondary education | 105 | 52.2 |
| College and above | 64 | 31.8 |
| **Father’s education** |  |  |
| No formal education | 1 | 0.5 |
| Primary education | 19 | 9.5 |
| Secondary education | 79 | 39.3 |
| College and above | 102 | 50.7 |
| **Residence location** |  |  |
| Rural | 55 | 27.4 |
| Urban | 146 | 72.6 |
| **School type** |  |  |
| Government | 62 | 30.8 |
| Private | 139 | 69.2 |
| **Boarding or Day school** |  |  |
| Boarding School | 119 | 59.2 |
| Day school | 82 | 40.8 |
| **Spectacle wearing pattern** |  |  |
| Full time wearer  Occasional wearers | 79  89 | 39.3  44.3 |
| Non wearer | 33 | 16.4 |
| **Distance from TV Screen** |  |  |
| ≤2 meters | 92 | 45.8 |
| >2 meters | 109 | 54.2 |
| **Mobile/tablet/computer Use** |  |  |
| No | 130 | 64.7 |
| Yes | 71 | 35.3 |

***Table 1: Participants background characteristics (N=201) (continued)***

|  |  |  |
| --- | --- | --- |
| **Variable** | **Frequency** | **Percentage** |
| **Hours near work** |  |  |
| ≤ 2 hour a day | 121 | 60.2 |
| > 2 hours a day | 80 | 39.8 |
| **Hours outdoor** |  |  |
| < 1 hour a day | 158 | 78.6 |
| > 1 hour a day | 43 | 21.4 |
| **Degree of Myopia** |  |  |
| Low | 131 | 65.2 |
| Moderate | 27 | 13.4 |
| High | 43 | 21.4 |
| **Family History** |  |  |
| No  Sibling wearing spectacles for distant vision  Parent waersing spectacles for distant vision | 100  50  41 | 49.7  24.9  20.4 |
| Yes (Either parent or sibling wearing spectacles) | 10 | 5 |

**Factors associated with myopia progression:**

Out of 201 participants, 127 (63.2%) experienced myopia progression. In the unadjusted analysis **(Table 2)**, several factors were significantly associated with progression. Male participants (49/89; 55.1%) had a lower progression rate compared to females (78/112; 69.6%) (PR = 0.79, 95% CI: 0.63–0.98, p = 0.04). Non-spectacle wearers (27/33; 81.8%) had a higher rate of progression than wearers (100/168; 59.5%) (PR = 1.37, 95% CI: 1.12–1.69, p = 0.002). Children who watched TV from a distance of ≤2 meters (74/92; 80.4%) were significantly more likely to progress compared to those who viewed from >2 meters (53/109; 48.6%) (PR = 1.65, 95% CI: 1.33–2.06, p < 0.001).

Mobile device users (57/71; 80.3%) showed a higher progression rate compared to non-users (70/130; 53.8%) (PR = 1.49, 95% CI: 1.22–1.82, p < 0.001). Those engaging in more than two hours of near work daily (68/80; 85%) had a significantly higher progression rate than those with ≤2 hours of near work (59/121; 48.8%) (PR = 1.74, 95% CI: 1.42–2.14, p < 0.001). Children who spent less than one hour outdoors per day (108/158; 68.4%) also had higher progression compared to those spending more than an hour outdoors (19/43; 44.2%) (PR = 0.65, 95% CI: 0.45–0.92, p = 0.015). A positive family history (82/101; 81.2%) was also strongly associated with progression compared to those with no history (45/100; 45%) (PR = 1.80, 95% CI: 1.42–2.29, p < 0.001).

Variables with a p-value <0.1 were entered into a stepwise multivariable regression model, with age and sex retained in the model by design. In the adjusted analysis **(Table 3)**, four variables remained significantly associated with myopia progression. Children aged over 13 years were significantly less likely to progress compared to those aged ≤9 years (PR = 0.64, 95% CI: 0.43–0.96, p = 0.03). Viewing TV at a distance of ≤2 meters remained a risk factor (PR = 1.31, 95% CI: 1.07–1.62, p = 0.01), as did performing more than two hours of near work per day (PR = 1.55, 95% CI: 1.23–1.94, p < 0.001). A positive family history continued to show a strong association (PR = 1.53, 95% CI: 1.23–1.91, p < 0.001).

