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Refractive Error and Visual Function in Children Under Non-cycloplegic Screening Conditions

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Abstract

Background: To assess the prevalence of refractive error and reduced uncorrected visual acuity (UCVA) in children, and to evaluate the extent to which visual acuity reflects refractive status under conditions similar to those used in primary care and school-based vision screening. **Methods:** A cross-sectional study was conducted in 190 children (mean age 8.35 ± 2.94 years) attending routine optometric examinations in Lisbon, Portugal. Refractive status was assessed by non-cycloplegic retinoscopy and classified using spherical equivalent. UCVA was measured with logMAR charts. Reduced UCVA was defined as >0.10 logMAR. Multivariable logistic regression was performed to identify factors associated with reduced UCVA. **Results:** Hyperopia was the most common refractive status (56.8%), followed by emmetropia (22.6%) and myopia (20.5%), with a shift toward myopia with increasing age. Reduced UCVA was present in 30.5% of children and increased with age. Among children with reduced UCVA, 67.2% were not using optical correction. However, because UCVA was measured under deliberately uncorrected conditions, this finding should not be interpreted as confirmed presenting visual impairment or definitive unmet need, but rather as an indicator of potential need for further visual assessment. Notably, 68.7% of children with refractive error had normal UCVA, while 6.3% without refractive error showed reduced UCVA. **Conclusions:** In this pediatric clinical sample, visual acuity alone may not reliably reflect refractive status, particularly for low-magnitude refractive errors, under non-cycloplegic, routine screening-like conditions. However, because the study included children attending routine optometric examinations rather than a school-based or population-based sample, the findings should not be interpreted as population-representative and should be generalized with caution.

Keywords

refractive error, uncorrected visual acuity, pediatric population, vision screening, visual function

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1. Introduction

Uncorrected refractive errors (UREs) are a leading cause of avoidable visual impairment worldwide and represent a major public health concern affecting individuals across all age groups.[1,2] It is estimated that approximately 259 million people are visually impaired globally, including nearly 98 million individuals affected by uncorrected refractive errors.[3] More recent

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estimates suggest that over one billion individuals live with vision impairment that is either preventable or unaddressed, and projections indicate a substantial increase in this burden in the coming decades.[4-6]

Refractive errors arise from a mismatch between the optical power of the eye and its axial length, resulting in blurred retinal images and reduced visual performance. The main types of refractive errors include myopia and hyperopia, classified as spherical errors, and astigmatism, which results from optical asymmetry and frequently coexists with spherical components.[7-9] Although refractive errors are not considered ocular diseases, they may significantly impair visual function and lead to symptoms such as blurred vision and asthenopia if left uncorrected.[7]

The impact of uncorrected refractive errors extends beyond vision, affecting educational attainment, employment opportunities, quality of life, and overall socioeconomic productivity.[10,11] Consequently, refractive errors have been recognized as a priority area within global initiatives aimed at reducing avoidable vision impairment and improving access to eye care services, including the WHO SPECS 2030 initiatives.[11,12]

In pediatric populations, refractive error represents the most common ocular condition and plays a critical role in visual development.[13] The prevalence of refractive errors varies depending on demographic and environmental factors, including age and urbanization, with higher rates of myopia reported in urban populations.[14] Importantly, uncorrected refractive errors in children have been associated with visual, academic, and cognitive difficulties, potentially affecting school performance and long-term developmental outcomes.[15]

Despite the availability of effective and relatively low-cost corrective interventions, a substantial proportion of children remain uncorrected, highlighting a persistent unmet need for vision care services.[13,16] Early detection through vision screening programs and timely correction are essential strategies to reduce the impact of refractive errors and improve both visual and functional outcomes.[17]

Visual acuity assessment is widely used in pediatric vision screening because it is simple, low-cost, and feasible in primary care and community settings. However, visual acuity may not fully reflect refractive status, particularly under non-cycloplegic, routine screening-like conditions, where low-magnitude refractive errors may remain undetected and reduced UCVA may occur for reasons other than refractive error. Therefore, the relationship between refractive status and functional visual performance in real-world screening contexts remains insufficiently characterized.

Accordingly, this study aimed to evaluate the frequency of refractive error and reduced uncorrected visual acuity (UCVA) in a pediatric clinical sample, to examine the relationship between refractive status and UCVA under non-cycloplegic screening-like conditions, and to identify factors associated with reduced UCVA.

2. Methods

2.1. Study Design

This was an observational, descriptive, and cross-sectional study conducted in a pediatric population undergoing routine optometric examinations. The study adhered to the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the the Higher Institute of Education and Sciences (ISEC), Lisbon, Portugal (approval number: CE/2022/03/01). Parents or legal guardians of all participants provided written informed consent prior to inclusion in the study.

