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Temporal Changes in the Severity and Refractive Profile of Pediatric Myopia in a Colombian Ophthalmology Clinic: Evidence Before, During, and After the COVID-19 Pandemic

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Abstract

Objective: Pediatric myopia is an increasing global vision health concern, and changes in behavioral patterns and healthcare utilization during the COVID-19 pandemic may have altered its clinical distribution. This study aimed to analyze temporal changes in the distribution and severity of myopia among children and adolescents evaluated between 2018 and 2025 at an ophthalmology clinic in Cartagena de Indias, Colombia. **Methods:** A retrospective observational study was conducted using electronic medical records of patients younger than 18 years evaluated at a specialized ophthalmology clinic between 2018 and 2025. Demographic and refractive variables, including age, sex, and spherical equivalent (SE), were analyzed at the eye level. The SE was calculated separately for each eye, and myopia severity was classified independently according to the corresponding SE value, records were grouped into pre-pandemic, pandemic, immediate post-pandemic, and recent post-pandemic periods, descriptive analyses, one-way analysis of variance, the Kruskal–Wallis test, Pearson's chi-square test, and ordinal logistic regression were performed. **Results:** A total of 6,006 eyes were included. Mild myopia was the predominant category (3,940; 65.6%), followed by moderate (1,486; 24.7%) and high myopia (580; 9.7%). Mean binocular SE differed significantly across epidemiological periods (ANOVA: $F = 10.38$; $p < 0.001$; Kruskal–Wallis: $H = 28.49$; $p < 0.001$), showing a shift toward more negative values from −2.314 D during the pre-pandemic period to −2.596 D during the immediate post-pandemic period and −2.621 D during the recent post-pandemic period. Females accounted for 56.7% of cases. Most diagnoses occurred among patients aged 7–17 years. In multivariable analysis, age, female sex, and post-pandemic periods were associated with higher myopia severity categories. **Conclusions:** This pediatric clinical population in Colombia showed a temporal shift toward more negative refractive values and a greater burden of moderate and high myopia after the pandemic. These findings support strengthening early detection and longitudinal monitoring, although they do not establish causality or demonstrate individual myopia progression.

Keywords: myopia, refractive errors, child, epidemiology, COVID-19

Introduction

Myopia represents one of the major emerging challenges for global visual health and is among the most common causes of preventable visual impairment, over the past decades, its prevalence has increased steadily across virtually all regions of the world, driven by demographic changes, lifestyle factors, and transformations in educational patterns [1,2]. Epidemiological projections estimate that by 2050, approximately 50% of the world's population will be myopic and nearly 10% will have high myopia, creating a scenario with substantial clinical, social, and economic implications [3].

Beyond being a correctable refractive error, myopia particularly in its more severe forms substantially increases the risk of developing potentially irreversible ocular conditions, including retinal detachment, glaucoma, early-onset cataract, and myopic maculopathy [4]. These complications represent an increasing cause of permanent visual impairment and impose a considerable burden on healthcare systems, particularly among pediatric populations, in whom early progression of the refractive error increases the cumulative risk of complications throughout adulthood [5,6]. Scientific evidence has demonstrated that the interaction between genetic predisposition and environmental factors plays a fundamental role in the development and progression of myopia, among the modifiable factors with the strongest supporting evidence are increased near-vision activities, prolonged use of digital devices, reduced exposure to natural light, and decreased engagement in outdoor activities [7,8]. These factors have gained particular relevance in recent years due to profound changes in the daily habits of children and adolescents [9].

The COVID-19 pandemic represented an unprecedented shift in these environmental factors, lockdown measures, the closure of educational institutions, and the widespread adoption of virtual learning substantially increased screen time while reducing daily exposure to outdoor environments [10,11]. Several studies, primarily from Asia and Europe, have reported increased incidence and progression of myopia during this period, particularly among school-aged children and adolescents, reinforcing the hypothesis that pandemic-related environmental changes accelerated the evolution of refractive error [12]. Nevertheless, the available evidence remains concentrated in Asian populations, whereas studies from Latin America are limited and generally cover relatively short observation periods, in Colombia, epidemiological information regarding the evolution of myopia before, during, and after the pandemic remains scarce, particularly among pediatric populations receiving care in real-world clinical settings. This lack of information limits the development of regional evidence-based strategies for screening, prevention, and control of myopia progression, in this context, clinical series encompassing periods before, during, and after the pandemic can provide a better understanding of temporal changes in disease distribution and generate information relevant to the planning of public health interventions in eye care and the strengthening of epidemiological surveillance programs [3,5]. Therefore, the objective of the present study was to analyze temporal changes in the epidemiological distribution and severity of myopia among children and adolescents younger than 18 years who received care between 2018 and 2025 at an ophthalmology clinic in Cartagena de Indias, Colombia, comparing periods before, during, and after the COVID-19 pandemic according to age, sex, and refractive severity.

Materials and Methods

Study Design

A retrospective observational study was conducted based on electronic clinical records, with temporal trend analyses using repeated cross-sectional assessments from 2018 to 2025.

Study Setting

Data were obtained from a referral ophthalmology clinic located in Cartagena de Indias, Colombia, providing specialized eye and visual care services to pediatric and adult populations from the department of Bolívar and neighboring regions.

Data Source

The institutional database systematically stores information generated during routine clinical care, including demographic variables, clinical history, and findings from optometric and ophthalmological examinations, for the present study, only variables required for the epidemiological analysis were extracted, including age, sex, date of consultation, sphere and cylinder measurements for both eyes, and the spherical equivalent calculated for each eye.

Data were extracted from records dated from January 1, 2018, through December 31, 2025, before statistical analysis, the database underwent a data-cleaning process that included removal of duplicate records, verification of variable consistency, identification of outliers, and exclusion of medical records with incomplete information for variables considered essential to the study.

Study Population

The target population comprised children and adolescents younger than 18 years with a diagnosis of myopia or refractive measurements compatible with this condition, the accessible population consisted of all eligible patients evaluated at a referral ophthalmology clinic in Cartagena de Indias, Colombia, between January 1, 2018, and December 31, 2025.

The unit of analysis was the individual eye, with refractive measurements from the right and left eyes analyzed independently. Data were obtained from electronic clinical records, and only records containing complete refractive information for both eyes and the demographic variables required for the analysis were included, given the retrospective nature of the study and the availability of all eligible records during the observation period, a census sampling approach was used, including all records that met the predefined inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

Inclusion Criteria

Clinical records were included when all of the following criteria were simultaneously met:

- Patients younger than 18 years who were evaluated between January 1, 2018, and December 31, 2025.
- Availability of a complete electronic medical record for the corresponding clinical encounter.
- Documentation of refractive assessment for both eyes, including sphere and cylinder values required to calculate the spherical equivalent.
- Clinical diagnosis of myopia or refractive values compatible with myopia, defined using a spherical equivalent equal to or below the cutoff established for the study.
- Availability of the demographic variables required for the analysis (age, sex, and date of consultation).

