Strabismus

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/istr20

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To cite this article: Hassan Hashemi, Mehdi Khabazkhoob, Carla Lança, Mohammad Hassan Emamian & Akbar Fotouhi (17 Jan 2024): Prevalence of anisometropia and its associated factors in school-age children, Strabismus, DOI: 10.1080/09273972.2023.2293883

To link to this article: https://doi.org/10.1080/09273972.2023.2293883

Published online: 17 Jan 2024.

STRABISMUS
https://doi.org/10.1080/09273972.2023.2293883

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Prevalence of anisometropia and its associated factors in school-age children

Hassan Hashemi MD [a], Mehdi Khabazkhoob PhD [b], Carla Lança PhD [c,d], Mohammad Hassan Emamian MD, PhD [e], and Akbar Fotouhi MD, PhD [f]

[a]Noor Research Center for Ophthalmic Epidemiology, Noor Eye Hospital, Tehran, Iran; [b]Department of Basic Sciences, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran; [c]Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), Instituto Politécnico de Lisboa, Lisboa, Portugal; [d]Comprehensive Health Research Center (CHRC), Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisboa, Portugal; [e]Ophthalmic Epidemiology Research Center, Shahroud University of Medical Sciences, Shahroud, Iran; [f]Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

ABSTRACT

Purpose: To determine the prevalence of anisometropia and the associated demographic and biometric risk factors in children.

Methods: This cross-sectional study was conducted on the elementary school children of Shahroud, east of Iran, in 2015. All rural students were recruited, while multistage cluster sampling was used to select the students in urban areas. All children underwent optometric examinations including the measurement of uncorrected and corrected visual acuity, autorefraction, and subjective refraction with cycloplegia. Biometric components were measured using the Allegro Biograph. Myopia and hyperopia were defined as a spherical equivalent ≤−0.5 and ≥ +2.00 diopter, respectively. Students with a history of ocular trauma or lack of cycloplegic refraction at least in one eye were excluded from the study.

Results: Of 6624 selected children, 5620 participated in the study. After applying the exclusion criteria, the data of 5357 students (boys: 52.8%, $n = 2834$) were analyzed. The mean age of the subjects was 9.2 ± 1.7 years (range: 6–12 years). The prevalence of anisometropia ≥ 1 D was 1.1% (95% CI: 0.8 to 1.4) in all children, 1.0% (95% CI: 0.7–1.3) in boys, 1.3% (95% CI: 0.8–1.7) in girls, 1.1% (95% CI: 0.8–1.4) in urban children, and 1.4% (95% CI: 0.5–2.3) in rural children. The prevalence of anisometropia was 8.8% (95% CI: 5.3–12.2) in myopic and 5.7% (95% CI: 2.8–8.5) in hyperopic children. Axial length asymmetry (OR = 40.9; 95%CI: 10.2–164.1), myopia (OR = 17.9; 95% CI: 9.4–33.9), and hyperopia (OR = 10.1; 95% CI: (5.1–19.7) were associated with anisometropia in multiple logistic regression model. More anisometropia was associated with more severe amblyopia. The odds of amblyopia (OR = 82.3: 38.2-177-3) and strabismus (OR = 17.6: 5.5–56.4) were significantly higher in anisometropic children. The prevalence of amblyopia was 21.7% in children with myopic anisometropia ≥ 3D, 66.7% in children with hyperopic anisometropia ≥ 3D, and 100% in cases with antimetropia ≥ 3D.

Conclusion: The prevalence of anisometropia was low in Iranian school children. However, a high percentage of anisometropic students had amblyopia and strabismus. Axial length was the most important biometric component associated with anisometropia.