2.2. Study Population

The study population comprised participants who attended routine optometric examinations in the Lisbon metropolitan region (Portugal). Data collection was carried out between October 2025 and January 2026. A consecutive sampling approach was used, whereby all pediatric patients attending during the study period were assessed for eligibility. The final analytical sample included 190 children with complete and valid clinical data (Figure 1).

Participants were included if complete information was available for age, sex, refractive error, visual acuity, and stereopsis. Specifically, the dataset included spherical and cylindrical refractive components, spherical equivalent, uncorrected and corrected visual acuity (recorded in logMAR units), and stereopsis measurements.

Refractive status was assessed by means of non-cycloplegic retinoscopy, visual acuity was evaluated using logMAR charts under standardized conditions, and stereopsis was measured using the Randot Dot 3 stereotest.

Participants presenting ocular media opacities, retinal abnormalities, or any condition that could compromise the reliability of visual or refractive measurements were excluded. In addition, records with incomplete data or poor measurement quality were not considered for analysis.

Each participant was assessed once during the study period, and no repeated measurements were included.

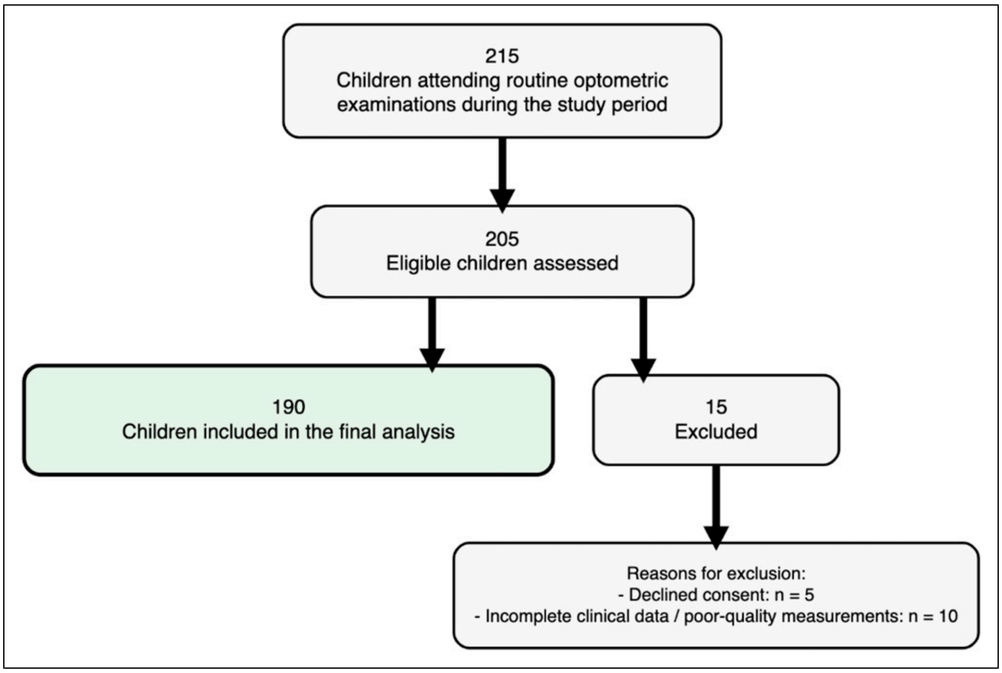

Figure 1. Participant flow diagram

2.3. Procedures

The clinical procedures consisted of non-cycloplegic static retinoscopy, visual acuity assessment using logMAR charts, and stereopsis evaluation, reflecting routine optometric clinical practice and real-world primary care. All examinations were performed during a single visit under standardized lighting conditions by experienced optometrists. Retinoscopy and visual acuity assessment were performed as part of the same routine optometric examination. Formal masking between the optometrists performing retinoscopy and those assessing visual acuity was not implemented.

Non-cycloplegic retinoscopy was intentionally used to simulate screening-like conditions, where cycloplegic refraction is not routinely performed. This approach was consistent with the screening-simulation design of the study, although it may introduce refractive misclassification, particularly in younger children. Retinoscopy was performed using a streak retinoscope at a fixed working distance of 67 cm. Participants were instructed to fixate on a high-contrast distant target positioned at approximately 4 m in order to minimize accommodative response during the examination. The movement of the retinal reflex was observed while sweeping the retinoscope streak across the pupil. The working distance lens (1.50 D) was subtracted from the final neutralization value.

Uncorrected visual acuity (UCVA) was measured monocularly using standardized logMAR charts without optical correction in all participants, including habitual spectacle wearers. When available, corrected visual acuity (CVA) was also recorded using the participant's habitual optical correction. Therefore, UCVA in this study reflects visual performance under a deliberately uncorrected testing condition rather than presenting visual acuity in daily life. For analytical purposes, normal UCVA was defined as ≤0.10 logMAR, while reduced UCVA was defined as >0.10 logMAR. This threshold was selected to identify mildly reduced UCVA, as 0.10 logMAR corresponds approximately to 20/25 Snellen acuity and is close to commonly used pediatric visual acuity screening thresholds, including 20/30 or 20/32 for children aged 5 years and older.[18]

Stereopsis was evaluated using the Randot Dot 3 stereotest under standardized conditions, and results were recorded in arcseconds. For descriptive purposes, reduced stereopsis was defined as values greater than 60 arcseconds.

