Original Article

Characteristics of astigmatism in school-age children aged 5 to 13 years in northeast Sichuan: a cross-sectional school-based study

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Background: Astigmatism is closely associated with myopia progression, vision loss, eye fatigue and amblyopia, which seriously endangers children's eye health. This study aims to investigate the prevalence and characteristic distribution of astigmatism in children in Langzhong City, providing valuable insights for allocating resources and develop prevention and control strategies.

Methods: A cross-sectional study and random sampling survey were conducted. Between January and November 2021, 21,415 students aged 5 to 13 years from 14 primary schools in Langzhong City underwent non-cycloplegic refractive testing using autorefraction. The data on myopia were analyzed using SPSS (Statistical Package for the Social Sciences) version 23.0.

Results: The inclusion criterion was set at an absolute astigmatism value of ≥0.50D. Among the 21,415 children studied, 61.70% were found to have astigmatism. The prevalence of astigmatism varied significantly across different grades (χ^2=501.414, P<0.001). The predominant types of astigmatism were mild astigmatism (0.50–1.00D) and with-the-rule astigmatism. Mixed astigmatism was primarily observed in children in grades 1 and 2, while compound myopic astigmatism was more common in children in grades 3 to 6. These differences were statistically significant. As the degree of astigmatism increased, the proportions of against-the-rule astigmatism, oblique astigmatism, compound myopic astigmatism, and simple hyperopic astigmatism decreased, whereas the proportions of with-the-rule astigmatism, mixed astigmatism, and compound hyperopic astigmatism increased.

Conclusions: The prevalence of astigmatism among school-age children aged 5 to 13 years in northeast Sichuan is notably high, with compound myopic astigmatism and with-the-rule astigmatism being the most common types. Regular refractive examinations are crucial for the early detection and management of astigmatism.

Keywords: Astigmatism; northeast Sichuan; refractive error; school-age children

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Introduction

Astigmatism is a prevalent cause of impaired vision and visual dysfunction in school-aged children. In recent years, it has emerged as a significant public health concern, with its prevalence in children and adolescents steadily increasing (1). Uncorrected astigmatism can lead to vision loss, eye fatigue, amblyopia, and impaired accommodative function. Additionally, inaccurate correction of the astigmatism axis can result in abnormal head posture (1). Astigmatism is also associated with the development of myopia (2,3). Therefore, understanding the characteristics of astigmatism in school-age children is crucial for clinical examination and precise correction, which holds great clinical significance for the treatment of astigmatism and the enhancement of visual function in children. This study aims to provide a foundation for the treatment of astigmatism in children in northeast Sichuan by analyzing the prevalence, type, cylinder power, and axis of astigmatism in school-age children aged 5 to 13 years. We present this article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-24-70/rc).

Methods

Study design and participants

This cross-sectional school-based study focused on refractive errors and was conducted from January to November 2021 in Langzhong City, a county-level city in Sichuan Province with a population of approximately 810,000. Langzhong City has around 32,000 primary school students. Fourteen primary schools were randomly selected using random overall sampling. With permission from the schools, refractive examinations were performed on all primary school students in the selected schools. The final valid sample consisted of 21,415 students, representing 67% of all primary school students in the region, including 10,792 boys (50.4%) and 10,623 girls (49.6%). The ages of the participants ranged from 5 to 13 years, with an average age of 8.82±1.791 years (mean ± standard deviation). Student information, including name, gender, ID number, roll number, and grade, was obtained from school rosters.

All participants underwent routine eye examinations conducted by an ophthalmologist or optometrist. The inclusion criteria were as follows: (I) permanent primary school students in Langzhong City; (II) no history of ophthalmic diseases, ocular trauma, or surgery except for refractive error; (III) physically and mentally healthy with no congenital developmental abnormalities or related diseases affecting vision and refractive examination; (IV) no use of orthokeratology lenses in the previous 3 months; (V) no administration of myopia medication, including atropine, in the past 6 months.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was reviewed and approved by the Ethics Committee of Langzhong People's Hospital (No. 2021002), and the investigation was carried out with the consent of the Education Bureau and the schools. Informed consent was obtained from each participant and their guardians.

