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Incidence of Progressive Myopia among Myopic Children and Adolescents in Erbil City

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ABSTRACT: Background and Objectives: We sought to evaluate the rate of progressive myopia alongside the average annual myopia progression among myopic children and adolescents within Erbil, Iraq.

Methods: We carried out this prospective cohort study at North Eye Medical Center in Erbil, Iraq, from May 2025 to May 2026. This study enrolled 122 myopic children between the ages of 5 and 17 years. Visual acuity and refractive error were measured using standardized ophthalmic examinations. An annual spherical equivalent change of ≥ 0.50 D indicated progressive myopia. The data were analyzed using IBM SPSS Statistics version 27.

Results: A total of 122 myopic children and adolescents (mean age: 10.80 ± 3.30 years) were included. The incidence of progressive myopia during the 12-month follow-up was 27.0%. The mean annual myopia progression rate was -0.38 ± 0.36 D/year. Progressive myopia was significantly more frequent in girls than boys (36.9% vs. 15.8%, $P = 0.009$). Younger children (5–12 years) showed significantly greater myopia progression than adolescents (13–17 years) ($P = 0.047$). Children with daily digital device use showed greater myopia progression than those without daily digital device use ($P = 0.002$). Conclusion: Progressive myopia was common among children and adolescents in Erbil. Younger age and daily digital device use were associated with greater myopia progression. Girls had a higher proportion of progressive myopia than boys. These findings emphasize the importance of regular follow-up of children at risk of progressive myopia.

INTRODUCTION:

Nearsightedness, or myopia, is the primary refractive error, and a major cause of vision impairment in young populations^{1,2}. It currently affects about 23% of the world's population, and this proportion is expected to increase to nearly 50% by 2050². Typically, progressive myopia involves a yearly spherical equivalent shift of at least 0.50 D³. Axial elongation in myopia increases the likelihood of developing severe, sight-threatening ocular pathologies^{1,2,4}. Globally, surging myopia rates have created a significant public health challenge^{1,5}. Myopia develops due to both genetic and environmental factors^{1,6}. Extended screen use and time are closely associated with the growing rates of childhood myopia^{7,8}. Uncorrected myopia remains a major public health concern because it can reduce visual function and affect children's academic performance, daily activities, social participation and overall quality of life⁹⁻¹¹. Over the past ten years, research has prioritized minimizing axial elongation and myopic progression to preserve long-term vision, as myopia heavily predisposes individuals to severe pathologies like glaucoma, cataracts, retinal detachment, and myopic maculopathy^{2,4,11}. The annual global economic burden of uncorrected refractive errors is estimated at US\$202 billion in lost gross domestic product¹². Visual impairment and its related psychological strain can

diminish the overall well-being of myopic patients^{10, 11}. Several pharmacological, optical and environmental interventions are available to slow myopia progression^{12, 13}. Good treatment adherence is important for their effectiveness¹⁴. Therefore, understanding the causes of myopia and taking early preventive measures can help to reduce myopia progression and long-term consequences^{6, 12}. Information on the incidence of progressive myopia in Erbil is limited. Therefore, we investigated the 12-month incidence of progressive myopia alongside annual progression rates among myopic pediatric and adolescent cohorts in Erbil, Iraq.

METHODOLOGY:

From May 2025 to May 2026, we conducted this prospective cohort study at Erbil's North Eye Medical Center. Based on a single population proportion formula with an expected incidence of 5%, a 5% margin of error, and a 95% confidence level, the minimum required sample size was 73 participants. We enrolled 122 eligible myopic children (5-12 years) and adolescents (13-17 years). All enrolled participants who completed the 12-month follow-up monitoring period were included in the final data analysis. Inclusion criteria were spherical equivalent of ≤ -0.5 D in both eyes, best-corrected visual acuity (BCVA) of 20/25 (0.10 LogMAR) or better, plus a documented refraction record within the prior 12 months. Participants with ocular abnormalities, systemic conditions affecting ocular growth or visual development, previous or current myopia-control treatment, or a myopia-corrective surgery were excluded.