For each participant, spherical and cylindrical refractive components and spherical equivalent (SE) were calculated and recorded in negative-cylinder notation. The spherical equivalent was computed as SE = sphere + (cylinder/2). Refractive status classification was based on spherical equivalent values and followed established clinical criteria consistent with the International Myopia Institute definitions and subsequent IMI updates: myopia (SE ≤ −0.50 D), hyperopia (SE ≥ +0.50 D), and emmetropia (SE > −0.50 D and SE < +0.50 D).[13,19]

2.4. Statistical Analysis

Statistical analysis was performed using R software (version 4.4.2). Analyses were conducted using data from the right eye only to avoid inter-eye correlation and ensure independence of observations, as inclusion of both eyes from the same participant would violate the assumption of independent observations in standard regression models. Data were cleaned and formatted prior to analysis, excluding records with missing values or implausible measurements.

Continuous variables were summarized using mean ± standard deviation (SD) or median and interquartile range (IQR), as appropriate, while categorical variables were expressed as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test.

Refractive status was classified based on spherical equivalent, and age was categorized into three groups (≤6, 7–9, and ≥10 years). The prevalence of refractive error and reduced uncorrected visual acuity (UCVA) was calculated overall and by age group. UCVA was dichotomized according to predefined clinical thresholds.

Group comparisons were performed using chi-square tests for categorical variables and Student's t-test or Mann–Whitney U test for continuous variables, as appropriate.

A multivariable logistic regression model (generalized linear model with binomial distribution) was used to identify factors associated with reduced UCVA. Variables were selected a priori based on clinical relevance and included age, sex, spherical equivalent, and log-transformed stereopsis. Spherical equivalent was included as a continuous predictor in the main model, whereas refractive status categories were used only for descriptive and stratified analyses to avoid collinearity and redundancy between these related refractive variables. Adjusted odds ratios (OR) with 95% confidence intervals (CI) were reported. Model discrimination was assessed using the area under the receiver operating characteristic curve (AUC), and calibration was evaluated using the Hosmer–Lemeshow goodness-of-fit test. To explore the potential influence of non-linearity in age, an additional sensitivity model was fitted using age categories (≤6, 7–9, and ≥10 years) instead of age as a continuous variable. Statistical significance was set at $p < 0.05$. A sensitivity analysis was performed to evaluate the influence of low-magnitude refractive errors on the observed refractive–function mismatch. For this analysis, refractive error was reclassified using more restrictive clinically significant thresholds, defined as myopia ≤ −1.00 D or hyperopia ≥ +1.50 D. Mismatch rates were then recalculated and compared with the primary definition based on spherical equivalent thresholds of ≤ −0.50 D or ≥ +0.50 D.

In addition, although no a priori sample size calculation was performed, the achieved sample size allows an assessment of the precision of the main prevalence estimates. Under a conservative assumption of a 50% prevalence, a sample of 190 participants corresponds to an approximate margin of error of ±7–8% at a 95% confidence level. For the multivariable logistic regression, 58 children presented reduced UCVA, and four predictors were included in the main model, corresponding to approximately 14.5 events per variable. Therefore, the model met the commonly used rule of at least 10 events per variable, although the results should still be interpreted as exploratory.

3. Results

3.1 Socio-Demographic and Clinical Characteristics

A total of 190 participants were included in the study. The mean age was 8.35 ± 2.94 years (range: 4–16 years). When stratified by age, the sample included 63 children aged ≤6 years, 70 aged 7–9 years, and 57 aged ≥10 years (Supplementary Table 1). A clear shift in refractive distribution was observed across these groups. Although the sex distribution was relatively balanced, females accounted for 89 (46.8%) of the sample, while males represented 101 (53.2%).

The mean spherical equivalent (SE) was 0.33 ± 1.71 diopters, ranging from −7.00 to +12.50 diopters. The mean uncorrected visual acuity was 0.15 ± 0.27 logMAR, while the mean corrected visual acuity was 0.05 ± 0.24 logMAR.

With regard to binocular vision, the mean stereopsis was 73.9 ± 96.4 arcseconds, ranging from 12 to 400.

With respect to refractive correction status, 21 participants (11.1%) were using optical correction (spectacles), whereas the majority of the sample (88.9%) were uncorrected (Table 1).