KEYWORDS
Anisometropia; axial length; children; Iran; myopia

Introduction

Refractive anisometropia is a common vision disorder in which aniseikonia impairs binocular vision. It has been shown that each one-diopter of anisometropia is associated with 1% difference in the retinal image size. Reduced stereopsis is common in the presence of anisometropia and affects binocular vision.[1,2]

Amblyopia development secondary to anisometropia is a major concern if amblyopia is not treated during childhood.[3,4] Amblyopia is one of the most important causes of visual impairment in children, which is mainly associated with anisometropia[1,4,5] with about 50% of the cases of amblyopia attributed to anisometropia.[5–8] Strabismus is another consequence of anisometropia, especially in children.[8] The most important age for diagnosis and correction of anisometropia is the age when amblyopia develops[8]; however, this disorder is associated with academic achievement and vision quality of school-age children and students due to binocular vision defects.[9] Several epidemiological studies have determined the prevalence of anisometropia in children and adults across the

CONTACT Mohammad Hassan Emamian emamian@shmu.ac.ir Ophthalmic Epidemiology Research Center, 7 Tir square, Shahroud University of Medical Sciences, Shahroud 3614773947, Iran

world.[5,10–20] Different prevalence rates have been reported for this binocular vision disorder depending on the definition. The reported prevalence varies between 1 and 10% in children according to a spherical equivalent (SE) equal to or worse than one diopter.[5,11–21] Its demographic and environmental risk factors have also been investigated.[12,22,23] Axial length is considered as the most important biometric component related to anisometropia[24] with changes in the biometric structures of the fellow eyes resulting in different refractions. However, recent studies have shown that other biometric components are also involved in the development of anisometropia.[25,26]

This study was conducted to determine the prevalence of anisometropia and the associated demographic and biometric risk factors in children.

Methods

Data from the first phase of Shahroud Schoolchildren Eye Cohort Study were used in this study. This cross-sectional study was conducted in the rural and urban populations of Shahroud, northeast of Iran, in 2015. The methodological details of this study and the examinations conducted have been published elsewhere.[27] All children living in rural areas were selected due to their small population, while multistage cluster sampling was applied in urban areas. Each classroom was considered a cluster. There were 473 clusters in the urban areas of Shahroud, of which 200 clusters were selected using systematic random sampling. After selecting the clusters, the children's parents were asked to sign informed consent forms containing study details and objectives.

The children's demographic characteristics and past medical history were collected through interviews with parents. Optometric examinations and imaging studies were performed.

Non-cycloplegic auto refraction was performed for all children using the Nidek ARK-510A auto refractokeratometer. In children wearing spectacles, spectacle-corrected visual acuity was measured and lensometry was performed. Uncorrected visual acuity was measured using the Nidek CP-770 chart projector at three meters and the autorefraction data were refined with Heine Beta retinoscope (HEINE Optotechnik, Herrsching, Germany). Subjective refraction was performed in students whose visual acuity was less than 20/20. After subjective refraction and in the final stage of the examinations, cycloplegic refraction was measured at least 30 minutes after instilling cyclopentolate 1% drops twice, 5 minutes apart, using retinoscopy and auto refractometry. The Allegro Biograph (WaveLight AG, Erlangen, Germany) was used to measure biometric components (axial length, anterior chamber depth, central corneal thickness, lens thickness, corneal white to white diameter) in all participants.

After applying the best optical correction, unilateral and alternate cover tests were done to determine the presence of strabismus. Near and distance cover tests were performed at 40 cm and 3 meters, respectively. Only the students with manifest strabismus were evaluated in this study. Stereoacuity was evaluated using the Stereo Fly Test (Stereo Optical Company Inc., Chicago, USA) at a distance of 40 cm according to the standard test procedure under normal lighting conditions. Subjects with a history of ocular trauma or lack of cycloplegic refraction at least in one eye were excluded from the study.

Anisometropia was defined based on the cycloplegic autorefraction SE difference between the fellow eyes. Spherical and cylindrical anisometropia were defined based the difference between sphere and cylinder power values of fellow eyes, respectively. The prevalence of spherical and cylindrical anisometropia equal to or greater than 1.00 D was reported.[18,21]

To show the severity of anisometropia, its prevalence was also reported based on cut points equal to or worse than 2 and 3 D.

Myopia and hyperopia were defined as SE ≤−0.5 D and SE ≥ +2.00 D, respectively.[28,29] Amblyopia was defined as a best-corrected visual acuity of 20/30 or worse in one eye or a difference of at least two lines of best-corrected visual acuity between the fellow eyes.[30–32] The severity of amblyopia was categorized as; mild (a visual acuity (VA) of 6/9 to 6/12 or 0.2 to 0.3 logMAR), moderate (a VA of 6/12 to 6/36 or 0.31 to 0.8 logMAR), and severe (a VA worse than 6/36 or 0.81 logMAR); If the VA of both eyes was reduced, the VA of the worse eye was considered for amblyopia classification.[33] Asymmetry of biometric components was

Table 1. Mean and 95% confidence intervals (CI) of anisometropia, anisospherical and anisocylindrical and prevalence of anisometropia by age, sex and residence places.