Exclusion Criteria

Records meeting any of the following conditions were excluded:

- Medical records with incomplete information for any variable considered essential to the study.
- Records containing refractive information for only one eye, preventing binocular classification of myopia severity.
- Duplicate records corresponding to the same clinical encounter.
- Refractive values considered inconsistent or biologically implausible after the database-cleaning process.

- Records in which the spherical equivalent could not be calculated because of incomplete information or data-entry errors.

Study Variables

Demographic, temporal, and refractive variables were collected from electronic clinical records. Variables were selected according to the study objectives and operationalized in advance using a standardized protocol, the primary outcome variable was myopia severity, whereas age, sex, and epidemiological period were considered explanatory variables, the operational definition, measurement scale, and classification of each variable are presented in Table 1.

Table 1. Operationalization of Study Variables

Variable	Variable type	Measurement scale	Operational definition	Unit/Category
Age	Independent	Continuous quantitative	Patient's age at the time of consultation	Years
Age group	Independent	Ordinal categorical	Age classification according to developmental stage	0–6 years; 7–12 years; 13–17 years
Sex	Independent	Nominal categorical	Sex recorded in the medical record	Male/Female
Year of consultation	Independent	Ordinal categorical	Year in which the ophthalmological consultation was performed	2018–2025
Epidemiological period	Independent	Ordinal categorical	Temporal grouping according to the context of the COVID-19 pandemic	Pre-pandemic; Pandemic; Immediate post-pandemic; Recent post-pandemic
Sphere OD	Independent	Continuous quantitative	Spherical power recorded for the right eye	Diopters (D)
Sphere OS	Independent	Continuous quantitative	Spherical power recorded for the left eye	Diopters (D)
Cylinder OD	Independent	Continuous quantitative	Cylindrical power recorded for the right eye	Diopters (D)
Cylinder OS	Independent	Continuous quantitative	Cylindrical power recorded for the left eye	Diopters (D)
Spherical equivalent OD	Derived variable	Continuous quantitative	Sphere OD + (Cylinder OD/2)	Diopters (D)
Spherical equivalent OS	Derived variable	Continuous quantitative	Sphere OS + (Cylinder OS/2)	Diopters (D)

Myopia severity	Dependent	Ordinal categorical	Clinical classification according to spherical equivalent	Non-myopic; mild; moderate; high

OD: right eye; **OS:** left eye.

Myopia severity was considered the primary outcome variable, whereas age, sex, and epidemiological period were considered explanatory variables for assessing potential differences in the temporal distribution of the condition.

Definition and Classification of Myopia

The spherical equivalent (SE) is a commonly used reference parameter for the epidemiological classification of refractive errors because it integrates the spherical and cylindrical components of refraction into a single measure, in the present study, the SE was calculated separately for each eye using the following formula: SE = sphere + (cylinder/2). Myopia severity was then classified independently for each eye according to its corresponding SE value.

The definition of myopia and its severity classification were established according to the recommendations of the International Myopia Institute (IMI) [6,23], which are widely accepted for clinical and epidemiological studies. This approach was adopted to facilitate comparison of the findings with the international literatura, the cutoff points used to classify myopia severity are presented in Table 2.

Table 2. Classification of Myopia Severity According to Spherical Equivalent

Category	Spherical equivalent (D)	Clinical interpretation
Non-myopic	> −0.50	Absence of myopia
Mild myopia	≤ −0.50 and > −3.00	Refractive error with a low risk of associated complications
Moderate myopia	≤ −3.00 and > −6.00	Greater likelihood of progression and development of ocular complications
High myopia	≤ −6.00	High risk of myopic maculopathy, glaucoma, early-onset cataract, and retinal detachment

Note: Adapted from Flitcroft DI, He M, Jonas JB, et al. *IMI – Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies*. Investigative Ophthalmology & Visual Science. 2019.

Data Extraction and Processing

Information was extracted from the institution's electronic medical-record database, including only records that met the predefined inclusion criterio, before analysis, the information was anonymized by removing personal identifiers, thereby ensuring patient confidentiality in accordance with applicable ethical regulations.

The database subsequently underwent a systematic data-cleaning and quality-control process, including identification of duplicate records, verification of variable consistency, detection of outliers, and assessment of missing data for variables considered essential to the study, records containing inconsistencies or insufficient information for classification of myopia severity were excluded from the analysis.

Once data cleaning was completed, the spherical equivalent for each eye was calculated using the standard formula (SE = Sphere + Cylinder/2), after which myopia severity was classified according to the methodological criteria established for the study, finally, the definitive database was exported for statistical analysis.

The complete process of extraction, cleaning, validation, and processing of clinical records was summarized as follows:

1. Electronic medical records
2. Record extraction
3. Application of inclusion criteria
4. Data anonymization
5. Data cleaning and quality control
6. Missing data, duplicate records, and inconsistent values
7. Calculation of spherical equivalent
8. Classification of myopia severity
9. Final database
10. Statistical analysis

Statistical Analysis

Database processing and cleaning were performed using the Python programming language within the Jupyter Notebook development environment (Anaconda Navigator distribution), the Pandas and NumPy libraries were used for variable type adjustment and the management of outliers and missing data, numerical analyses and descriptive graphical analyses of correlations and temporal trends were performed using Matplotlib and SciPy.

Before analysis, the database underwent a verification process to assess data consistency, identify duplicate records, and detect missing or inconsistent values, records that did not meet the predefined quality criteria were excluded from the analysis in accordance with the established methodological criterio, initially, a descriptive analysis of the study variables was performed, quantitative variables were summarized using measures of central tendency and dispersion, expressed as mean ± standard deviation (SD) when normally distributed, or as median and interquartile range (IQR) when the normality assumption was not met, categorical variables were described using absolute and relative frequencies (%).

The distribution of continuous variables was assessed using the Shapiro–Wilk test, whereas homogeneity of variances was evaluated using Levene's test, based on these results, comparisons among multiple groups were performed using one-way analysis of variance (ANOVA) for variables with a normal distribution and homogeneous variances, and the nonparametric Kruskal–Wallis test when these assumptions were not met, associations between categorical variables, including myopia severity, sex, age groups, and epidemiological periods, were assessed using Pearson's chi-square test, when statistically significant associations were identified, adjusted standardized residuals were examined to identify the categories contributing to the observed differences, to independently assess the association between demographic and temporal characteristics and myopia severity, an ordinal logistic regression model was fitted, with myopia severity as the dependent variable and age, sex, and epidemiological period as independent variables, as presented in Table 3. If the proportional odds assumption was not met, multinomial logistic regression would be used as an alternative approach, model results were expressed as adjusted odds ratios (ORs), with corresponding 95% confidence intervals (95% CIs) and p-values.