Highlight box

Key findings
- The prevalence of astigmatism among school-age children aged 5 to 13 years in northeast Sichuan is notably high, with compound myopic astigmatism and with-the-rule astigmatism being the most common types.

What is known and what is new?
- Astigmatism is a prevalent cause of impaired vision and visual dysfunction in school-aged children, with its prevalence in children and adolescents steadily increasing.
- This study provides detailed prevalence data and characteristic distribution of astigmatism types among school-age children in Langzhong City.

What is the implication, and what should change now?
- Regular refractive examinations are crucial for early detection and management of astigmatism in children.

Investigation methods

The measurement of non-cycloplegic refraction was performed using a table-mounted NIDEK auto kerato-refractometer (Model: ARK-1, Japan). Astigmatism was recorded in the minus cylinder format. It was defined as an absolute cylindrical refractive error of ≥0.50D in either eye in the non-cycloplegic state. When both eyes exhibited astigmatism, the severity and type of astigmatism were analyzed based on the eye with the larger absolute value.

Astigmatism was categorized into five types according to the relationship between the two principal meridians' focal points and the retina: simple myopic astigmatism, simple hyperopic astigmatism, compound myopic astigmatism, compound hyperopic astigmatism, and mixed

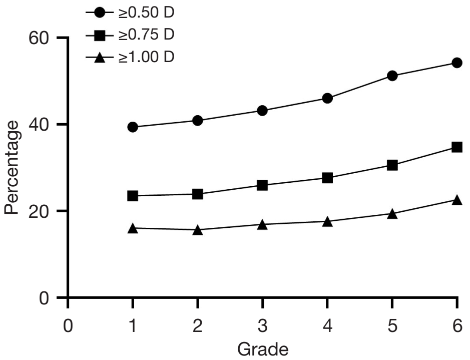

Figure 1 Astigmatism prevalence across different grades under various inclusion criteria.

astigmatism. Furthermore, astigmatism was classified into three categories based on the meridian with the maximum refractive force (highest minus value): with-the-rule astigmatism (principal meridians of maximum refractive force at 90°±30°), against-the-rule astigmatism (principal meridians of maximum refractive force at 180°±30°), and oblique astigmatism (any other meridian).

According to the degree of astigmatism, participants were divided into five groups: 0.50–1.00D (mild astigmatism), 1.25–2.00D (moderate astigmatism), 2.25–3.00D (medium-high astigmatism), 3.25–4.00D (high astigmatism), and ≥4.25D (severe astigmatism).

The table-mounted NIDEK non-cycloplegic autorefractor (Model: ARK-1, Japan) was employed for diopter examination. The Eye Health Home management system, an online myopia warning and prevention platform developed by Huiyan Optometry Technology Co., Ltd., China, was used for data collection, transmission, and storage. Data were collected by ophthalmologists, technicians, or nurses with national optometry certification and who had undergone standardized professional training.

Three measurements were taken from each eye, and the average of these readings was used for analysis. If any two readings from one eye differed by more than 0.5 diopters, the eye was re-measured.

Statistical analysis

SPSS 23.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for data analysis. The data were recorded by two individuals to ensure accuracy. The chi-squared test was used for comparison between rates. P<0.05 was considered statistically significant.

Results

Astigmatism prevalence

Astigmatism prevalence was assessed using inclusion criteria of absolute astigmatism values of ≥0.50D, ≥0.75D, and ≥1.00D. The prevalences were 45.88% (19,649 eyes), 27.76% (11,889 eyes), and 18.08% (7,742 eyes), respectively. Across these three detection criteria, significant differences in astigmatism prevalence were observed between different school grades (χ^2=501.414, 335.373, and 163.339, respectively; all P values <0.001), with prevalence increasing with school age (*Figure 1*). When using an absolute value of astigmatism of ≥0.50D as the standard, girls had a higher prevalence of astigmatism compared to boys (χ^2=9.876, P=0.002) (*Table 1*).

In this study, the criterion of an absolute astigmatism value of ≥0.50D was adopted to facilitate comparison with existing literature. A total of 13,212 children (61.70%) out of 21,415 school-age children were found to have astigmatism. This included 6,437 children with binocular astigmatism and 6,775 children with monocular astigmatism, accounting for 30.06% and 31.64% of the total participants, respectively. For children with astigmatism in both eyes, the eye with the higher astigmatism value was used for statistical analysis.