Independent variables		n	Anisometropia (D) Mean (95%CI)	Anisospherical (D) Mean (95%CI)	Anisocylindrical (D) Mean (95%CI)	Anisometropia ≥1D % (95%CI)
	Total	5357	0.18 (0.17–0.19)	0.18 (0.18–0.19)	0.18 (0.18–0.19)	1.12 (0.84–1.41)
Sex	Boy	2834	0.18 (0.17–0.19)	0.18 (0.17–0.19)	0.18 (0.17–0.19)	0.99 (0.65–1.34)
	Girl	2523	0.18 (0.17–0.19)	0.19 (0.17–0.20)	0.19 (0.18–0.20)	1.27 (0.82–1.72)
Place of residence	Urban	4311	0.18 (0.17–0.19)	0.18 (0.18–0.19)	0.18 (0.18–0.19)	1.09 (0.79–1.39)
	Rural	1046	0.18 (0.16–0.21)	0.19 (0.16–0.21)	0.19 (0.17–0.21)	1.43 (0.53–2.34)
Age	6	218	0.16 (0.13–0.19)	0.17 (0.15–0.20)	0.15 (0.13–0.18)	0.58 (0.08–3.94)*
	7	812	0.16 (0.15–0.18)	0.18 (0.16–0.19)	0.19 (0.18–0.20)	0.42 (0.14–1.28)*
	8	970	0.18 (0.16–0.21)	0.19 (0.17–0.21)	0.19 (0.17–0.20)	1.20 (0.47–1.93)
	9	1019	0.18 (0.17–0.19)	0.18 (0.17–0.20)	0.19 (0.18–0.21)	0.93 (0.37–1.49)
	10	847	0.18 (0.15–0.20)	0.17 (0.15–0.20)	0.17 (0.16–0.19)	1.15 (0.50–1.81)
	11	885	0.19 (0.17–0.21)	0.20 (0.17–0.22)	0.17 (0.16–0.19)	1.81 (0.96–2.66)
	12	606	0.18 (0.16–0.20)	0.18 (0.16–0.21)	0.20 (0.18–0.22)	1.37 (0.33–2.40)

D: diopter; *The confidence intervals were calculated by binomial distribution.

considered as the absolute value of difference between fellow eyes.[12,26]

Statistical analysis

The cluster sampling and design effects were considered for standard error calculation. Moreover, sampling weight was applied using post standardization. Anisometropia, spherical anisometropia, and cylindrical anisometropia were reported as mean and standard deviation. Anisometropia ≥ 1 D was used to calculate its prevalence as well as its association with study variables. The prevalence of anisometropia was presented as percentage and 95% confidence intervals (CI) based on its type (myopic anisometropia, hyperopic anisometropia, antimetropia) and severity. The prevalence of amblyopia was also reported by the type and severity of anisometropia. The mean asymmetry of biometric components was compared between anisometropic and non-anisometropic subjects. Simple and multiple logistic regression analysis were applied to investigate the association of risks factors with anisometropia.

Ethical considerations

This study was approved by the Ethics Committee of Shahroud University of Medical Sciences. The study adhered to the tenets of the Helsinki Declaration at all stages. Written informed consent was obtained from the parents. In addition, verbal assent was obtained from schoolchildren prior to each procedure.

Results

A total of 6624 children were selected, of whom 5620 participated in the study. After applying the exclusion criteria, the data of 5357 children were analyzed, of whom 2834 (52.8%) were boys. The mean age of the subjects was 9.7 ± 1.7 years (range: 6–12 years). The prevalence of strabismus in this study was 0.5% (28 schoolchildren). Of these, 21 students had exotropia, 6 students had esotropia, and one had DVD. There were also 21 and 7 students with intermittent heterotropia and constant heterotropia, respectively.