Table 3. Factors Associated With the Myopic Outcome: Multivariable Logistic Regression Analysis

Variable	Adjusted OR	95% CI	p-value

Age	1.04	1.03–1.05	<0.001
Female sex	1.21	1.06–1.38	0.004
Immediate post-pandemic	1.45	1.28–1.64	<0.001
Recent post-pandemic	1.29	1.12–1.49	0.001

- An OR of 1.04 for age indicates that each additional year of age was associated with a 4% increase in the odds of belonging to a higher myopia-severity category.
- An OR of 1.21 for sex indicates that females had 21% higher odds of presenting with more severe forms of myopia compared with males.
- An OR of 1.45 for the epidemiological period indicates that during the post-pandemic period, the odds of presenting with greater myopia severity were 45% higher than during the pre-pandemic period.

An ordinal logistic regression model was fitted with myopia severity (non-myopic, mild, moderate, and high) as the dependent variable, after adjustment for age and sex, the epidemiological period remained significantly associated with greater myopia severity, in particular, the eye numbers evaluated during the immediate post-pandemic period had higher odds of belonging to a higher severity category compared with those evaluated during the pre-pandemic period (adjusted OR = 1.45; 95% CI: 1.28–1.64; $p < 0.001$), age also showed a positive association with disease severity (OR = 1.04 for each one-year increase), whereas female sex was associated with higher odds of more severe myopia compared with male sex, a statistical significance level of $\alpha = 0.05$ was used in all analyses, with p-values below this threshold considered statistically significant.

Ethical Considerations

The present study was approved by the Research Ethics Committee of Universidad del Sinú, Cartagena Section, under Approval No. CETBI 08-42-2026, the study was conducted in accordance with the ethical principles established in the Declaration of Helsinki of the World Medical Association for research involving human participants and with current Colombian regulations, particularly Resolution 8430 of 1993 of the Ministry of Health, which establishes scientific, technical, and administrative standards for health research.

Given the retrospective nature of the study and the exclusive use of previously recorded electronic medical records, with no intervention involving participants and no modification of their clinical care, the Research Ethics Committee classified the study as research involving no more than minimal risk, in view of these characteristics, the Ethics Committee authorized the use of clinical information and waived the requirement for individual informed consent, as the data had originally been collected for clinical care and were subsequently analyzed in an anonymized manner, without the possibility of directly or indirectly identifying participants, to ensure confidentiality and protection of the information, all records were coded and subjected to an anonymization process before data processing and statistical análisis, access to the database was restricted exclusively to the research team, and the information was used solely for scientific purposes, in accordance with the principles of confidentiality and the provisions established by Law 1581 of 2012 on the protection of personal data and other applicable regulations.

Results

General Characteristics of the Study Population

The mean age of the evaluated population was approximately 11 years, with an age range from 0 to 17 years, regarding the general ophthalmological findings, the spherical power of the right eye had a mean value of −2.59 D (range, −26.00 to +5.50 D), whereas the left eye showed a mean value of −2.72 D (range, −0.50 to +28.00 D), the cylindrical component showed an identical mean value of −0.90 D in both eyes, with values ranging from −9.00 D to 0.00 D.

Overall Distribution of Myopia Severity

After application of the inclusion and exclusion criteria, the analysis comprised 6,006 pediatric eyes diagnosed with myopia who were evaluated between 2018 and 2025, the distribution of myopia severity showed a clear predominance of mild myopia, identified in 3,940 eyes (65.6%), followed by moderate myopia in 1,486 cases (24.7%) and high myopia in 580 eyes (9.7%).

Overall, approximately two-thirds of the eyes had mild myopia, whereas moderate and high myopia accounted for approximately one-quarter and one-tenth of cases, respectively, the overall distribution of myopia severity is presented in Table 4.

Table 4. Distribution of Myopia Severity Among Analyzed Eyes

Myopia severity	n	%
Mild myopia	3,940	65.6
Moderate myopia	1,486	24.7
High myopia	580	9.7
Total	**6,006**	**100.0**

Temporal Trend in Myopia Severity (2018–2025)

The annual distribution of myopia severity showed variations throughout the study period (Figure 1). Overall, mild myopia remained the predominant category in every year analyzed, followed by moderate and high myopia, maintaining a consistent pattern throughout the observation period, during 2018 and 2019, corresponding to the pre-pandemic period, the distribution of the three severity categories was relatively stable, in 2020, coinciding with the onset of the COVID-19 pandemic, a decrease in the number of patients receiving care was observed, affecting all myopia severity categories proportionally, from 2021 onward, the volume of clinical records progressively recovered, reaching the highest values in 2024 and 2025.

Although the absolute number of cases increased during the post-pandemic period, mild myopia continued to represent the most frequent category, whereas high myopia consistently accounted for the smallest proportion of patients throughout the follow-up period, the temporal evolution of the three severity categories is presented in Figure 1, showing relative stability in the distribution of myopia and a gradual increase in the number of patients evaluated following the resumption of healthcare services.

Temporal trend in myopia severity among pediatric eyes evaluated between 2018 and 2025.