This study followed the Declaration of Helsinki and was approved by the Kurdistan Board of Medical Specialties Research Ethics Committee (Approval No. 1630, 18/5/2025). Parents or guardians completed a structured survey that captured age, sex, ocular and medical history profiles, past refractive corrections, and daily digital screen time (smartphone or iPad usage lasting ≥ 2 hours/day). All subjects had an extensive ocular evaluation at the initial assessment and after 12 months. For the right eye (OD), UCVA and BCVA were measured using a standardized logMAR chart at 4 meters. A Topcon KR-800 autorefractor-keratometer (Topcon Corp., Tokyo, Japan) was utilized for cycloplegic autorefraction and keratometry. Following the administration of two drops of 1% Cyclopentolate spaced 5 minutes apart, three distinct measurements were collected and averaged 30 minutes after the last drop. Spherical equivalent refraction was calculated as: $SER = Sphere + \frac{Cylinder}{2}$ where Sphere represents the spherical power. Cylinder represents the cylindrical power obtained from averaged cycloplegic autorefraction readings. To minimize measurement bias, all examinations were performed by the same ophthalmologist. To avoid inter-eye correlation, only the right eye (OD) data were analyzed prior to study commencement. An annual refractive shift of ≥ 0.50 D characterized progressive myopia. Primary outcomes were the incidence of progressive myopia and the annual spherical equivalent variation. Secondary outcomes compared gender, digital device exposure, and specific age cohorts (5-12 years or 13-17 years). Data analysis was performed via IBM SPSS Statistics version 27. Participant demographic traits were synthesized through descriptive statistics, incorporating frequency, percentages, mean, and standard deviation values. To address non-normally distributed data, correlations between myopic progression rates and the categorical traits sex, age cohort, and digital screen exposure were computed using the Chi-square and Mann-Whitney U metrics. A two-tailed p-values of ≤ 0.05 determined statistical significance.

RESULTS:

Data from 122 pediatric and adolescent myopic patients were evaluated. The cohort included 65 girls (53.3%) and 57 boys (46.7%) spanning ages 5–17 years (mean: 10.80 ± 3.30 years), with an initial mean spherical equivalent of -3.01 ± 1.38 D. Following 12 months of observation, 33 participants (27.0%) developed progressive myopia, defined by a shift ≥ 0.50 D. Stable refraction was maintained in 73.0% ($n = 89$) of the sample (Figure 1).