Sex, outdoor time, and age 10–13 years were not significantly associated in the adjusted model. The final model showed no multicollinearity (VIF = 1.96).

**Table 2:** Distribution of Myopia progression and its associated factors in unadjusted/crude analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Progression of Myopia,** (N=127) | **Unadjusted** | **P-value** |
|  | **n(%)** | **PR(95%CI)** |  |
|  |  |  |  |
| **Age of the participant in Years** |  |  |  |
| ≤9 | 14(58.3) | 1.00 |  |
| 10-13 | 64(73.6) | 1.26(0.88-1.81) | 0.209 |
| >13 | 49(54.4) | 0.93(0.63-1.38) | 0.728 |
| **Sex of the participant** |  |  |  |
| Female | 78(69.6) | 1.00 |  |
| Male | 49(55.1) | 0.79(0.63-0.98) | 0.04 |
| **Spectacle wearing pattern** |  |  |  |
| Wearer | 100(59.5) | 1.00 |  |
| Non wearer | 27(81.8) | 1.37(1.12-1.69) | 0.002 |
| **Distance from TV Screen** |  |  |  |
| ≤2 | 74(80.4) | 1.65(1.33-2.06) | <0.001 |
| >2 | 53(48.6) | 1.00 |  |
| **Mobile Use** |  |  |  |
| No | 70(53.8) | 1.00 |  |
| Yes | 57(80.3) | 1.49(1.22-1.82) | <0.001 |
| **Hours near work in a day** |  |  |  |
| ≤ 2 hour a day | 59(48.8) | 1.00 |  |
| > 2 hours a day | 68(85) | 1.74(1.42-2.14) | <0.001 |
| **Hours outdoor in a day** |  |  |  |
| < 1 hour a day | 108(68.4) | 1.00 |  |
| > 1 hour a day | 19(44.2) | 0.65(0.45-0.92) | 0.015 |
| **Degree of Myopia** |  |  |  |
| Low | 26(60.5) | 1.00 |  |
| Moderate | 83(63.4) | 1.05(0.78-1.42) | 0.737 |
| High | 18(66.7) | 0.95(0.72-1.25) | 0.739 |
| **Family History** |  |  |  |
| No history | 45(45) | 1.00 |  |
| Yes (Either parent or sibling wearing spectacles) | 82(81.2) | 1.80(1.42-2.29) | <0.001 |

**Table 3**: Adjusted analysis for factors associated with Myopia progression

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Adjusted PR** | **95%CI** | **P-value** |
| **Age of the participant in Years** |  |  |  |
| ≤9 | 1.00 |  |  |
| 10-13 | 0.79 | 0.54-1.14 | 0.215 |
| >13 | 0.64 | 0.43-0.96 | 0.03 |
| **Sex of the participant** |  |  |  |
| Female | 1.00 |  |  |
| Male | 0.91 | 0.74-1.13 | 0.394 |
| **Distance from TV Screen** |  |  |  |
| ≤2 | 1.31 | 1.07-1.62 | 0.01 |
| >2 | 1.00 |  |  |
| **Hours near work in a day** |  |  |  |
| ≤ 2 hour a day |  |  |  |
| > 2 hours a day | 1.55 | 1.23-1.94 | <0.001 |
| **Hours outdoor in a day** |  |  |  |
| < 1 hour a day | 1.00 |  |  |
| > 1 hour a day | 0.75 | 0.52-1.07 | 0.111 |
| **Family History** |  |  |  |
| No history | 1.00 |  |  |
| Yes (Either parent or sibling wearing spectacles) | 1.53 | 1.23-1.91 | <0.001 |

**DISCUSSION**

This study evaluated the proportion and associated factors of myopia progression among pediatric patients attending the Kilimanjaro Christian Medical Centre (KCMC) in Northern Tanzania. The results of the study revealed that the proportion of myopia progression was 63%. The analysis revealed that children who engaged in prolonged near work, had a positive family history of myopia, viewed television screens at less than 2 meters, or were younger than 9 years in age were significantly more likely to experience progression. Although other variables such as spectacle wear, sex, and mobile device use were not retained in the adjusted model, their significance in unadjusted analyses suggests they may still play a contributory role in specific subgroups.