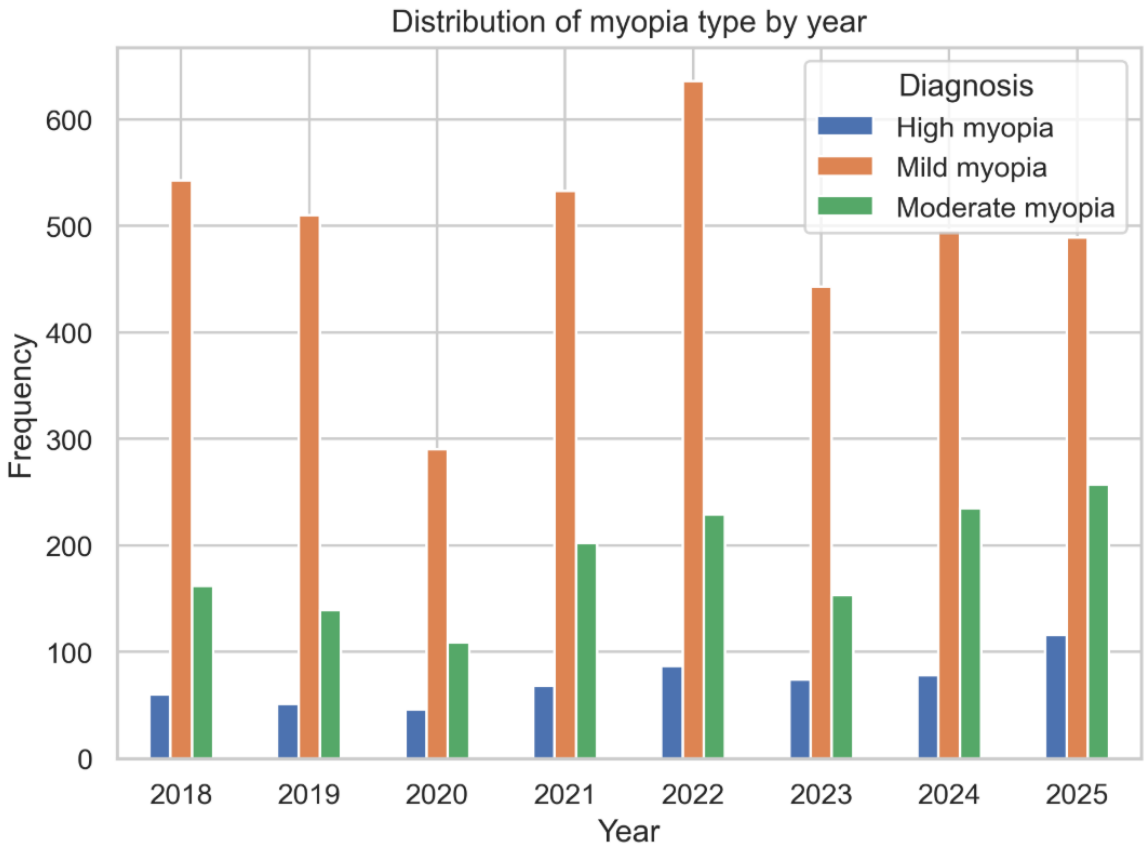


Figure 1. Annual distribution in the number of eyes with mild, moderate, and high myopia evaluated between 2018 and 2025. A decrease in the number of records was observed during 2020, followed by a progressive recovery in subsequent years, with mild myopia remaining the predominant category throughout the study period.

Temporal Trend and Analysis of Variance of the Spherical Equivalent

The analysis of the spherical equivalent (SE) showed statistically significant differences among the epidemiological periods (Table 5), one-way analysis of variance (ANOVA) demonstrated differences in mean SE between groups ($F = 10.38$; $p < 0.001$), because the distribution of the variable did not fully meet the assumptions of normality, these findings were corroborated using the nonparametric Kruskal–Wallis test, which also confirmed statistically significant differences ($H = 28.49$; $p < 0.001$).

Analysis of the means and their corresponding 95% confidence intervals (95% CIs) demonstrated a progressive shift in the spherical equivalent toward more negative values beginning in the post-pandemic period, during the pre-pandemic period (2018–2019), the mean SE was −2.314 D (95% CI, −2.441 to −2.187 D), whereas during the pandemic period (2020), the mean was −2.102 D (95% CI, −2.312 to −1.892 D), subsequently, during the immediate post-pandemic period (2021–2023), the mean SE decreased to −2.596 D (95% CI, −2.694 to −2.498 D), reaching −2.621 D (95% CI, −2.768 to −2.474 D) during the recent post-pandemic period (2024–2025).

Overall, these findings demonstrate a temporal trend toward more negative spherical equivalent values during the post-pandemic periods, indicating a progressive increase in the mean magnitude of myopia in the study population.

Table 5. Mean Spherical Equivalent of the Eyes by Epidemiological Period

Epidemiological period	Mean SE (D)	95% CI
Pre-pandemic (2018–2019)	−2.314	−2.441 to −2.187
Pandemic (2020)	−2.102	−2.312 to −1.892
Immediate post-pandemic (2021–2023)	−2.596	−2.694 to −2.498
Recent post-pandemic (2024–2025)	−2.621	−2.768 to −2.474

ANOVA: $F = 10.38$; $p < 0.001$.

Kruskal–Wallis: $H = 28.49$; $p < 0.001$.

Distribution of Myopia by Sex Across Epidemiological Periods

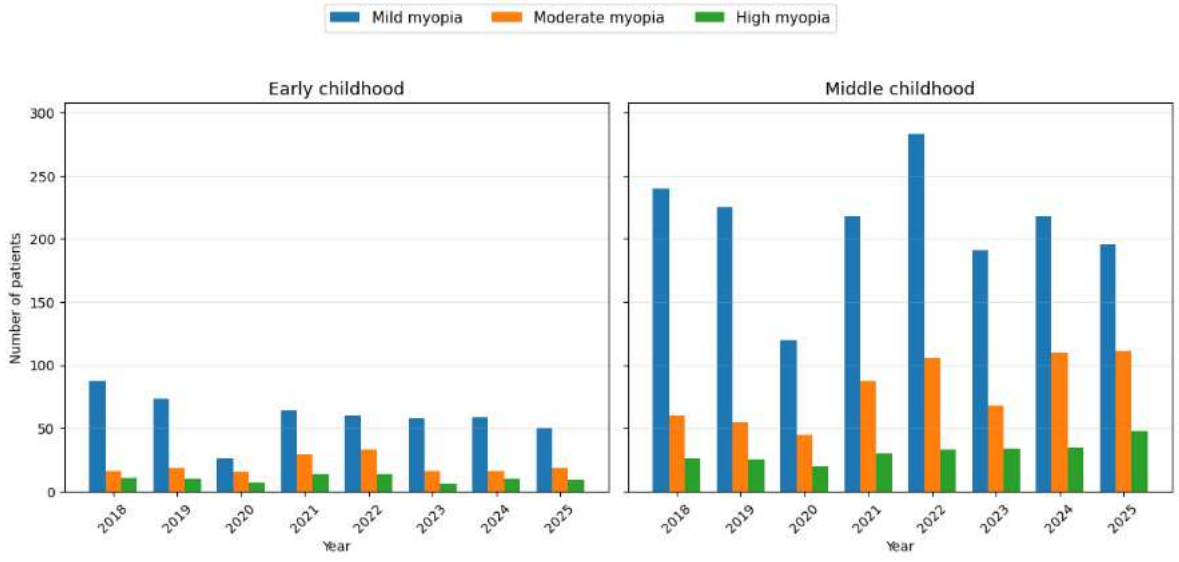
Of the 6,006 eyes included in the study, 3,406 (56.7%) were female and 2,600 (43.3%) were male. The sex distribution remained similar across the different epidemiological periods evaluated (Table 6), to determine whether the proportion of patients by sex differed across the study periods, Pearson's chi-square test was applied, the analysis did not demonstrate a statistically significant association between sex and epidemiological period ($\chi^2 = 3.12$; df = 3; $p = 0.373$), indicating that the relative distribution of males and females remained stable throughout the observation period.

Distribution of Myopia Diagnoses by Age Group

The distribution of myopia diagnoses differed across the age groups evaluated (Figure 2), adolescents aged 13–17 years accounted for the largest number of cases throughout the study period, followed by children aged 7–12 years, whereas early childhood (0–6 years) consistently showed the lowest frequency of diagnoses, all three age groups showed a decrease in the number of cases during 2020, followed by a progressive increase from 2021 onward, the 7–12-year and 13–17-year groups reached their highest frequencies during 2022 and 2025, whereas the 0–6-year group showed a more moderate recovery and remained the group with the lowest number of diagnoses throughout the study period.