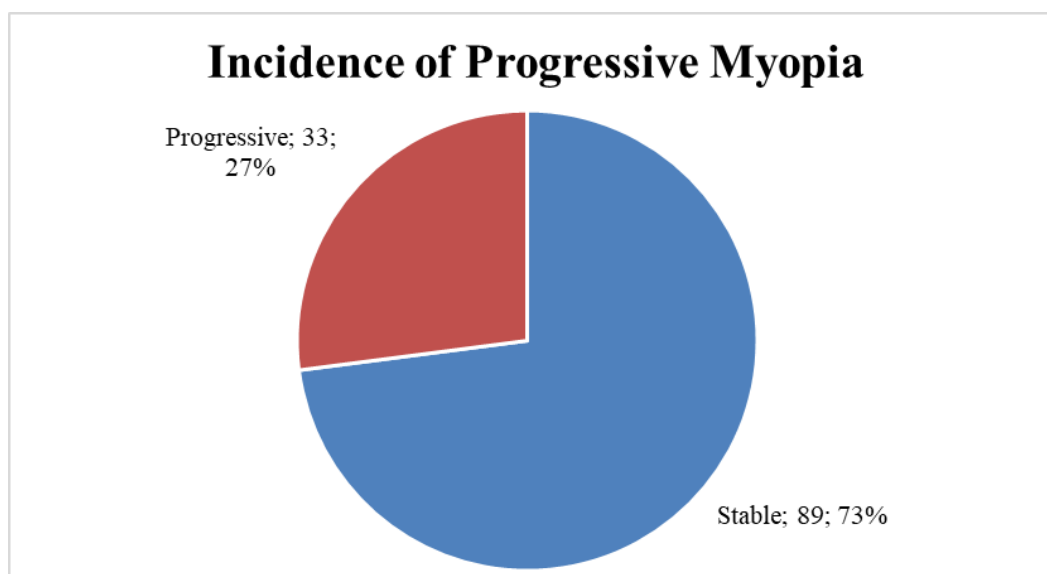


Figure 1. Incidence of progressive myopia among myopic children and adolescents (N = 122). Across the entire cohort, the mean variation in spherical equivalent (SE) was -0.38 ± 0.36 D, exhibiting a median shift of -0.25 D (interquartile range [IQR]: -0.38 to 0.00). The distribution was negatively skewed (skewness = -1.37), indicating that while most participants experienced minimal progression, a subset demonstrated substantial myopic shifts ranging up to -1.63 D. The median SE change was identical for both sexes at -0.25 D (Table 1). However, girls demonstrated a wider range of progression, with a more negative minimum SE change (-1.63 D) compared with boys (-1.25 D), and higher mean annual myopia progression (-0.46 ± 0.43 D vs. -0.29 ± 0.23 D, respectively). The Mann-Whitney U test revealed no statistically significant difference in annual myopia progression between boys and girls ($U = 1570.50$, $p = 0.128$). However, when comparing the proportion of progressors using the chi-square test, a significant difference emerged. Among girls, 36.9% ($24/65$) were classified as progressive compared to only 15.8% ($9/57$) among boys ($\chi^2 = 6.874$, $p = 0.009$; Fisher's exact test $p = 0.014$). This suggests that while the magnitude of progression among those who progressed did not differ significantly between sexes, girls had a higher proportion of progressive myopia in this cohort.

Table 1. Myopia Progression by Gender

Variable	Boys (n = 57)	Girls (n = 65)	Test Statistic	p-value
SE Change (mean $\pm$ SD)	-0.29 ± 0.23 D	-0.46 ± 0.43 D		
SE Change (median, IQR)	-0.25 (-0.25 , -0.25)	-0.25 (-0.50 , -0.13)	$U = 1570.50^\dagger$	0.128
Range of SE Change	-1.25 to 0.00	-1.63 to 0.00		
Progressive cases, n (%)	9 (15.8%)	24 (36.9%)	$\chi^2 = 6.874^*$	0.009
Annual progression (mean $\pm$ SD)	-0.29 ± 0.23 D/yr	-0.46 ± 0.43 D/yr		

* $\dagger$ Mann-Whitney U test used for comparison of median SE change; Pearson chi-square test used for comparison of proportions

Younger children (5-12 years) exhibited significantly greater myopia progression compared to adolescents (13-17 years). The median SE change was -0.25 D in both groups; however, the younger group showed a wider range of progression (minimum: -1.63 D) and a higher mean annual myopia progression (-0.44 ± 0.40 D vs. -0.27 ± 0.23 D for adolescents) (Table 2). The Mann-Whitney U test demonstrated a statistically significant difference in annual myopia progression between the two age groups ($U = 1312.50$, $p = 0.047$). The proportion of progressors was also significantly higher in the younger age group: 33.3% ($27/81$) of children aged 5-12 years progressed compared to only 14.6% ($6/41$) of adolescents aged 13-17 years ($\chi^2 = 4.824$, $p = 0.028$; Fisher's exact test $p = 0.032$).

Table 2. Myopia Progression by Age Group

Variable	5-12 years (n = 81)	13-17 years (n = 41)	Test Statistic	p-value
SE Change (mean $\pm$ SD)	-0.44 $\pm$ 0.40 D	-0.27 $\pm$ 0.23 D		
SE Change (median, IQR)	-0.25 (-0.50, -0.13)	-0.25 (-0.25, -0.25)	U = 1312.50†	0.047
Range of SE Change	-1.63 to 0.00	-1.00 to 0.00		
Progressive cases, n (%)	27 (33.3%)	6 (14.6%)	$\chi^2 = 4.824^*$	0.028
Annual progression (mean $\pm$ SD)	-0.44 $\pm$ 0.40 D/yr	-0.27 $\pm$ 0.23 D/yr		

*† Mann-Whitney U test used for comparison of median SE change; Pearson chi-square test for comparison of proportions

Table 3 compares myopia progression between children with and without daily digital device use. Children with daily digital device use demonstrated significantly greater myopia progression than those without daily digital device use. The median SE change was -0.25 D (IQR: -0.50 to -0.25) among children with daily digital device use compared to -0.25 D (IQR: -0.25 to -0.13) among those without daily digital device use (Mann-Whitney U = 1208.50, p = 0.002). Although the medians were identical, the wider interquartile range among children with daily digital device use (-0.50 to -0.25) compared with those without daily digital device use (-0.25 to -0.13) indicates greater variability and a shift toward more severe progression in the daily digital device use group. The mean SE change was -0.49 $\pm$ 0.38 D among digital device users versus -0.31 $\pm$ 0.34 D among those without daily digital device use, further supporting the greater magnitude of progression in the daily digital device use group.