Composition of the degree of astigmatism

The range of astigmatism degrees in children from this region was 0.00–6.75D. The majority of cases were classified as mild astigmatism (0.50–1.00D), followed by moderate astigmatism (1.25–2.00D), which together accounted for 93.89% of all astigmatism cases.

In China, primary education spans 6 years, with students advancing from grade 1 through grade 6. The first and second grades are considered lower grades, the third and fourth grades are middle grades, and the fifth and sixth grades are senior grades. There were statistically significant differences in the degree of astigmatism among different grades (χ^2=39.063, P=0.007). Specifically, there was a notable difference between grades 1 and 6 in terms of low to moderate astigmatism (≤2.00D), while the proportions of medium-high, high, or severe astigmatism (>2.00D) remained relatively stable across different grades.

As school age increased, the prevalence of mild astigmatism rose, while moderate astigmatism decreased. The proportion of mild astigmatism stabilized in the middle

Table 1 Astigmatism prevalence in different grades and genders

	Total	Grades								Gender			
		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	χ^2 value	P value	Male	Female	χ^2 value	P value
The number of investigated eyes	42,830	7,552	6,808	6,846	7,242	7,252	7,130	–	–	21,584	21,246	–	–
Degree of astigmatism													
≥0.50D	19,649 (45.88)	2,976 (39.41)	2,787 (40.94)	2,960 (43.24)	3,337 (46.08)	3,718 (51.27)	3,871 (54.29)	501.414	<0.001	9,740 (45.13)	9,909 (46.64)	9.876	0.002
≥0.75D	11,889 (27.76)	1,775 (23.50)	1,629 (23.93)	1,778 (25.97)	2,003 (27.66)	2,223 (30.65)	2,481 (34.80)	335.373	<0.001	5,907 (27.37)	5,982 (28.16)	3.319	0.06
≥1.00D	7,742 (18.08)	1,214 (16.07)	1,067 (15.67)	1,160 (16.94)	1,278 (17.65)	1,408 (19.42)	1,615 (22.65)	163.339	<0.001	3,878 (17.97)	3,864 (18.19)	0.35	0.55

Data are presented as n or n (%).

Table 2 Astigmatism degree in different grades and genders

	Total	Grades								Gender			
		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	χ^2 value	P value	Male	Female	χ^2 value	P value
The number of investigated eyes	19,649	2,976	2,787	2,960	3,337	3,718	3,871	–	–	9,740	9,909	–	–
Degree of astigmatism								39.063	0.007			5.837	0.21
0.50–1.00D	14,653 (74.57)	2,184 (73.39)	2,103 (75.46)	2,226 (75.20)	2,556 (76.60)	2,781 (74.80)	2,803 (72.41)			7,198	7,455		
1.25–2.00D	3,796 (19.32)	616 (20.70)	515 (18.49)	533 (18.01)	581 (17.50)	714 (19.20)	837 (21.62)			1,940	1,856		
2.25–3.00D	737 (3.75)	114 (3.83)	108 (3.86)	117 (3.95)	114 (3.42)	138 (3.71)	146 (3.77)			376	361		
3.25–4.00D	311 (1.58)	37 (1.24)	42 (1.51)	56 (1.89)	62 (1.86)	56 (1.51)	58 (1.50)			151	160		
≥4.25D	152 (0.77)	25 (0.84)	19 (0.68)	28 (0.95)	24 (0.72)	29 (0.78)	27 (0.70)			75	77		

Data are presented as n or n (%).

grades. However, in the senior grades, mild astigmatism significantly decreased, and moderate astigmatism significantly increased. There were no significant differences in the distribution of astigmatism across genders (χ^2=5.837, P=0.212) (*Table 2*).