In all age groups, mild myopia was the most frequent category, followed by moderate and high myopia, and this distribution pattern remained consistent throughout the analyzed period.

Annual Evolution in the Number of Eyes Diagnosed with Myopia by Age Group (2018–2025)



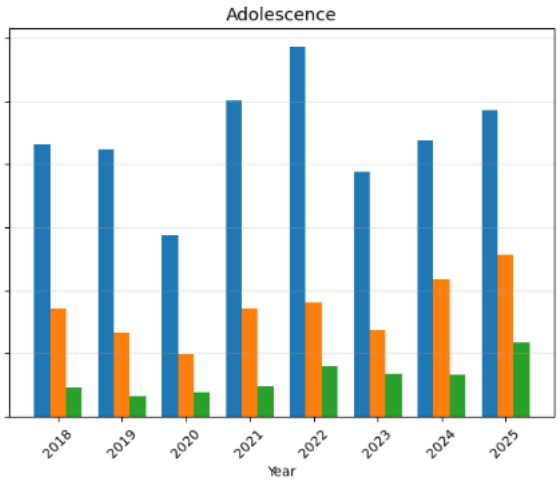


Figure 2. Annual evolution in the number of eyes diagnosed with myopia according to age group between 2018 and 2025. Adolescents accounted for the largest number of cases throughout the study period, whereas early childhood showed the lowest frequencies.

Distribution of Myopia Severity by Sex

The distribution of myopia severity showed a predominance of females across all categories analyzed (Table 6), Among eyes with mild myopia, 2,245 (57.0%) were female and 1,695 (43.0%) were male, a similar pattern was observed for moderate myopia, with 795 females (53.5%) and 691 males (46.5%), in the high-myopia category, the female predominance was more pronounced, with 366 cases (63.1%) among females compared with 214 cases (36.9%) among males.

Overall, these findings indicate a higher frequency of cases among females across all three severity categories, with the most pronounced difference observed for high myopia.

Table 6. Distribution of Myopia Severity by Sex

Myopia severity	Females, n (%)	Males, n (%)	Total
Mild myopia	2,245 (57.0)	1,695 (43.0)	3,940
Moderate myopia	795 (53.5)	691 (46.5)	1,486
High myopia	366 (63.1)	214 (36.9)	580
Total	**3,406 (56.7)**	**2,600 (43.3)**	**6,006**

Note: Percentages represent the sex distribution within each myopia-severity category.

Temporal Trend in Myopia Diagnoses by Sex

The temporal evolution of myopia showed a similar pattern in eyes from female and male patients, characterized by a decrease in the number of eyes during 2020, followed by a progressive increase in subsequent years (Figure 3), throughout the study period, the number of analyzed eyes from female patients was higher than that from male patients. The highest number of eyes among female patients was observed in 2022, with 544 eyes, whereas among male patients, the maximum was reached in 2025, with 418 eyes. Although the absolute number of analyzed eyes remained higher among female patients throughout the time series, the increase observed among male patients was more pronounced during the final years of the study, reducing the absolute difference between the sexes toward the end of the observation period, among eyes classified as having high myopia, the number of eyes from male patients increased from 26 in 2018 to 54 in

2025, representing a 107.7% increase over the observation period. The annual evolution of the number of analyzed eyes by sex is presented in Figure 3.

Distribution of Analyzed Eyes by Sex and Year

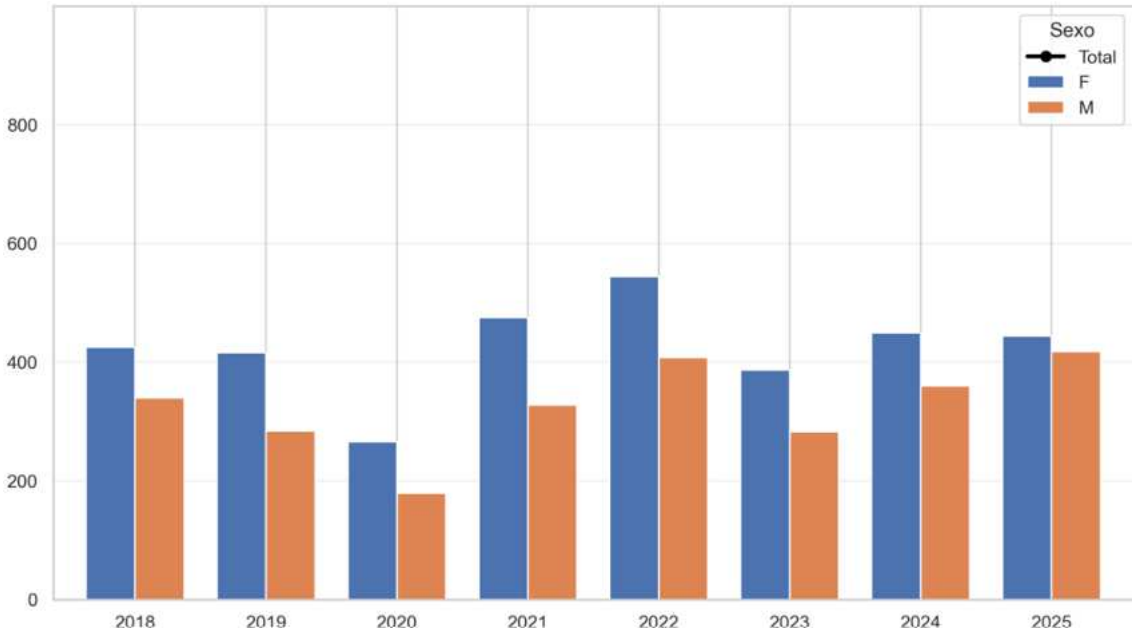


Figure 3. Annual evolution in the number of eyes diagnosed with myopia by sex between 2018 and 2025. Both groups showed a decrease in the number of eyes during 2020, followed by a progressive increase in subsequent years.

Comparison of Myopia Distribution Between the Pre-pandemic and Post-pandemic Periods

To evaluate changes in the distribution of myopia across epidemiological periods, the frequencies observed during the pre-pandemic period (2018–2019) were compared with those recorded during the immediate post-pandemic period (2021–2023) and the recent post-pandemic period (2024–2025), the year 2020 was excluded because of its atypical pattern of clinical care (Table 7), compared with the pre-pandemic period, all severity categories showed an increase in the number of diagnoses during the immediate post-pandemic period, mild myopia increased from 1,053 to 1,902 cases, whereas moderate myopia increased from 301 to 693 cases and high myopia from 111 to 275 cases, during the recent post-pandemic period, all three categories continued to show higher numbers of cases than during the pre-pandemic period, despite covering a shorter observation Interval, during this period, 985 cases of mild myopia, 492 cases of moderate myopia, and 194 cases of high myopia were recorded, remaining above the frequencies observed before the pandemic, comparative analysis showed statistically significant differences in the distribution of myopia severity across epidemiological periods ($\chi^2 = 58.15$; df = 4; $p < 0.001$).