A relatively high proportion (63.2%) of participants experienced myopia progression, aligning with findings from other regions, including Ghana (56.8%), the United Kingdom (62%), and Ireland (53%) (Wong and Dahlmann-Noor, 2020; Kyei *et al.*, 2024; Moore *et al.*, 2024).This relatively high proportion may be attributed to high urban residency (72.6%) and low engagement in outdoor activities, with 78.6% of participants reporting less than one hour outdoors daily conditions known to contribute to myopia progression. (Shih *et al.*, 2010; Lee *et al.*, 2015; Nouraeinejad, 2022). The findings suggest a growing burden of myopia in both high income and low resource settings.

In the adjusted analysis, age remained a significant predictor of myopia progression. Children older than 13 years were found to be 36% less likely to experience progression compared to those aged 9 years and below (p = 0.03). This trend may reflect underlying differences in the etiology and natural history of myopia development across age groups. It has been suggested that myopia arising in early childhood may represent a more genetically driven and aggressive subtype, with a higher likelihood of progressing to high myopia. In contrast, older children may already be approaching the plateau phase of refractive change, where ocular growth slows and myopia stabilizes (Hyman *et al.*, 2005). A similar pattern was observed by (Kumar *et al.*, 2020) and (Wang *et al.*, 2021), who reported reduced progression rates among older children reinforcing the notion that early onset myopia tends to follow a more aggressive course.

Although sex was not significantly associated with progression in the adjusted analysis, unadjusted results showed that males had a significantly lower prevalence of progression compared to females (p=0.04). This finding is consistent with studies conducted in France and Ireland (Tricard *et al.*, 2022; Moore *et al.*, 2024) and may be attributed to sex related behavioral and biological differences. Females may engage in less outdoor activity and experience earlier hormonal changes that influence scleral remodeling and axial elongation via increased levels of estrogen and matrix metalloproteinase activity (Marin-Castaño *et al.*, 2003).

Spectacle wearing patterns were significantly associated with myopia progression in the unadjusted analysis. Non-wearers were 37% more likely to experience progression compared to wearers (p=0.002). Previous studies from Malaysia and Ghana (Allen *et al.*, 2013; Koomson *et al.*, 2016) support the protective effect of full-time spectacle wear, likely due to correction of hyperopic defocus and reduction of accommodative strain. In this study, 84% of non-spectacle wearers belonged to the low myopia group. This group may underestimate the need for correction, potentially increasing the risk of progression due to uncorrected refractive error.

Mobile device use was significantly associated with myopia progression in the unadjusted model. Children who used mobile devices were 49% more likely to experience progression than non-users (p<0.001), consistent with previous studies linking screen exposure to accommodative stress and hyperopic defocus (Koomson *et al.*, 2016; Yao *et al.*, 2019; Huang *et al.*, 2020). Although mobile use did not remain significant in the adjusted model, it may serve as a surrogate marker for prolonged near work and reduced time spent outdoors both established risk factors for progression(Thibos *et al.*, 2013; Saxena *et al.*, 2017).

Viewing television at a distance of two meters or less was associated with a 31% higher prevalence of progression and remained significant in both unadjusted (p<0.001) and adjusted(p=0.001) models. With similar findings seen in studies done in India (Saxena *et al.*, 2017). Closer viewing distances increase accommodative demand and may result in sustained hyperopic retinal defocus, which promotes axial elongation (Liu *et al.*, 2021).