Types of astigmatism

Astigmatism divided by type of refractive state

A total of 19,649 eyes (astigmatism ≥0.50D) were included in this study. The distribution of refractive types of astigmatism was as follows: compound myopic astigmatism (57.35%), mixed astigmatism (27.29%), simple myopic astigmatism (14.10%), simple hyperopic astigmatism (0.68%), and compound hyperopic astigmatism (0.58%). Mixed astigmatism was predominantly observed in children in grades 1 and 2, while compound myopic astigmatism was more common among children in grades 3 to 6. There were significant differences in the composition of refractive types of astigmatism in children across different grades

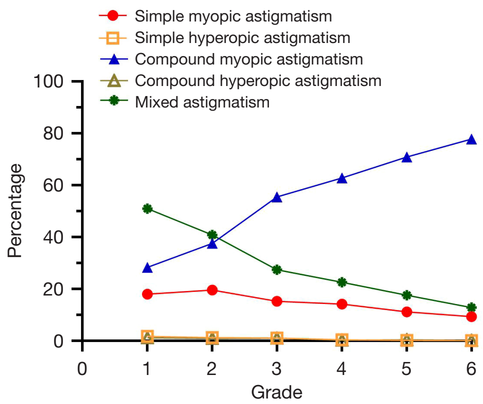

Figure 2 Distribution of refractive types of astigmatism in different grades.

(χ^2=2,681.627, P<0.001). The prevalence of compound myopic astigmatism increased significantly with age, whereas the prevalence of mixed astigmatism, simple myopic astigmatism, simple hyperopic astigmatism, and compound hyperopic astigmatism decreased with age (*Figure 2*).

There were also significant differences in the composition of refractive types of astigmatism between genders (χ^2=31.362, P<0.001). Except for compound myopic astigmatism and compound hyperopic astigmatism, which had a slightly higher prevalence in girls, the proportion of boys was marginally higher in the remaining types of astigmatism (*Table 3*).

Astigmatism divided by type of meridian position

Astigmatism was primarily composed of with-the-rule astigmatism (78.81%), followed by against-the-rule astigmatism (12.27%) and oblique astigmatism (8.93%). The axial distribution of astigmatism varied significantly between different grades (χ^2=93.637, P<0.001), but there was no significant difference in axial composition between genders (χ^2=5.180, P=0.07). In lower grades (1 and 2), the prevalence of with-the-rule astigmatism increased with age, while oblique astigmatism remained relatively stable throughout primary school (*Table 3*, *Figure 3*).

Distribution characteristics of various types of astigmatism in children with varying degrees of astigmatism

In children with varying degrees of astigmatism, there were statistically significant differences in the refractive type of astigmatism (χ^2=198.321, P<0.001) and the axial distribution of astigmatism (χ^2=575.679, P<0.001). As astigmatic power increased, the composition ratio of compound myopic astigmatism and simple hyperopic astigmatism gradually decreased. Conversely, the composition ratio of with-the-rule astigmatism showed an increasing trend, while the proportions of against-the-rule astigmatism and oblique astigmatism decreased (*Figures 4,5*).

Axial composition and distribution of different types of astigmatism

The Pearson's coefficient of contingency (C) between the type of astigmatism and the astigmatism axis was 0.716, which was statistically significant (P=0.004). This indicates a close relationship between the type of astigmatism and the axial direction of astigmatism. The distribution of astigmatism refractive types among primary school students in this region was dominated by with-the-rule astigmatism. The differences in the axial composition of different types of astigmatism were statistically significant (χ^2=42.391, P<0.001) (*Table 4*).

Discussion

Previous studies have demonstrated that the accuracy of auto-refractometers in screening for astigmatism in children without cycloplegia is high, with no statistically significant difference compared to cycloplegia measurements (4,5). The principle underlying this technology is similar to that of retinoscopy, providing comparable accuracy while offering the advantages of simplicity, safety, and efficiency (6). This technology can significantly save time in clinical practice. Wong *et al.* found that automated computer refraction techniques were up to 96% accurate without inducing ciliary paralysis (7). Goyal *et al.* studied the effect of cycloplegia on astigmatism in children aged 4 to 17 years and reported no statistical difference in the astigmatism axis and degree before and after cycloplegia. They concluded that non-cycloplegic autorefraction measurements are safe and effective for assessing astigmatism in children (8). Fotouhi *et al.* also observed no significant change in the incidence of astigmatism in high school students before and after cycloplegia (9). Therefore, using non-cycloplegic autorefraction measurements is unlikely to result in significant deviations when assessing the prevalence of astigmatism. In this investigation, non-cycloplegic computer optometry was employed due to the large sample size and the need for effective screening.