3.2 Prevalence of Refractive Error

Overall, hyperopia was the most prevalent refractive error, affecting 108 participants (56.8%), followed by emmetropia in 43 (22.6%) and myopia in 39 (20.5%). Hyperopia was most frequent in younger children, affecting 43 participants (68.3%) aged ≤6 years, and decreased progressively with age to 40 (57.1%) in those aged 7–9 years and 25 (43.9%) in children aged ≥10 years. In contrast, the prevalence of myopia increased with age, from 10 cases (15.9%) in the youngest group to 14 (20.0%) in children aged 7–9 years and 15 (26.3%) in those aged ≥10 years. Similarly, emmetropia showed a gradual increase

Table 1. Socio-Demographic and Clinical Characteristics by Sex

Characteristic	Female (n = 89)	Male (n = 101)	p-value
Age, years	8.00 (6.00–10.00)	8.00 (6.00–10.00)	0.976
Spherical equivalent, D	0.50 (0.00–1.00)	0.50 (−0.38–1.00)	0.551
Uncorrected visual acuity, logMAR	0.05 (0.00–0.15)	0.05 (0.00–0.22)	0.266
Stereopsis, arcsec	32.00 (12.60–100.00)	25.00 (12.60–100.00)	0.809
Spectacle use, n (%)			>0.999
No	79 (88.8%)	90 (89.1%)	
Yes	10 (11.2%)	11 (10.9%)	

Note. Continuous variables are presented as median (Q1–Q3), and categorical variables as n (%). P-values were obtained using the Mann–Whitney U test for continuous variables and the chi-square or Fisher's exact test for categorical variables, as appropriate.

across age groups, from 10 participants (15.9%) in children aged ≤6 years to 16 (22.9%) in those aged 7–9 years and 17 (29.8%) in the oldest group (Figure 2).

3.3. Prevalence of Reduced Uncorrected Visual Acuity

A total of 58 children (30.5%) presented reduced uncorrected visual acuity, while 132 (69.5%) had normal UCVA.

When stratified by age, the prevalence of reduced uncorrected visual acuity showed an age-related pattern, being 16 cases (25.4%) in children aged ≤6 years, 14 (20.0%) in those aged 7–9 years, and increasing markedly to 28 (49.1%) in children aged ≥10 years, indicating a higher frequency of reduced UCVA in older children.

Among the 21 participants with available corrected visual acuity data, mean visual acuity improved from 0.60 ± 0.45 logMAR (uncorrected) to 0.10 ± 0.12 logMAR (corrected), corresponding to an average improvement of approximately 0.50 logMAR.

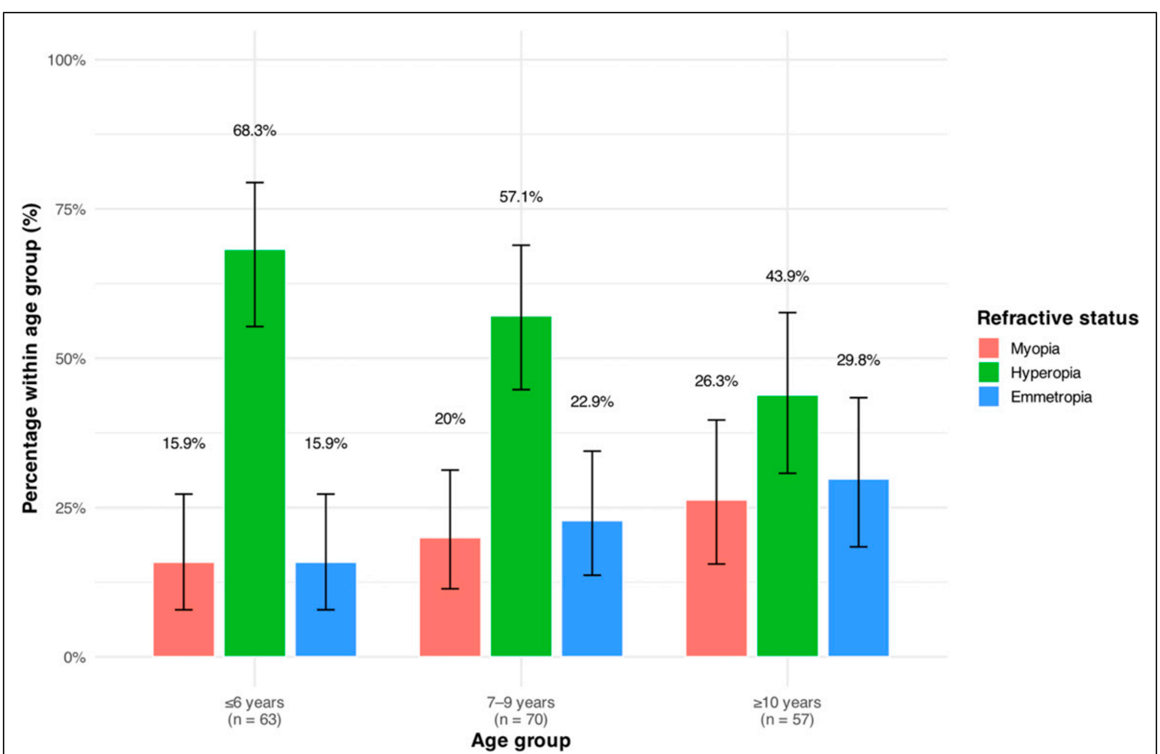

Figure 2. Distribution of refractive error by age group. Percentages were calculated within each age group. Error bars represent 95% confidence interval. Denominators were n = 63 for ≤6 years, n = 70 for 7–9 years, and n = 57 for ≥10 years