Engaging in near work for more than two hours per day after school hours was strongly associated with myopia progression in both crude (p <0.001) and adjusted analyses (p<0.001). This is consistent with global literature that identifies prolonged near work as a major contributor to increased accommodative demand and associated ocular growth (Thibos *et al.*, 2013; Saxena *et al.*, 2017).These findings underscore the importance of limiting extended near tasks, particularly in urban school-aged populations.

Family history of myopia defined in this study as having at least one parent or sibling who wears spectacles for distance vision was another strong and independent predictor of myopia progression. This supports the well documented role of genetic predisposition in myopia development and highlights the importance of early screening and monitoring among children with a positive family history (Liang *et al.*, 2004; Liao *et al.*, 2019).

Although spending more than one hour outdoors per day appeared protective in unadjusted analysis (P=0.015), this association was not statistically significant in the adjusted model. This may be due to the limited variability in outdoor exposure among participants. A large majority (78.6%) reported spending less than one hour outdoors per day likely below the threshold required to confer a significant protective effect, as suggested in other studies (Bron, Paterson and Cunha-Vaz, 2004; Lee *et al.*, 2015; Saxena *et al.*, 2017). Moreover, **outdoor time may serve as an indirect measure of other protective behaviors** particularly reduced near work. Children who spend more time outdoors are less likely to be engaged in prolonged reading, writing (Wu *et al.*, 2013). Therefore, the inclusion of near work as a separate covariate in the regression model may have accounted for much of the effect initially attributed to outdoor exposure.

In this study no association was found between myopia progression and the degree of myopia. Typically, higher degrees of myopia are associated with progression due to increased scleral thinning and axial elongation (Kumah *et al.*, 2013).However, in this study, a high proportion of non-spectacle wearers (84%) belonged to the low myopia group, whereas moderate and high myopia groups had greater spectacle compliance. Given that full-time spectacle wear has a protective effect against progression (J. Bao et al, 2015; Wen *et al.*, 2020), this difference in spectacle use may explain the similar progression rates across all severity groups

Parental education was moderately high, with 52.2% of mothers having completed secondary education and 50.7% of fathers attaining college level or higher education. These figures represent an improvement compared to earlier Tanzanian data, where only 37% of mothers and 27% of fathers had achieved similar education levels (Wedner *et al.*, 2002). A similar trend has been reported in Kenya (Okenwa-Vincent, Naidoo and Clarke-Farr, 2022). Higher parental education may create more academically intensive home environments, potentially increasing time spent on near work a known risk factor for myopia progression (Gwiazda *et al.*, 2011).

The prevalence of screen exposure was also high, with all participants reporting access to a television and 45.8% viewing it from less than two meters away. Additionally, 35.3% of children owned mobile phones, tablets, or computers. These rates far exceed those reported in earlier Tanzanian studies (Wedner *et al.*, 2002), where 67% had access to television and only 9.7% to computers. This rising trend in digital screen use underscores the need for targeted education on healthy visual habits. **Parental awareness, in particular, is essential, as many may be unfamiliar with simple strategies that can help delay the onset and slow the progression of myopia** (Wang *et al.*, 2021; Muley, 2022)

**Conclusion**

This study highlights a substantial burden of myopia progression among children attending the KCMC Pediatric Eye Clinic, with nearly two thirds of participants showing myopia progression. Independent predictors of progression included younger age, prolonged near work, close television viewing distance, and a positive family history of myopia. Although other factors such as spectacle non wear and mobile device use were significant in unadjusted models, they did not retain significance after adjustment suggesting potential confounding or indirect associations through related behaviors such as near work or reduced outdoor activity.

**Recommendations**  
Educational initiatives should target caregivers to improve awareness of modifiable risk factors. School-based policies could be particularly effective, including structured limits on screen time during school hours, increased outdoor activities, and educational programs for both parents and children about healthy visual behaviors. Consistent spectacle wear should be encouraged. Clinicians should explore evidence based interventions such as low dose atropine and myopia control lenses. Policymakers are urged to support school screening programs and access to affordable eye care. Further largescale community studies are needed to support region specific strategies.