Astigmatism is a refractive error where two perpendicular

Table 3 Distribution of astigmatism types in different grades, genders, and astigmatism degrees

	Total	Grades								Gender				Degree of astigmatism				
		Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	χ^2 value	P value	Male	Female	χ^2 value	P value	0.50–1.00D	1.25–2.00D	≥2.25D	χ^2 value	P value
The number of investigated eyes	19,649	2,976	2,787	2,960	3,337	3,718	3,871	–	–	9,740	9,909	–	–	14,653	3,796	1,200	–	–
Type of refraction								2,681.627	<0.001			31.362	<0.001				198.321	<0.001
Simple myopic astigmatism	2,771 (14.10)	534 (17.94)	544 (19.52)	450 (15.20)	471 (14.11)	414 (11.14)	358 (9.25)			1,480 (15.20)	1,291 (13.03)			2,237 (12.27)	398 (10.48)	136 (11.33)		
Simple hyperopic astigmatism	134 (0.68)	50 (1.68)	34 (1.22)	30 (1.01)	12 (0.36)	5 (0.13)	3 (0.08)			72 (0.74)	62 (0.63)			122 (0.83)	11 (0.29)	1 (0.08)		
Compound myopic astigmatism	11,268 (57.35)	841 (28.26)	1,047 (37.57)	1,642 (55.47)	2,094 (62.75)	2,634 (70.84)	3,010 (77.76)			5,410 (55.54)	5,858 (59.12)			8,502 (58.02)	2,182 (57.48)	584 (48.67)		
Compound hyperopic astigmatism	113 (0.58)	34 (1.14)	24 (0.86)	28 (0.95)	8 (0.24)	14 (0.38)	5 (0.13)			55 (0.56)	58 (0.59)			81 (0.55)	22 (0.58)	10 (0.83)		
Mixed astigmatism	5,363 (27.29)	1,517 (50.97)	1,138 (40.83)	810 (27.36)	752 (22.54)	651 (17.51)	495 (12.79)			2,723 (27.96)	2,640 (26.64)			3,711 (25.36)	1,183 (31.16)	469 (39.08)		
Astigmatism axis								93.637	<0.001			5.180	0.07				575.679	<0.001
With-the-rule astigmatism	15,485 (78.81)	2,202 (73.99)	2,156 (77.36)	2,404 (81.22)	2,684 (80.43)	2,932 (78.86)	3,107 (80.26)			7,717 (79.23)	7,768 (78.39)			10,955 (74.76)	3,402 (89.62)	1,128 (94.00)		
Against-the-rule astigmatism	2,410 (12.27)	503 (16.90)	372 (13.35)	314 (10.61)	359 (10.76)	454 (12.21)	408 (10.54)			1,199 (12.31)	1,211 (12.22)			2,139 (14.60)	224 (5.90)	47 (3.92)		
Oblique astigmatism	1,754 (8.93)	271 (9.11)	259 (9.29)	242 (8.18)	294 (8.81)	332 (8.93)	356 (9.20)			824 (8.46)	930 (9.39)			1,559 (10.64)	170 (4.48)	25 (2.08)		

Data are presented as n or n (%).

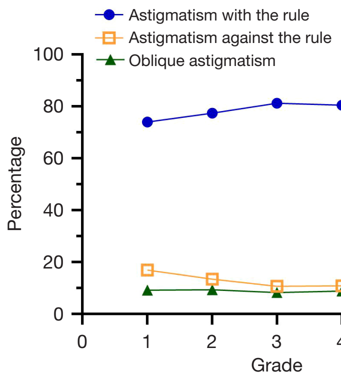

Figure 3 Distribution of axial types of astigmatism in different grades.

principal meridians form two focal points either in front of or behind the retina, leading to a blurred diffuse circle on the retina instead of a clear focal point. The impact of astigmatism on vision depends on its degree. Astigmatism less than 0.50D typically does not significantly affect visual acuity and usually does not require correction (10). However, higher levels of astigmatism can lead to decreased vision. Some studies have found that uncorrected astigmatism leads to a linear decrease in visual acuity, with each diopter causing approximately a 1 to 2 line reduction in logarithm of minimum angle resolution (logMAR) distance visual acuity (11-13). De Gracia *et al.* found that even a relatively low amount of astigmatism (0.50D) can cause blurred vision (14). Therefore, an absolute cylindrical