The proportion of progressors was significantly higher among children who utilized digital devices daily, with 39.1% (18/46) identified as progressive, in contrast to merely 19.7% (15/76) in non-users ($\chi^2 = 5.462$, p = 0.019; Fisher's exact test p = 0.022). This nearly two-fold difference in the proportion of progressors, combined with faster annual myopia progression and wider variability, highlights the strong association between daily digital device use and faster myopia progression in children and adolescents.

Table 3. Myopia Progression by Daily Digital Device Use

Variable	Daily Digital Device Use (n = 46)	No Daily Digital Device Use (n = 76)	Test Statistic	p-value
SE Change (mean $\pm$ SD)	-0.49 $\pm$ 0.38 D	-0.31 $\pm$ 0.34 D		
SE Change (median, IQR)	-0.25 (-0.50, -0.25)	-0.25 (-0.25, -0.13)	U = 1208.50†	0.002
Range of SE Change	-1.50 to 0.00	-1.63 to 0.00		
Progressive cases, n (%)	18 (39.1%)	15 (19.7%)	$\chi^2 = 5.462^*$	0.019
Annual progression (mean $\pm$ SD)	-0.49 $\pm$ 0.38 D/yr	-0.31 $\pm$ 0.34 D/yr		

*† Mann-Whitney U test used for comparison of median SE change; *Pearson chi-square test used for comparison of proportions.

The mean annual myopia progression rates across subgroups are presented in Figure 2.

The bars represent the mean annual progression rates, with higher bars indicating faster myopic shift. Error bars illustrate the standard deviation, providing insight into the variability of progression rates within each subgroup. The overall mean progression rate for the entire cohort was -0.38 $\pm$ 0.36 D/year. Girls exhibited a higher annual progression rate (-0.46 $\pm$ 0.43 D/year) compared to boys (-0.29 $\pm$ 0.23 D/year); however, this variation failed to reach statistical significance (p = 0.128). The wider error bars among girls (0.43) compared to boys (0.23) suggest greater individual heterogeneity in progression among females.

Children aged 5-12 years progressed at a mean rate of -0.44 $\pm$ 0.40 D/year, significantly faster than adolescents aged 13-17 years (-0.27 $\pm$ 0.23 D/year; p = 0.047). The narrower error bars in the adolescent group indicate more consistent progression rates among older participants. The most pronounced difference emerged when comparing daily digital device use: children with daily digital device use progressed at nearly double the rate (-0.49 $\pm$ 0.38 D/year) compared with those without daily digital

device use (-0.31 ± 0.34 D/year; $p = 0.002$). Both groups showed moderate variability, although children with daily digital device use demonstrated faster annual myopia progression.