**Strengths and Limitations**

This study provides valuable data on the rate and determinants of myopia progression among children attending KCMC, serving as a foundation for future interventions. The use of objective rather than subjective refraction methods enhanced the accuracy and reliability of measurements. Several strategies were employed to minimize bias: recall bias was reduced through the use of short recall periods, a structured and pretested questionnaire, parental or caregiver verification of responses, and face to face interviews; non-response bias was mitigated by including participants who had previously visited the hospital and were therefore more likely to return. Nonetheless, the cross sectional design and single-center setting may limit the generalizability of the findings.

**Ethical Approval and Consent:**

Ethical approval was obtained from the Kilimanjaro Christian Medical University College Research and Ethics Review Committee (KCMU-CRERC), reference number PG 82/2023. Confidentiality of participant names and personal hospital information was strictly maintained. Participants identified as needing further medical evaluation were referred for appropriate management. Written informed consent (or assent, where applicable) was obtained from all participants or their guardians.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFERENCES:**

Allen, P.M. *et al.* (2013) ‘A randomised clinical trial to assess the effect of a dual treatment on myopia progression: The Cambridge Anti-Myopia Study’, *Ophthalmic and Physiological Optics*, 33(3), pp. 267–276. Available at: https://doi.org/10.1111/opo.12035.

Bron, A.J., Paterson, C. and Cunha-Vaz, J. (2004) ‘Experimental Eye Research: Editorial’, *Experimental Eye Research*, 78(3), pp. 1–11. Available at: https://doi.org/10.1016/j.exer.2003.11.002.

Cooper, J. and Tkatchenko, A. V (2018) ‘A Review of Current Concepts of the Etiology and Treatment of Myopia’, 44(4). Available at: https://doi.org/10.1097/ICL.0000000000000499.

Flitcroft, D.I. *et al.* (2019) ‘IMI – Defining and classifying myopia: A proposed set of standards for clinical and epidemiologic studies’, *Investigative Ophthalmology and Visual Science*, 60(3), pp. M20–M30. Available at: https://doi.org/10.1167/iovs.18-25957.

Fricke, T.R. and Flanagan, J. (2019) ‘Myopia : a growing epidemic’, (January), pp. 27–28.

Graddipneurosci, K.A.R. (2018) ‘C L I N I C A L A N D E X P E R I M E N TA L Myopia : is the nature-nurture debate fi nally over ?’, pp. 1–15. Available at: https://doi.org/10.1111/cxo.12845.

Grzybowski, A. *et al.* (2020) ‘全球。儿童。近视发病率。’, *BMC ophthalmology*, 20(1), p. 27. Available at: https://doi.org/10.1186/s12886-019-1220-0%0AREVIEW.

Gwiazda, J. *et al.* (2011) ‘Association of education and occupation with myopia in COMET parents’, *Optometry and Vision Science*, 88(9), pp. 1045–1053. Available at: https://doi.org/10.1097/OPX.0b013e31822171ad.

Holden, B.A. *et al.* (2016) ‘Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050’, *Ophthalmology*, 123(5), pp. 1036–1042. Available at: https://doi.org/10.1016/j.ophtha.2016.01.006.

Hsu, C.C. *et al.* (2016) ‘Prevalence and risk factors for myopia in second-grade primary school children in Taipei: A population-based study’, *Journal of the Chinese Medical Association*, 79(11), pp. 625–632. Available at: https://doi.org/10.1016/j.jcma.2016.02.011.

Hsu, C.C. *et al.* (2017) ‘Risk factors for myopia progression in second-grade primary school children in Taipei: A population-based cohort study’, *British Journal of Ophthalmology*, 101(12), pp. 1611–1617. Available at: https://doi.org/10.1136/bjophthalmol-2016-309299.

Huang, P.C. *et al.* (2020) ‘Protective behaviours of near work and time outdoors in myopia prevalence and progression in myopic children: A 2-year prospective population study’, *British Journal of Ophthalmology*, 104(7), pp. 956–961. Available at: https://doi.org/10.1136/bjophthalmol-2019-314101.