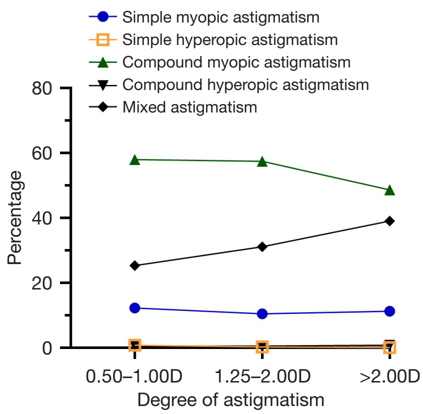

Figure 4 Refractive distribution of astigmatism based on different degrees of astigmatism.

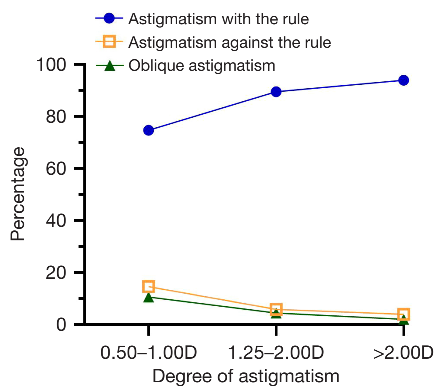

Figure 5 Axial distribution of astigmatism based on different degrees of astigmatism.

Table 4 Axial distribution in different types of astigmatism

	Types of astigmatism and refraction						
	Simple myopic astigmatism	Simple hyperopic astigmatism	Compound myopic astigmatism	Compound hyperopic astigmatism	Mixed astigmatism	χ^2 value	P value
The number of investigated eyes	2,771	134	11,268	113	5,363	–	–
Astigmatism axis						42.391	<0.001
With-the-rule astigmatism	2,078 (74.99)	114 (85.07)	8,962 (79.53)	99 (87.61)	4,232 (78.91)		
Against-the-rule astigmatism	416 (15.01)	9 (6.72)	1,314 (11.66)	11 (9.73)	660 (12.31)		
Oblique astigmatism	277 (10.00)	11 (8.21)	992 (8.80)	3 (2.65)	471 (8.78)		

Data are presented as n or n (%).

degree of ≥0.50D was established as the diagnostic criterion (10). The results of this study revealed that the prevalence of astigmatism among school-age children aged 5 to 13 years in Langzhong City was 61.70%. This rate is comparable to the 63.3% prevalence (astigmatism ≥0.50D) found in children aged 6 to 11 years in Yongchuan District, Chongqing City, another location in the western region (15). However, it is lower than the rates reported in Hangzhou (72.39%) (4), and Yunnan (68.03%) (16), but higher than those in Xinjiang (17), Wenzhou City (18), Taiwan (10), Ireland (19), Europe (20), the Middle East (21) and other regions. Tang *et al.* used meta-analysis to discover that the prevalence of astigmatism in children and adolescents in China is significantly higher than in other countries (22), which may be due to different inclusion criteria, study populations, or measurement techniques.

Our study results indicated that the prevalence of astigmatism increases with age, a finding consistent with many studies (17,21,23). This increase was more pronounced among children in higher grades, possibly due to increased academic pressure, excessive eye use, and a rising rate or degree of myopia with age (19). Imbalanced development of the eyeball's various axes due to poor eye habits or external environmental factors may contribute to the onset and progression of astigmatism. However, some studies have shown a decrease in astigmatism with age or no correlation at all (4,18,19,22,24).

This study also found that the prevalence of astigmatism in girls was significantly higher than in boys, consistent with findings from Yunnan (16) and other locations. However, other research has reported higher prevalence in boys (17,23), or no significant gender difference (4,16,18). These findings suggest that the relationship between astigmatism prevalence, age, and gender requires further investigation.

Regarding the degree of astigmatism, we found that most children across different grades had moderate to low astigmatism (≤2.00D), accounting for 93.89% of cases, with no significant gender differences. This finding aligns with other studies (4,15,16). Previously, it was believed that the composition of astigmatism types stabilizes after the age of five, which could then be used to determine the type of astigmatism in children (25). The results of this study revealed that the proportion of children with severe astigmatism (>2.00D) remained relatively stable throughout primary school, while there was a downward trend in mild astigmatism and an upward trend in moderate astigmatism among older children. This suggests that the refractive system of school-aged children is still developing, resulting in significant variations in astigmatism. To prevent low astigmatism from progressing to moderate or severe astigmatism, regular dioptometry should be performed, and emphasis should be placed on eye hygiene and care practices (26).