Importantly, 39 children (20.5% of the total sample and 67.2% of those with reduced UCVA) had reduced UCVA and were not using optical correction, suggesting a potential need for further visual assessment and, where appropriate, optical correction. Conversely, 19 children (32.8%) with reduced UCVA were already using optical correction. Because UCVA was measured without correction in all participants, including habitual spectacle wearers, reduced UCVA should not be interpreted as presenting visual impairment or as confirmed unmet need.

This pattern of reduced UCVA among children not using optical correction was observed across all age groups, affecting 14 children (22.2%) aged ≤6 years, 11 (15.7%) aged 7–9 years, and 14 (24.6%) aged ≥10 years. When expressed relative to the number of children with reduced UCVA in each age group, these proportions were 87.5% (14/16), 78.6% (11/14), and 50.0% (14/28), respectively.

3.4. Refractive–Function Mismatch

A substantial discrepancy between refractive status and UCVA under uncorrected testing conditions was observed. A total of 101 out of 147 children with refractive error (68.7%) had normal UCVA (53.2% of the total sample), with very low logMAR values (mean 0.02 logMAR). This finding indicates that many children classified as having refractive error according to the study thresholds did not show reduced UCVA; however, this should be interpreted cautiously because many of these cases may correspond to low-magnitude refractive errors with limited immediate functional significance.

Conversely, 12 children (6.3%) exhibited reduced UCVA (>0.10 logMAR) in the absence of refractive error, representing 20.7% of all children with reduced UCVA. These children had a mean UCVA of 0.29 logMAR, with an overall mean difference of 0.41 logMAR between children with normal and reduced UCVA. In addition, 11 children (5.8%) presented reduced stereopsis (>60 arcseconds) despite having no significant refractive error. Median stereopsis values were comparable between children with and without refractive error (32 vs 25 arcseconds, respectively), and no association was observed when refractive error was defined using broad spherical equivalent thresholds (p = 0.814). Furthermore, among children without refractive error, 27.9% presented reduced UCVA, suggesting that reduced UCVA under uncorrected testing conditions cannot be solely explained by refractive status.

In the sensitivity analysis, refractive error was redefined using clinically significant thresholds of myopia ≤ −1.00 D or hyperopia ≥ +1.50 D. Under this definition, 59/190 children (31.1%) were classified as having refractive error, compared with 147/190 (77.4%) using the primary threshold of SE ≤ −0.50 D or ≥ +0.50 D. Among children with refractive error, normal UCVA was observed in 31/59 (52.5%) using the clinically significant definition, compared with 101/147 (68.7%) in the primary analysis.

3.5. Factors Associated With Reduced Uncorrected Visual Acuity

In the adjusted model, increasing age was significantly associated with higher odds of reduced UCVA (OR = 1.16; 95% CI: 1.03–1.30; p = 0.016). Spherical equivalent was also significantly associated with the outcome (OR = 0.73; 95% CI: 0.56–0.92; p = 0.013), indicating that more myopic refractive errors were related to worse visual performance. Log-transformed stereopsis showed a borderline association with reduced UCVA (OR = 1.35; 95% CI: 0.98–1.88; p = 0.068). No statistically significant association was observed for sex (p = 0.123) Table 2.

Model performance was modest, with moderate discrimination as indicated by an AUC of 0.70 (95% CI: 0.60–0.79). The Hosmer–Lemeshow test did not show clear evidence of poor calibration, although the result was borderline ($\chi^2 = 15.02$, df = 8, p = 0.059). In the sensitivity model using age categories instead of continuous age, children aged ≥10 years had higher odds of reduced UCVA compared with those aged ≤6 years (OR = 2.54; 95% CI: 1.09–6.06; p = 0.032), while the 7–9 years group did not differ significantly (OR = 0.79; 95% CI: 0.33–1.87; p = 0.585). The model with age categories had a similar fit to the continuous-age model (AIC 201.53 vs 201.75; likelihood-ratio test p = 0.137).