Hyman, L. *et al.* (2005) ‘Relationship of Age, Sex, and Ethnicity With Myopia Progression and Axial Elongation in the Correction of Myopia Evaluation Trial’, 123(July).

Ip, J.M. *et al.* (2008) ‘Role of near work in myopia: Findings in a sample of Australian school children’, *Investigative Ophthalmology and Visual Science*, 49(7), pp. 2903–2910. Available at: https://doi.org/10.1167/iovs.07-0804.

J. Bao et al (2015) ‘Influence of Near Tasks on Posture in Myopic’, 92(8), pp. 908–915.

Jones-Jordan, L.A. *et al.* (2012) ‘Time outdoors, visual activity, and myopia progression in juvenile-onset myopes’, *Investigative Ophthalmology and Visual Science*, 53(11), pp. 7169–7175. Available at: https://doi.org/10.1167/iovs.11-8336.

Kobia-Acquah, E. *et al.* (2022) ‘Regional variations and temporal trends of childhood myopia prevalence in Africa: A systematic review and meta-analysis’, *Ophthalmic and Physiological Optics*, 42(6), pp. 1232–1252. Available at: https://doi.org/10.1111/opo.13035.

Koomson, N.Y. *et al.* (2016) ‘Relationship between reduced accommodative lag and myopia progression’, *Optometry and Vision Science*, 93(7), pp. 683–691. Available at: https://doi.org/10.1097/OPX.0000000000000867.

Kumah, B.D. *et al.* (2013) ‘Optometry and Vision Science Volume 90 issue 12 2013 [doi 10.1097\_OPX.0000000000000099] Kumah, Ben D.; Ebri, Anne; Abdul-Kabir, Mohammed; Ahmed, Abdul-S -- Refractive Error and Visual Impairment in .pdf’, 90(12), pp. 1456–1461.

Kumar, P. *et al.* (2020) ‘Myopia progression varies with age and severity of myopia’, pp. 1–9. Available at: https://doi.org/10.1371/journal.pone.0241759.

Kyei, S. *et al.* (2024) ‘Dynamics of Myopia Progression in Ghana—Evidence From Clinical Practice: A Retrospective Cohort Study’, *Health Science Reports*, 7(12), pp. 1–10. Available at: https://doi.org/10.1002/hsr2.70273.

Lee, Y.Y. *et al.* (2015) ‘Risk factors for and progression of myopia in young Taiwanese men’, *Ophthalmic Epidemiology*, 22(1), pp. 66–73. Available at: https://doi.org/10.3109/09286586.2014.988874.

Liang, C.L. *et al.* (2004) ‘Impact of family history of high myopia on level and onset of myopia’, *Investigative Ophthalmology and Visual Science*, 45(10), pp. 3446–3452. Available at: https://doi.org/10.1167/iovs.03-1058.

Liao, C. *et al.* (2019) ‘Role of Parental Refractive Status in Myopia Progression : 12-Year Annual Observation From the Guangzhou Twin Eye Study’.

Liu, J. *et al.* (2021) ‘Adolescent Vision Health During the Outbreak of COVID-19 : Association Between Digital Screen Use and Myopia Progression’, 9(May), pp. 1–7. Available at: https://doi.org/10.3389/fped.2021.662984.

Marin-Castaño, M.E. *et al.* (2003) ‘Regulation of estrogen receptors and MMP-2 expression by estrogens in human retinal pigment epithelium’, *Investigative Ophthalmology and Visual Science*, 44(1), pp. 50–59. Available at: https://doi.org/10.1167/iovs.01-1276.

Moore, M. *et al.* (2024) ‘Myopia progression patterns among paediatric patients in a clinical setting’, *Ophthalmic and Physiological Optics*, 44(2), pp. 258–269. Available at: https://doi.org/10.1111/opo.13259.

Muley, S. (2022) ‘Awareness of Myopia Amongst Parents of School Going Children in a Survey Done in a Tertiary Care Centre in Vidarbha Region’, 6(March), pp. 455–460.

Nouraeinejad, A. (2022) ‘Urbanization as a factor for myopia progression’, *Klinika Oczna*, 124(2), pp. 124–125. Available at: https://doi.org/10.5114/ko.2022.116834.