From the perspective of astigmatism refractive types, mixed astigmatism was predominantly observed in primary school students in grades 1 and 2, while compound myopic astigmatism was more common among students in grades 3 to 6. Additionally, there was an upward trend in compound myopic astigmatism with increasing grade levels, whereas other types of astigmatism showed a downward trend. According to the research by Xiong *et al.* (1), factors such as heavy academic burdens, increased short-distance eye use, and reduced outdoor activities contribute to the development of myopia and the transformation of mixed astigmatism into compound myopic astigmatism. However, as the severity of astigmatism increases, the composition ratio of compound myopic astigmatism decreases, while that of mixed astigmatism increases, consistent with findings in Hangzhou (4) and Wuhan (1).

The effect of astigmatism on vision is closely related to its magnitude and axial direction (27,28). Studies have shown that with-the-rule astigmatism has the least impact on visual clarity, whereas against-the-rule or oblique astigmatism results in greater visual blurring (11,29,30). Astigmatic blur can alter the perceived clarity of retinal images, leading to changes in the visual system (31,32). The type, size, and axial direction of astigmatism influence this adaptation, with larger astigmatic blur typically causing a greater adaptation effect (33). This short-term adaptation can shift the focal position of the retinal image, potentially changing the type of astigmatism to reduce its blurring effect and improve vision.

Our study also found a close relationship between astigmatism type and axis. Astigmatic blurring can affect the development of spherical ametropia, especially in children undergoing visual development (34,35). Blurred astigmatism may result in myopia or hyperopia, disrupting normal ocular growth and development. The axis and degree of astigmatism can influence the growth and development of the eyeball. With-the-rule astigmatism is usually associated with higher spherical ametropia, particularly higher degrees of myopia (36,37). Conversely, against-the-rule astigmatism is more common in individuals engaged in near-work activities (38).

From the perspective of the axial distribution of astigmatism, with-the-rule astigmatism was predominant across different grades, followed by against-the-rule astigmatism. This finding aligns with the results of numerous studies (24,39). However, the axial direction of astigmatism tends to stabilize after the third grade, indicating that the axial direction is unstable and subject to change in younger children and adolescents. In optometry, it is essential to monitor axial variations in younger school-age children closely. This observation contrasts with earlier studies suggesting that the axis of astigmatism gradually shifts from with-the-rule to against-the-rule astigmatism with age (40) or does not change significantly (15,18). The change in the axial direction of astigmatism may be related to eyelid pressure (41) or the compensating effect of internal eye astigmatism (24). Therefore, further investigation into the axial change expectation of astigmatism is required. Despite the relatively low proportion of oblique astigmatism (24), it significantly impacts visual acuity in clinical practice and should be taken seriously.

While this study provides valuable insights into the distribution of astigmatism among primary school students in western China, it has some limitations. Although the effect of cycloplegia on the prevalence of astigmatism in children is minimal, the absence of cycloplegia can result in higher myopia outcomes, potentially biasing the distribution of astigmatism types. Consequently, different outcomes might have been observed had cycloplegia been used (9).

Conclusions

In summary, the prevalence of astigmatism among school-age children aged 5–13 years in Langzhong City is high and increases with age. As astigmatism progresses, the composition ratio of compound myopic astigmatism gradually decreases, while the proportion of with-the-rule astigmatism increases. Astigmatism significantly impacts vision development, yet the current accurate correction rate of astigmatism remains low. Therefore, it is crucial for relevant departments to prioritize accurate astigmatism correction alongside myopia control. Early detection, intervention, and treatment are essential for effectively managing astigmatism. Given that astigmatism prevalence varies across regions, regular refractive screening in different areas is vital for timely detection and treatment of astigmatism.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-24-70/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-24-70/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was reviewed and approved by the Ethics Committee of Langzhong People’s Hospital (No. 2021002), and the investigation was carried out with the consent of the Education Bureau and the schools. Informed consent was obtained from each participant and their guardians.

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