More specifically, the 2021–2023 period showed an increase in the frequency of moderate and high myopia compared with the pre-pandemic period (2018–2019), whereas during 2024–2025 the frequencies remained higher than those observed before the pandemic, although lower than those recorded during the immediate recovery period, these findings indicate that the distribution of myopia severity was not homogeneous across the different periods analyzed, the changes observed after the COVID-19 pandemic suggest that factors such as increased screen exposure, reduced outdoor activity, and recovery of ophthalmic services may have influenced both disease detection and progression.

Table 7. Comparison of Myopia Severity Distribution Across Epidemiological Periods

Myopia severity	Pre-pandemic (2018–2019), n (annual mean)	Immediate post-pandemic (2021–2023), n (annual mean)	Change vs. pre-pandemic (%)	Recent post-pandemic (2024–2025), n (annual mean)	Change vs. pre-pandemic (%)
Mild myopia	1,053 (526.5)	1,902 (634.0)	+20.4%	985 (492.5)	−6.5%
Moderate myopia	301 (150.5)	693 (231.0)	+53.5%	492 (246.0)	+63.5%
High myopia	111 (55.5)	275 (91.7)	+65.2%	194 (97.0)	+74.8%
Total	**1,465 (732.5)**	**2,870 (956.7)**	**+30.6%**	**1,671 (835.5)**	**+14.1%**

Table note: Annual means were calculated by dividing the total number of cases by the number of years included in each epidemiological period (pre-pandemic = 2 years; immediate post-pandemic = 3 years; recent post-pandemic = 2 years). Percentage changes represent the variation in the annual mean relative to the pre-pandemic period.

Discussion

The analysis of myopia severity provides an additional dimension for interpreting these findings. Although mild myopia was the predominant category throughout the study period, moderate and high myopia showed substantial increases when the chronological periods were compared. During the pre-pandemic period, 1,053 mild, 301 moderate, and 111 high myopia cases were recorded, compared with 1,902, 693, and 275 cases, respectively, during the immediate post-pandemic period, thus, the proportional increase was more pronounced for the higher-severity categories than for mild myopia, this pattern warrants attention because the clinical significance of myopia depends not only on its prevalence but also on the degree of refractive error and the likelihood of progression toward levels associated with a greater long-term risk of ocular complications, contemporary evidence supports early identification and management as particularly relevant for preventing children with early-onset myopia from progressing toward high myopia [13]. However, comparisons of frequencies across periods of different durations and with variable patterns of healthcare utilization should not be interpreted as direct changes in population incidence.

The age distribution showed a clearly defined gradient, with the highest concentration of diagnoses among children aged 7–12 and adolescents aged 13–17 years, whereas the 0–6-year age group consistently had the fewest records, this pattern is consistent with the international epidemiology of myopia, in which its frequency increases substantially during the school years and adolescence, the greater diagnostic burden during these stages may reflect both the onset and progression of myopia during ocular growth and greater exposure to educational demands and near-vision activities, nevertheless, the lower frequency observed among children aged 0–6 years should not automatically be interpreted as lower susceptibility, as it may also be related to reduced access to specialized refractive examinations or a lower likelihood of clinical diagnosis at younger ages, the World Health Organization recognizes the importance of screening during the preschool and school years to enable early identification of refractive errors and timely referral for care [15,16].

The female predominance observed in the cohort represents another relevant finding, females accounted for 3,406 of the 6,006 records and showed a greater cumulative burden across mild, moderate, and high myopia categories, in particular, females accounted for 57% of mild myopia, 53% of moderate myopia, and 63% of high myopia cases, however, the test of independence did not identify a statistically significant association between sex and temporal period ($\chi^2 = 3.12$; df = 3; $p = 0.3727$), indicating that the proportional distribution by sex remained relatively stable across the chronological periods, this finding is important because it prevents the female predominance from being interpreted as evidence of a sex-specific temporal change, sex-related differences described in international epidemiological studies may be associated with differences in age at onset, progression trajectories, environmental exposure, visual behavior, and healthcare utilization;

however, these mechanisms were not directly evaluated in our database, therefore, in the present study, it is more appropriate to describe the female predominance as a characteristic of the cohort rather than as a causal factor or independent predictor.

A plausible explanation for part of the changes observed after 2020 involves environmental and behavioral changes associated with lockdowns and the transformation of school routines, during the pandemic, many children simultaneously experienced reduced outdoor exposure, increased engagement in near-vision activities, and greater exposure to digital devices, recent literature supports the potential protective role of outdoor time, a meta-analysis published in 2025 found that interventions aimed at increasing outdoor exposure were associated with benefits in terms of spherical equivalent and axial elongation, although substantial heterogeneity was observed across studies and the certainty of evidence was low [17]. Similarly, a 2025 meta-analysis of 45 studies involving 335,524 participants found a dose-response association between digital screen exposure and myopia; each additional hour of daily exposure was associated with higher odds of myopia, although substantial heterogeneity was reported across studies and the certainty of evidence was considered low [18]. These findings suggest that visual behavior is a relevant component of the phenomenon but do not support attributing an independent causal effect to screen exposure, because digital device use frequently coexists with greater near work, reduced physical activity, and less time spent outdoors.

This interpretation is particularly important for the present study because none of these environmental exposures was individually measured, therefore, the pandemic should be regarded as a temporal context characterized by profound changes in the visual and behavioral environment rather than as a directly evaluated causal exposure, indeed, a systematic review and meta-analysis specifically examining COVID-19 lockdowns found more rapid myopia progression during periods of confinement, with increased screen exposure, reduced outdoor activity, and greater near work proposed as potential mechanisms [14]. An updated systematic review published in 2026 also found an association between longer duration of near work and childhood myopia, although considerable heterogeneity was observed among the included studies [19]. Collectively, these findings support the biological plausibility of environmental changes as part of the explanation for the phenomenon observed in our cohort; however, they do not allow determination of which individual factor contributed most substantially in this population.

From a pathophysiological perspective, these associations may be related to the regulation of ocular growth and axial elongation, exposure to outdoor environments, particularly under conditions of bright illumination, appears to exert a protective effect against the onset and progression of myopia, whereas prolonged near-vision activities combined with reduced outdoor exposure may promote conditions associated with myopia development in susceptible individuals [17]. Nevertheless, contemporary evidence supports a multifactorial model involving interactions among genetic predisposition, ocular development, education, and environmental factors rather than a linear relationship between a single exposure and myopia, accordingly, the IMI 2025 recommends an approach based on early identification, risk assessment, and individualized management rather than attributing the phenomenon to a single environmental factor [13].