Okenwa-Vincent, E.E., Naidoo, J. and Clarke-Farr, P. (2022) ‘Factors associated with uncorrected refractive errors in school-going adolescents in Kakamega County, Kenya’, *Ophthalmology Journal*, 7(0), pp. 152–162. Available at: https://doi.org/10.5603/oj.2022.0021.

Saxena, R. *et al.* (2017) ‘Incidence and progression of myopia and associated factors in urban school children in Delhi : The North India Myopia Study ( NIM Study )’, pp. 1–12.

Shih, Y.F. *et al.* (2010) ‘Comparing myopic progression of urban and rural Taiwanese schoolchildren’, *Japanese Journal of Ophthalmology*, 54(5), pp. 446–451. Available at: https://doi.org/10.1007/s10384-010-0860-7.

Sinshaw, A. *et al.* (2021) ‘Prevalence and associated factors of myopia among school children in Bahir Dar city ’, 51, pp. 14–18. Available at: https://doi.org/10.1371/journal.pone.0248936.

Thibos, L.N. *et al.* (2013) ‘Spherical aberration and the sign of defocus’, *Optometry and Vision Science*, 90(11), pp. 1284–1291. Available at: https://doi.org/10.1097/OPX.0000000000000040.

Tricard, D. *et al.* (2022) ‘Progression of myopia in children and teenagers : a nationwide longitudinal study’, pp. 1104–1109. Available at: https://doi.org/10.1136/bjophthalmol-2020-318256.

Wang, J. *et al.* (2021) ‘Progression of Myopia in School-Aged Children after COVID-19 Home Confinement’, *JAMA Ophthalmology*, 139(3), pp. 293–300. Available at: https://doi.org/10.1001/jamaophthalmol.2020.6239.

Wedner, S.H. *et al.* (2002) ‘Myopia in secondary school students in Mwanza City, Tanzania: The need for a national screening programme’, *British Journal of Ophthalmology*, 86(11), pp. 1200–1206. Available at: https://doi.org/10.1136/bjo.86.11.1200.

Wen, L. *et al.* (2020) ‘Objectively measured near work, outdoor exposure and myopia in children’, *British Journal of Ophthalmology*, 104(11), pp. 1542–1547. Available at: https://doi.org/10.1136/bjophthalmol-2019-315258.

Wicaksana, A. and Rachman, T. (2018) *済無No Title No Title No Title*, *Angewandte Chemie International Edition, 6(11), 951–952.* Available at: https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf.

Wong, K. and Dahlmann-Noor, A. (2020) ‘Myopia and its progression in children in London, UK: a retrospective evaluation’, *Journal of Optometry*, 13(3), pp. 146–154. Available at: https://doi.org/10.1016/j.optom.2019.06.002.

Wong, T.Y. *et al.* (2014) ‘Epidemiology and Disease Burden of Pathologic Myopia and Myopic Choroidal Neovascularization: An Evidence-Based Systematic Review’, *American Journal of Ophthalmology*, 157(1), p. 9–25.e12. Available at: https://doi.org/10.1016/j.ajo.2013.08.010.

Wu, P.C. *et al.* (2013) ‘Outdoor activity during class recess reduces myopia onset and progression in school children’, *Ophthalmology*, 120(5), pp. 1080–1085. Available at: https://doi.org/10.1016/j.ophtha.2012.11.009.

Wu, P.C. *et al.* (2018) ‘Myopia Prevention and Outdoor Light Intensity in a School-Based Cluster Randomized Trial’, *Ophthalmology*, 125(8), pp. 1239–1250. Available at: https://doi.org/10.1016/j.ophtha.2017.12.011.

Yao, L. *et al.* (2019) ‘Refractive change and incidence of myopia among a group of highly selected senior high school students in China: A prospective study in an aviation cadet prerecruitment class’, *Investigative Ophthalmology and Visual Science*, 60(5), pp. 1344–1352. Available at: https://doi.org/10.1167/iovs.17-23506.