Table 2. Multivariable Logistic Regression Analysis of Factors Associated With Reduced Uncorrected Visual Acuity

Variable	OR	95% CI	p-value
Age (years)	1.16	1.03–1.30	0.016
Male sex	1.73	0.87–3.51	0.123
Spherical equivalent (D)	0.73	0.56–0.92	0.013
Stereopsis (log-transformed)	1.35	0.98–1.88	0.068

4. Discussion

The present study examined the prevalence of refractive error and reduced UCVA in a pediatric population, with a particular focus on the relationship between refractive status and functional visual performance under routine clinical optometric conditions. The main findings indicate: (i) a high prevalence of refractive error with a clear age-related pattern, (ii) a proportion of children with reduced UCVA who were not using optical correction, and (iii) a discrepancy between refractive status and UCVA under uncorrected testing conditions.

The overall prevalence of refractive error in our sample was higher than that reported in most school-based studies. For example, Mayro et al[20] reported a prevalence of 13.1% in a large cohort of schoolchildren in Philadelphia, while Bakare et al[21] described a prevalence of approximately 12% in India, and Asare et al[22] reported only 1.8% in Ghana. More recent school-based studies have also shown considerable variability in refractive error estimates according to the population assessed, age range, screening pathway, and refractive criteria used. Nguyen et al[17] reported a high burden of clinically significant refractive error among children receiving school-based eye examinations after vision screening, while Garcia-Lozada et al[23] found that refractive error patterns varied with age among school-aged children in Colombia. In contrast, a substantially larger proportion of children in our study were classified as having refractive error. This discrepancy does not necessarily reflect true epidemiological differences, but rather highlights the impact of methodological variability. Unlike previous studies that typically focus on clinically significant or uncorrected refractive error, our classification was based on spherical equivalent thresholds and included low-magnitude refractive errors. Furthermore, the use of non-cycloplegic retinoscopy may have influenced refractive classification, particularly in younger children. Thus, our findings underscore that prevalence estimates are highly sensitive to diagnostic criteria and measurement techniques.

Despite these differences in magnitude, the age-related refractive pattern observed in this study is consistent with the existing literature. Hyperopia predominated in younger children and decreased with age, while myopia increased progressively. This pattern aligns with findings from both school-based cohorts and global analyses, including those reported by Yang et al,[24] who described an increasing burden of URE during childhood and adolescence. Similarly, the prevalence of reduced UCVA increased markedly with age in our study, from 25.4% in younger children to 49.1% in older children, further supporting the notion that reduced UCVA becomes more frequent as refractive errors evolve and visual demands increase.

A clinically relevant finding was that a substantial proportion of children with reduced UCVA were not using optical correction. Specifically, among children with reduced UCVA, 67.2% were not using optical correction, suggesting a potential need for further visual assessment and, where appropriate, optical correction. However, this finding should be interpreted cautiously because UCVA was measured without correction in all participants, including habitual spectacle wearers. Therefore, reduced UCVA in this study reflects visual performance under an intentionally uncorrected testing condition and should not be equated with presenting visual impairment or confirmed unmet need.

Nevertheless, the presence of reduced UCVA among children not using optical correction may still be clinically relevant, as it can help identify children who may benefit from comprehensive visual assessment. Previous studies have similarly reported a high burden of uncorrected refractive error among schoolchildren. For instance, Asare et al.[22] reported that none of the children with refractive error were corrected, while Bakare et al.[21] also documented a high burden of uncorrected refractive error among schoolchildren. Moreover, large-scale clinical data from García-Gil et al.[25] demonstrated that uncorrected refractive error remains highly prevalent even in healthcare systems with broad service coverage. Taken together, these findings suggest that undercorrection or lack of correction remains an important public health issue, although the present results should be interpreted in light of the deliberately uncorrected UCVA assessment.

It should also be noted that reduced UCVA was defined using a threshold of >0.10 logMAR, which is relatively stringent compared with some commonly used screening thresholds. If less stringent criteria, such as 20/30 or 20/40, had been applied, the estimated prevalence of reduced UCVA would likely have been lower. This may also have influenced the magnitude of the observed refractive–function mismatch, as some children classified as having reduced UCVA under the present definition may have been considered normal using alternative screening criteria.

The most relevant contribution of this study lies in the identification of a marked mismatch between refractive error and UCVA under uncorrected testing conditions. However, it is important to distinguish between refractive error as defined by the study thresholds and clinically significant refractive error requiring intervention. Notably, 68.7% of children with refractive error exhibited normal UCVA, while 6.3% of children without refractive error presented reduced UCVA. Many of the cases contributing to this mismatch involved low-magnitude refractive errors, which may have limited immediate functional significance and should not necessarily be interpreted as requiring optical correction. These findings therefore suggest that refractive error, particularly when defined using broad thresholds, is not always associated with measurable functional impairment.