The findings also have clinical and public health implications for Colombia, the concentration of cases among individuals aged 7–17 years and the shift toward higher-severity categories suggest that pediatric myopia management should extend beyond the simple prescription of optical correction toward a model integrating detection, diagnosis, monitoring, and progression control, this approach is consistent with contemporary WHO recommendations emphasizing the early detection of visual disorders in children and adolescents and the establishment of referral and follow-up pathways after screening [15,16]. Colombia also has an institutional framework for visual health assessment within health promotion and maintenance pathways. Resolution 3280 of 2018 establishes visual acuity assessment from three years of age and provides for referral for specialized evaluation when risk factors or visual abnormalities are identified [20]. Accordingly, our findings support strengthening existing strategies, particularly among school-aged populations, rather than necessarily establishing an entirely new healthcare structure, from a public health perspective, the challenge is to ensure that screening effectively translates into diagnosis and follow-up, the WHO has recently highlighted the need to strengthen refractive error services through integrated models linking community, primary,

secondary, and tertiary levels of care, while improving the availability, accessibility, and quality of services [21,22]. In Colombia, this approach could facilitate coordination among educational institutions, primary care services, optometry, and ophthalmology, particularly in populations facing geographic or socioeconomic barriers to healthcare access, however, because our data were obtained from a clinical institution, they cannot be used to estimate inequalities in access or to assess the effectiveness or cost-effectiveness of these strategies, therefore, the public health implications should be understood as an orientation derived from the observed patterns rather than as a direct evaluation of the Colombian healthcare system.

Among the strengths of this study is, first, the broad eight-year observation period, which allowed comparison of a pre-pandemic period, the pandemic year, and different stages of subsequent recovery, this temporal perspective provides greater context than a single cross-sectional assessment and enables identification of patterns that would be difficult to detect within a single year, second, the cohort size (n = 6,006) allowed simultaneous characterization of myopia severity, spherical equivalent, age, and sex, third, the use of clinical records from routine healthcare settings provides evidence of patient characteristics under real-world conditions and Finally, combining categorical severity analyses with quantitative assessment of spherical equivalent allowed the phenomenon to be evaluated from two complementary perspectives.

These strengths should be considered alongside several limitations, the first is selection bias, as the cohort was derived from an ophthalmology institution and therefore does not necessarily represent the general pediatric population of Cartagena, the Caribbean region, or Colombia, the second limitation arises from the retrospective design and the inability to ensure complete uniformity across all variables recorded over the eight-year period, the third, and particularly important, limitation is that the pandemic simultaneously altered visual behaviors and access to healthcare services, consequently, it is not possible to completely distinguish a genuine change in the refractive profile from an increase in diagnoses resulting from the recovery of previously postponed consultations, fourth, the study lacked standardized individual-level measurements of outdoor time, near work, digital device use, physical activity, sleep, family history, and socioeconomic conditions, finally, the absence or limited availability of longitudinal axial length measurements prevents the study from demonstrating individual structural progression, these limitations require the findings to be interpreted as temporal trends observed in a clinical population rather than as estimates of population incidence or evidence of causality.

These limitations also define the main priorities for future research, prospective, multicenter studies are needed to follow the same children over several years while combining serial cycloplegic refraction with ocular biometry, particularly axial length measurements, future Colombian cohorts should also incorporate standardized assessments of outdoor time, near work, screen exposure, physical activity, sleep, family history, and socioeconomic factors, monitoring these variables would help determine whether the refractive shift identified in our cohort represents a persistent modification of individual trajectories or, at least in part, changes in patterns of healthcare utilization, it would also be relevant to develop risk prediction models adapted to the Colombian population and to evaluate the effectiveness, adherence, safety, and cost-effectiveness of myopia-control interventions in real-world care settings.

Overall, the findings show that myopia in this Colombian clinical population underwent a relevant temporal change between 2018 and 2025, characterized by a shift in spherical equivalent toward more negative values and a greater burden of moderate and high myopia after the pandemic, particularly among school-aged children and adolescents, the consistency of this pattern with international evidence regarding refractive changes during the pandemic period reinforces its relevance. Nevertheless, the retrospective and clinical characteristics of the cohort prevent these changes from being directly attributed to COVID-19, screen exposure, or any other specific environmental factor, the principal contribution of this study therefore lies not only in documenting an increase in diagnoses but also in demonstrating a longitudinal change in the refractive profile and severity of myopia in a clinical population from Colombia's Caribbean región, these findings support the need to strengthen early identification and follow-up of children and adolescents, particularly during the school years, and provide a basis for prospective research integrating environmental factors, ocular biometry, and myopia-control strategies within the Colombian context.

Conclusion

The findings of this study demonstrate a relevant temporal change in the myopia profile of a pediatric population receiving care at an ophthalmology service in Colombia's Caribbean region between 2018 and 2025, following the pandemic, an increase in the diagnostic burden was observed, accompanied by a shift in spherical equivalent toward more negative values and a greater representation of moderate and high myopia categories, the highest concentration of cases occurred among children and adolescents aged 7–17 years, whereas females accounted for the largest proportion of cumulative diagnoses, with no evidence of significant changes in sex distribution across the study periods.

These findings are consistent with the international trend toward an increasing burden of myopia in recent years and with refractive changes reported during the pandemic period, however, because of the retrospective and clinical nature of the study, a causal relationship between the pandemic, environmental or behavioral changes, and the observed refractive changes cannot be established, in particular, the results should be interpreted as temporal trends within a clinical population rather than as estimates of myopia incidence or individual progression.

The identification of a refractive shift toward more negative values and a greater representation of moderate and high myopia highlights the importance of strengthening early detection and longitudinal monitoring of children and adolescents, particularly during the school years, these findings provide regionally relevant evidence and constitute a basis for future multicenter and prospective studies in Colombia incorporating cycloplegic refraction, axial length, environmental and behavioral factors, family history, and individual monitoring of myopia progression, overall, the study supports moving from a model focused exclusively on refractive correction toward comprehensive strategies integrating early detection, risk stratification, longitudinal follow-up, and myopia progression control.

Strengths and Limitations

Strengths

This study has several strengths, including the broad eight-year observation period (2018–2025), the size of the population analyzed (n = 6,006), and the availability of clinical information derived from real-world healthcare settings, in addition, the simultaneous assessment of myopia severity, spherical equivalent, age, and sex allowed the phenomenon to be characterized from multiple dimensions, the comparison of pre-pandemic and post-pandemic periods also provided a temporal framework for identifying changes in the refractive profile of the study population.

Limitations

The interpretation of these findings should take several limitations into consideration. First, the study population was drawn from a specialized ophthalmology institution; therefore, selection bias may be present, and the findings should not be directly extrapolated to the general pediatric population of Colombia, second, the retrospective design precludes causal inference, and the reduction in ophthalmic consultations during 2020 may have substantially influenced the number of myopia diagnoses recorded that year, third, comparisons across epidemiological periods do not demonstrate individual refractive progression, as the study was not designed as a longitudinal follow-up of the same patients or eyes over time.