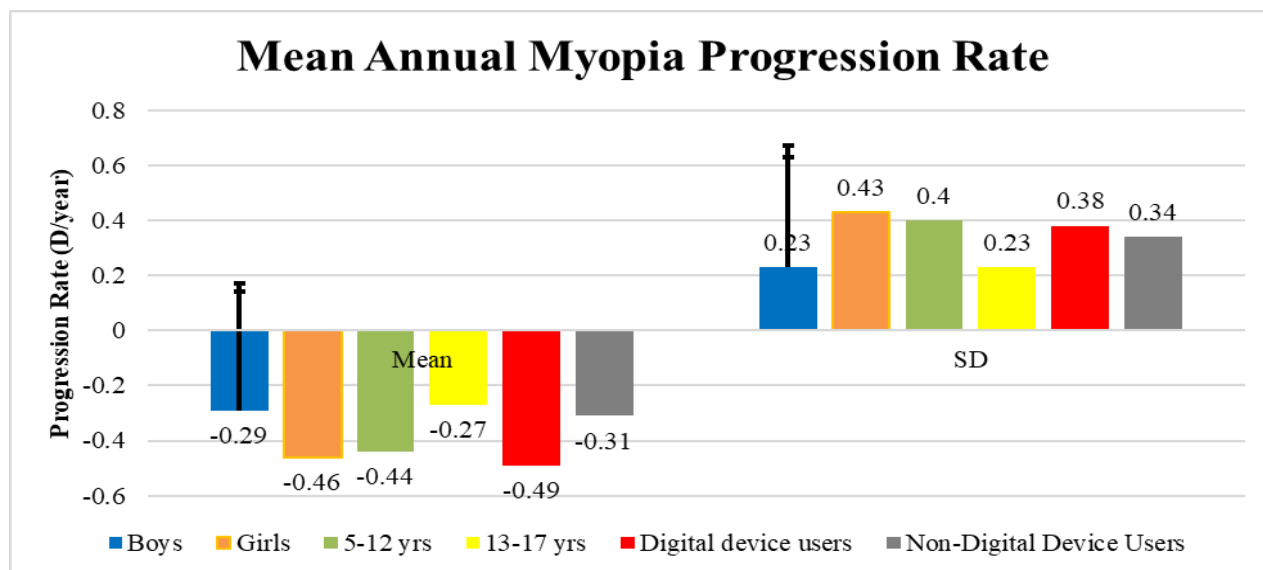


Figure 2. Mean annual myopia progression rates (D/Year)

Error bars represent standard deviation. More negative values indicate myopic progression. Mann-Whitney U test; $N = 122$. The overall mean annual myopia progression for the entire cohort was -0.38 ± 0.36 D/year (mean $\pm$ SD), with a median of -0.25 D/year (IQR: -0.38 to 0.00) (Table 4). Subgroup analyses revealed that the girls progressed faster (-0.46 ± 0.43 D/year) than boys (-0.29 ± 0.23 D/year). Younger children (5-12 years) progressed faster (-0.44 ± 0.40 D/year) than adolescents (-0.27 ± 0.23 D/year). Finally, children with daily digital device use progressed faster (-0.49 ± 0.38 D/year) than those without daily digital device use (-0.31 ± 0.34 D/year). Statistically, the differences reached significance for age group ($p = 0.047$) and daily digital device use ($p = 0.002$), but not for gender ($p = 0.128$).

Table 4. Annual Myopia Progression Rates by Subgroup

Subgroup	Mean $\pm$ SD (D/year)	Median (IQR)	Range	p-value*
Overall (n = 122)	-0.38 ± 0.36	-0.25 (-0.38 to 0.00)	-1.63 to 0.00	
Gender				0.128
Boys (n = 57)	-0.29 ± 0.23	-0.25 (-0.25 to -0.25)	-1.25 to 0.00	
Girls (n = 65)	-0.46 ± 0.43	-0.25 (-0.50 to -0.13)	-1.63 to 0.00	
Age Group				0.047
5-12 years (n = 81)	-0.44 ± 0.40	-0.25 (-0.50 to -0.13)	-1.63 to 0.00	
13-17 years (n = 41)	-0.27 ± 0.23	-0.25 (-0.25 to -0.25)	-1.00 to 0.00	
Daily Digital Device Use				0.002
Users (n = 46)	-0.49 ± 0.38	-0.25 (-0.50 to -0.25)	-1.50 to 0.00	
Non-users (n = 76)	-0.31 ± 0.34	-0.25 (-0.25 to -0.13)	-1.63 to 0.00	

*Mann-Whitney U test for comparison of annual myopia progression between groups.

DISCUSSION:

This prospective cohort study investigated the 12-month incidence of progressive myopia among a pediatric population in Erbil, Iraq. For the purpose of this investigation, a yearly spherical equivalent modification of ≥ 0.50 D served as the definitive threshold for progressive myopia within this cohort. Our longitudinal study revealed that 27% of the cohort experienced progressive myopia. The mean annual progression in our cohort (-0.38 D/year) was comparable to that reported in a previous study, which reported annual progression of myopia of approximately -0.43 to -0.49 D/year among school-aged myopes¹⁵. Importantly, using a cutoff of ≥ 0.50 D/year is a widely accepted standard¹⁶. These findings establish a critical prospective baseline for pediatric refractive shifts in the Kurdistan Region of Iraq.