At the same time, the observed mismatch should also be interpreted in light of the non-cycloplegic nature of the refractive assessment. Accommodation-related measurement error may have contributed to refractive misclassification, particularly in younger children, and may therefore partly explain both the high proportion of children classified as having refractive error and the discrepancy observed between refractive status and UCVA. Therefore, these findings should not be interpreted as evidence that visual acuity-based screening is insufficient or performs poorly. Rather, they suggest that visual acuity assessment may be limited under certain non-cycloplegic, screening-like clinical conditions, particularly for detecting low-magnitude refractive errors.

The sensitivity analysis further supported this interpretation. When refractive error was redefined using clinically significant thresholds of myopia ≤ -1.00 D or hyperopia $\geq +1.50$ D, the proportion of children classified as having refractive error decreased from 77.4% to 31.1%, and the proportion of children with refractive error and normal UCVA decreased from 68.7% to 52.5%. This suggests that low-magnitude refractive errors contributed to the high prevalence estimates and to part of the observed refractive–function mismatch. Nevertheless, the persistence of some mismatch under the more restrictive definition suggests that UCVA and refractive status are not fully interchangeable measures, even when more clinically significant refractive thresholds are considered.

Furthermore, the presence of reduced UCVA in children without refractive error indicates that visual function cannot be fully explained by refractive status alone. This observation is partially consistent with findings from studies such as that of Bakare et al,[21] where a subset of children with decreased vision did not improve with refractive correction, suggesting alternative or additional contributors to reduced UCVA. Our results extend this evidence by demonstrating that the relationship between refractive error and UCVA under uncorrected testing conditions is neither linear nor deterministic.

Several mechanisms may help explain the observed refractive–function mismatch. First, accommodation may partially compensate for low-to-moderate hyperopic errors, particularly in younger children, allowing normal UCVA despite the presence of refractive error. Second, the relatively large depth of focus in children may reduce the functional impact of small refractive deviations under standard visual acuity testing conditions. Third, neural adaptation to habitual blur may influence functional visual performance, meaning that some children with refractive error may maintain apparently normal UCVA, while others may show reduced UCVA despite limited refractive findings. These mechanisms were not directly assessed in the present study, but they may contribute to the imperfect correspondence between refractive status and UCVA observed under non-cycloplegic, screening-like clinical conditions.

The multivariable analysis provides additional insight into this relationship, although the findings should be interpreted with caution. While spherical equivalent was significantly associated with reduced UCVA, suggesting that more myopic refractive errors may be related to worse visual performance, no overall association was observed when refractive error was considered as a categorical variable. This apparent discrepancy highlights the importance of how refractive error is defined and suggests that its functional impact may depend on magnitude and type rather than mere presence. Additionally, increasing age was associated with reduced UCVA, consistent with global evidence indicating that age is an important determinant of URE burden. However, model performance was modest, and the analysis included only a limited number of clinical covariates. Behavioural and environmental variables, such as near work, screen time, outdoor exposure, parental refractive status, and access to eye care, were not available. Therefore, these findings should be considered exploratory rather than confirmatory. Given the relatively small sample size, the absence of statistically significant associations for sex and stereopsis should also be interpreted cautiously, as limited statistical power and type II error cannot be excluded.

From a clinical and public health perspective, these findings support the use of complementary assessment strategies that integrate refractive, functional, binocular, and symptom-based evaluation to identify children who may require further assessment while minimizing the risk of overdiagnosis or unnecessary correction.

Several limitations should be considered when interpreting the findings of this study. First, and most importantly, refractive assessment was performed using non-cycloplegic retinoscopy. Although this approach reflects routine clinical and screening-like practice in many settings, it represents a major limitation in pediatric populations. Residual accommodation may lead to overestimation of myopia, underestimation of hyperopia, and misclassification of refractive status. This issue is central to the interpretation of the present findings, as accommodation-related measurement error may have directly influenced the estimated prevalence of refractive error, particularly hyperopia, as well as the magnitude of the observed refractive–function mismatch. Therefore, part of the discrepancy between refractive status and UCVA may reflect refractive misclassification resulting from non-cycloplegic assessment rather than a true dissociation between refractive error and visual function. Consequently, refractive findings and screening-related implications should be interpreted with caution, particularly when compared with studies using cycloplegic refraction. Nevertheless, the use of non-cycloplegic assessment may provide insight into screening-like evaluations commonly used in primary care or community settings, where cycloplegia is not routinely performed.

Second, UCVA was intentionally measured without optical correction in all participants, including habitual spectacle wearers, in order to simulate visual performance under uncorrected testing conditions. However, this approach may have led to an overestimation of functional visual impairment and could have influenced the observed associations between refractive error and UCVA. Importantly, these findings should not be interpreted as true presenting visual impairment or intrinsic visual deficit, but rather as visual performance under a deliberately uncorrected condition. This distinction is particularly relevant for habitual spectacle wearers, in whom reduced UCVA may overestimate functional impairment in daily life and may inflate estimates of reduced UCVA and apparent unmet need for optical correction. Presenting visual acuity was not systematically available for all participants, and this should be considered when interpreting the results.