The database also did not allow standardized assessment of potentially relevant exposures, including outdoor time, near work, digital device use, physical activity, sleep, and family history, finally, the limited availability of serial axial length measurements restricts the ability to directly assess structural ocular progression.

Conflicts of Interest

The authors declare that they have no financial, personal, or institutional conflicts of interest that could have influenced the design, conduct, analysis, interpretation, or publication of this study.

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Data Availability

The data supporting the findings of this study are not publicly available because of restrictions related to the confidentiality of clinical information and the protection of participants' personal data, aggregated data and/or additional methodological materials may be made available upon reasonable request to the corresponding author and subject to the relevant institutional and ethical approval.

Author Responsibility

All authors made substantial contributions to the work, reviewed and approved the final version of the manuscript, and accept responsibility for all aspects of the work, ensuring that any issues related to the accuracy or integrity of any part of the study were appropriately investigated and resolved.

Reference

1. Biswas S, El Kareh A, Qureshi M, Lee DMX, Sun C-H, Lam JSH, et al. The influence of the environment and lifestyle on myopia. J Physiol Anthropol [Internet]. 2024;43(1):7. Disponible en: http://dx.doi.org/10.1186/s40101-024-00354-7

2. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology [Internet]. 2016;123(5):1036–42. Disponible en: http://dx.doi.org/10.1016/j.ophtha.2016.01.006

3. World report on vision [Internet]. Who.int. World Health Organization; 2019 [citado el 12 de agosto de 2026]. Disponible en: https://www.who.int/publications/i/item/world-report-on-vision

4. Flitcroft DI. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog Retin Eye Res [Internet]. 2012;31(6):622–60. Disponible en: http://dx.doi.org/10.1016/j.preteyeres.2012.06.004

5. Burton MJ, Ramke J, Marques AP, Bourne RRA, Congdon N, Jones I, et al. The lancet global health commission on global eye health: Vision beyond 2020. Lancet Glob Health [Internet]. 2021;9(4):e489–551. Disponible en: http://dx.doi.org/10.1016/S2214-109X(20)30488-5

6. Wolffsohn JS, Jong M, Smith EL 3rd, Resnikoff SR, Jonas JB, Logan NS, et al. IMI 2021 reports and digest - reflections on the implications for clinical practice. Invest Ophthalmol Vis Sci [Internet]. 2021;62(5):1. Disponible en: http://dx.doi.org/10.1167/iovs.62.5.1

7. Morgan IG, French AN, Ashby RS, Guo X, Ding X, He M, et al. The epidemics of myopia: Aetiology and prevention. Prog Retin Eye Res [Internet]. 2018;62:134–49. Disponible en: http://dx.doi.org/10.1016/j.preteyeres.2017.09.004

8. Eppenberger LS, Grzybowski A, Schmetterer L, Ang M. Myopia control: Are we ready for an evidence based approach? Ophthalmol Ther [Internet]. 2024;13(6):1453–77. Disponible en: http://dx.doi.org/10.1007/s40123-024-00951-w

9. Xiong S, Sankaridurg P, Naduvilath T, Zang J, Zou H, Zhu J, et al. Time spent in outdoor activities in relation to myopia prevention and control: a meta-analysis and systematic review. Acta Ophthalmol [Internet]. 2017;95(6):551–66. Disponible en: http://dx.doi.org/10.1111/aos.13403

10. Wang J, Li Y, Musch DC, Wei N, Qi X, Ding G, et al. Progression of myopia in school-aged children after COVID-19 home confinement. JAMA Ophthalmol [Internet]. 2021;139(3):293–300. Disponible en: http://dx.doi.org/10.1001/jamaophthalmol.2020.6239

11. Cyril Kurupp AR, Raju A, Luthra G, Shahbaz M, Almatooq H, Foucambert P, et al. The impact of the COVID-19 pandemic on myopia progression in children: A Systematic Review. Cureus [Internet]. 2022;14(8):e28444. Disponible en: http://dx.doi.org/10.7759/cureus.28444

12. Chang P, Zhang B, Lin L, Chen R, Chen S, Zhao Y, et al. Comparison of Myopic Progression before, during, and after COVID-19 Lockdown. Ophthalmology [Internet]. 2021;128(11):1655–7. Disponible en: http://dx.doi.org/10.1016/j.ophtha.2021.03.029

13. Tahhan N, Bullimore MA, He X, Ostrin LA, Gawne TJ, Gifford KL, et al. IMI-2025 digest. Invest Ophthalmol Vis Sci [Internet]. 2025;66(12):27. Disponible en: http://dx.doi.org/10.1167/iovs.66.12.27

14. Kim DH, Park J, Hwang J-M, Yang HK. Myopic progression associated with COVID-19 pandemic in Korean children with myopia using 0.01% atropine eyedrops. Life (Basel) [Internet]. 2026;16(3):407. Disponible en: http://dx.doi.org/10.3390/life16030407

15. Manual de cribado visual y ocular [Internet]. Who.int. [citado el 12 de agosto de 2026]. Disponible en: https://www.who.int/es/publications/b/70764

16. Vision and hearing screening for school-age children: implementation handbook [Internet]. Who.int. World Health Organization; 2025 [citado el 12 de agosto de 2026]. Disponible en: https://www.who.int/publications/i/item/9789240105201

17. Martinez-Perez C, Sanchez-Tena MA, Sánchez-González J-M, Villa-Collar C, Alvarez-Peregrina C. Influence of outdoor time on the spherical equivalent and axial length in childhood myopia: A meta-analysis. Acta Ophthalmol [Internet]. 2025;103(8):864–78. Disponible en: http://dx.doi.org/10.1111/aos.17478

18. Ha A, Lee YJ, Lee M, Shim SR, Kim YK. Digital screen time and myopia: A systematic review and dose-response meta-analysis. JAMA Netw Open [Internet]. 2025;8(2):e2460026. Disponible en: http://dx.doi.org/10.1001/jamanetworkopen.2024.60026

19. Song Y, Zheng W, Yang X, Yang S, Du F, Tian H. Near-work activity duration and myopia in children: An updated systematic review and meta-analysis. Biomed Rep [Internet]. 2026;24(5):58. Disponible en: http://dx.doi.org/10.3892/br.2026.2131

20. Resolución 3280 de 2018 Ministerio de Salud y Protección Social [Internet]. Gov.co. [citado el 12 de agosto de 2026]. Disponible en: https://www.alcaldiabogota.gov.co/sisjur/normas/Norma1.jsp?dt=S&i=80433

21. Competency-based refractive error teams [Internet]. Who.int. World Health Organization; 2025 [citado el 12 de agosto de 2026]. Disponible en: https://www.who.int/publications/i/item/9789240109209

22. Refractive error situation analysis tool (RESAT) [Internet]. Who.int. [citado el 12 de agosto de 2026]. Disponible en: https://www.who.int/publications/b/78046