Although the average annual rate of myopic progression did not vary significantly between sexes ($p = 0.128$), gender was closely linked to overall progression outcomes. Notably, when progression was analyzed categorically using the predefined threshold of ≥ 0.50 D/year, a significantly higher proportion of girls than boys (36.9% vs. 15.8%, $p = 0.009$) met the criterion for progressive myopia. Thus, our finding indicates a difference in the proportion classified as progressive rather than statistically significant difference in the magnitude of annual refractive change between sexes. These findings are consistent with previous longitudinal studies reporting sex-related differences in myopia progression, with girls often showing faster myopia progression rates than boys¹⁷. This difference may be related to earlier female puberty and more device use between sexes, as suggested by previous studies. These findings suggest that closer monitoring of myopic girls may be beneficial.

Age was significantly associated with myopia progression. Younger children progressed significantly faster than adolescents ($p = 0.047$). 33.3% of younger children crossed the ≥ 0.50 D/year threshold compared to only 14.6% of adolescents ($p = 0.028$). This is consistent with global longitudinal studies showing younger age as an important predictor of rapid myopic progression¹⁷. Our findings in younger children were similar to another longitudinal study, which reported the same median progression (-0.25 D/year) up to age 12¹⁸. This may be explained by the greater susceptibility to axial elongation in younger eyes. These outcomes underscore the necessity of timely ophthalmic screening during early childhood.

Digital device use was significantly associated with faster myopia progression. Children using digital devices had a greater mean annual progression than non-users (-0.49 D vs. -0.31 D, $p = 0.002$). Progressive myopia was observed in 39.1% of digital device users compared with 19.7% of non-users ($p = 0.019$). These results correspond with prior prospective longitudinal data establishing that prolonged daily smartphone use predicts a more rapid advancement of myopia in pediatric cohorts¹⁹. Continuous close-up viewing during digital device use may increase the risk of myopia progression¹⁹. These findings support promoting healthy digital device habits among children in Erbil.

This study has important public health implications for the Kurdistan Region of Iraq as one of the first prospective studies of myopia progression in children. Myopia progressed in 27% of participants within one year, highlighting the need for school vision screening and early treatment. Digital device use was significantly associated with faster progression ($p = 0.002$), and younger children were at risk ($p = 0.047$). These findings provide local evidence to support myopia control protocols and help reduce future high myopia and its complications.

This study has three main limitations. The study was performed at a single center, which may limit the generalizability of the findings; the utilization of digital devices depended on parental accounts that could be influenced by recall bias, additionally outdoor activities and parental myopia were not assessed, preventing evaluation of their potential influence on myopia progression. However, our study has strong methodological advantages: analyzing only the right eye avoided inter-eye correlation, and all examinations were performed by the same examiner using the same standardized protocol, ensuring high measurement consistency. Multi-center studies are needed to validate our regional observations.

CONCLUSIONS:

Within Erbil, a moderate yearly incidence of myopic progression was observed across both child and adolescent participants. Greater progression and a higher proportion of progressive cases were observed among younger age and those reporting a daily digital device use. Girls had a higher proportion of progressive myopia than boys, although the differences in annual SE change between sexes was not statistically significant. These findings highlight the importance of early screening and that evidence-based myopia control strategies are essential, further investigation of factors associated with progression in the Kurdistan Region of Iraq.

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Abdulsalam; resources, Didar Sddeg; data curation, Iman Abdulsalam; writing—original draft preparation, Iman Abdulsalam; writing—review and editing, Didar Sddeg; visualization, Iman Abdulsalam; supervision, Didar Sddeg and Ahmed Yahya Hassan. All authors have read and agreed to the published version of the manuscript.

Ethical Statement: Ethical approval was obtained from the Kurdistan Board of Medical Specialties Research Ethics Committee (No. 1630; May 18, 2025) under the Declaration of Helsinki. Written informed consent was obtained before participation.

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Declaration of Generative AI and AI-Assisted Technologies: During the preparation of this work, the authors used ChatGPT for improving readability and phrasing, English grammar and language correction, and rephrasing or restructuring existing author-written content. Following the use of this tool/service, the authors thoroughly reviewed, verified, and edited the content as needed, and accept full responsibility for the academic accuracy and scientific integrity of the final publication.

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Data Availability statement: Data are available upon request.

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