Third, the cross-sectional design limits causal inference and precludes the assessment of temporal relationships between refractive development and visual function. In addition, the inclusion of low-magnitude refractive errors may have influenced the observed relationship between refractive status and visual performance and may overestimate the proportion of children with clinically meaningful refractive findings. However, this issue was explored through a sensitivity analysis using more clinically significant thresholds for refractive error, which showed that the refractive–function mismatch decreased but remained present after excluding lower-magnitude refractive errors.

Fourth, the study was conducted in a single optometric clinical setting during routine eye examinations, rather than in a school-based or population-based sample. This limitation is important for the interpretation and generalizability of the findings. Children attending optometric examinations may differ systematically from the general pediatric population in terms of visual symptoms, parental concern, previous referral, prior access to eye care, or healthcare-seeking behavior. Therefore, prevalence estimates should not be interpreted as population-representative, and direct extrapolation to the broader pediatric population or to school-based screening settings should be made with caution. However, this clinical context also represents a strength of the study, as assessments were performed under conditions closely resembling those encountered in primary care and screening-like clinical settings, where evaluations are typically non-cycloplegic and rely primarily on visual acuity. In addition, the use of a consecutive clinical sample enhances transparency and reflects routine clinical practice, although it may limit the precision of prevalence estimates. Finally, although the events-per-variable ratio was acceptable for the multivariable model, the relatively small sample size may have limited the statistical power to detect weaker associations. Therefore, non-significant findings, particularly those related to sex and stereopsis, should be interpreted cautiously, as type II error cannot be excluded.

Future research should incorporate cycloplegic refraction to improve diagnostic accuracy and allow for more precise classification of refractive error, particularly in younger populations. In particular, studies directly comparing cycloplegic and non-cycloplegic assessments within the same pediatric population would be valuable to quantify the extent of refractive misclassification under screening-like conditions. Population-based and school-based studies are needed to confirm these findings and assess their external validity beyond clinical optometric samples. Longitudinal studies are also warranted to better understand the dynamic relationship between refractive changes and functional visual outcomes over time. Future work should include broader socioeconomic, behavioural, educational, and environmental variables, such as screen time, near work, outdoor activity, parental refractive status, and access to eye care, which may influence both refractive status and UCVA. Furthermore, future studies should explore the mechanisms underlying the observed refractive–function mismatch, including the potential role of binocular vision, accommodation, and neural adaptation. Finally, evaluating combined screening approaches that integrate refractive, functional, binocular, and symptom-based assessments may help optimize pediatric vision screening strategies, improving identification of children who may require further visual assessment while reducing the risk of overdiagnosis.

Conclusions

This study found a high frequency of refractive error in this pediatric clinical sample, with an age-related pattern characterized by a predominance of hyperopia in younger children and a progressive increase in myopia with age. However, because refractive status was assessed using non-cycloplegic retinoscopy, these estimates should be interpreted with caution, as accommodation-related measurement error may have influenced refractive classification, particularly in younger children. In addition, because this was a clinical optometric sample rather than a school-based or population-based sample, these findings should not be interpreted as population-representative and should be generalized with caution.

Reduced uncorrected visual acuity (UCVA) was also frequent and increased with age. More than two-thirds of children with reduced UCVA were not using optical correction, suggesting a potential need for further visual assessment and, where appropriate, optical correction. Nevertheless, because UCVA was measured under deliberately uncorrected testing conditions, this finding should not be interpreted as confirmed presenting visual impairment or definitive unmet need for optical correction.

Importantly, the study identified a discrepancy between refractive status and functional visual performance: many children with refractive error had normal UCVA, while some children without refractive error showed reduced UCVA. These findings suggest that visual acuity alone may be limited under non-cycloplegic, screening-like clinical conditions, particularly for detecting low-magnitude refractive errors. However, the observed mismatch may partly reflect refractive misclassification related to non-cycloplegic assessment rather than a true dissociation between refractive error and visual function. Complementary assessment strategies integrating refractive, functional, binocular, and symptom-based evaluation may help identify children who require further visual assessment while minimizing the risk of overdiagnosis or unnecessary correction.

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Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Higher Institute of Education and Sciences (ISEC), Lisbon, Portugal (approval number: CE/2022/03/01).

Consent to Participate

Written informed consent was obtained from the parents or legal guardians of all participants prior to inclusion in the study.

Author Contributions

Concept and design: AR, AFN, HN, and CMP.
Data collection: AR.
Data analysis: CMP.
Data interpretation: AR and CMP.
Drafting of the manuscript: AR and CMP.
Critical revision of the manuscript for important intellectual content: AR, AFN, HN, and CMP.
All authors read and approved the final version of the manuscript.

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Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Supplemental Material

Supplemental material for this article is available online.

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