Table 1 presents the mean values of anisometropia, spherical anisometropia, and cylindrical anisometropia as well as the prevalence of anisometropia in children by age, sex, and place of residence.

The mean, median, and interquartile range of anisometropia was 0.18 (95% CI: 0.17–0.19), 0.13, and 0.25 D, respectively. There was no significant difference in mean anisometropia between boys and girls ($p = .60$). The mean anisometropia was 0.16 D in 6-year-olds, 0.19 D in 11-year-olds, and 0.18 D in 12-year-olds, indicating no significant difference between age groups ($p = .24$). No significant difference was found in mean anisometropia between rural and urban students ($p = .76$). The mean spherical anisometropia and cylindrical anisometropia was the same [0.18 D, 95% CI: 0.18–0.19]. The prevalence of anisoastigmatism was 1.8% (95% CI: 1.4–2.2) according to anisosphere equal to or worse than one diopter.

The prevalence of anisometropia based on the cut point of ≥ 1 D was 1.1% (95% CI: 0.8–1.4) in all participants; 1.0% in boys, and 1.3% in girls,

indicating no significant difference between gender and anisometropia prevalence ($p = .33$). The lowest and highest prevalence of anisometropia was seen in 6-year-olds and 11-year-olds, respectively. No significant difference was found in the prevalence of anisometropia between urban and rural students ($p = .48$). The prevalence of anisometropia ≥ 2 D and ≥ 3 D was 0.3% (95% CI: 0.2–0.4) and 0.2% (95% CI: 0.1–0.3), respectively. Table 2 shows the prevalence of anisometropia by its type and by the severity of anisometropia. As seen in Table 2, the prevalence of myopic anisometropia, hyperopic anisometropia, and antimetropia was 0.3% (95% CI: 0.2–0.5), 0.5% (95% CI: 0.3–0.7), and 0.3% (95% CI: 0.1–0.4), respectively. In all severities of anisometropia, the highest and lowest prevalences were related to hyperopic anisometropia and antimetropia, respectively.

The prevalence of amblyopia was 0.4% (95% CI: 0.2–0.6) and 24.6% (95% CI: 13.6–35.6) in non-anisometropic and anisometropic children, respectively (Odds ratio = 82.3; 95% CI: 38.2–177.3: $p < .001$).

Examining the association between the severity of anisometropia and the severity of amblyopia showed that the average anisometropia was 0.2 ± 0.2 D in children without amblyopia, 1.2 ± 1.5 D in those with mild amblyopia, 2.9 ± 2.9 D in those with moderate amblyopia, and 11.6 D in those with severe amblyopia ($p < .001$). Table 3 shows the severity of amblyopia by the severity of anisometropia.

Overall, the prevalence of amblyopia was 23.6% in children with myopic anisometropia, 29.6% in children with hyperopic anisometropia, and 16.0% in those with antimetropia.

The prevalence of amblyopia was 21.7% in children with myopic anisometropia ≥ 3D, 66.7% in children with hyperopic anisometropia ≥ 3D, and 100% in cases with antimetropia ≥ 3D, respectively.

The mean anisometropia was 0.18 (95% CI: 0.17–0.18) and 0.63 (95% CI: 0.15–1.10) diopter in children with and without strabismus, respectively ($p = .066$, by independent samples t-test). The prevalences of strabismus were 0.4% (95% CI: 0.2–0.6) and 6.2% (95% CI: 0–12.8) in non-anisometropic and anisometropic children, respectively (Odds Ratio: 17.6; 95%CI: 5.5–56.4; $p < .001$).

The prevalence of esotropia was 0% in anisometropic cases. However, the prevalence of exotropia was 6.7%, 0%, 12.5% in children with anisometropia between 1 and 2 D, 2 to 3 D, and more than 3 D, respectively.

Anisometropia also significantly increased the odds of reduced stereopsis worse than 100 seconds of arc (Odds ratio = 29.7: 95% CI: 8.570–103.7).

Examining the association between anisometropia with amblyopia and strabismus through a multiple logistic regression model showed that the odds of amblyopia was 75.7 (95% CI: 162.0–

Table 2. The prevalence (% (95% confidence intervals)) of different types of anisometropia according to the severity of anisometropia in schoolchildren.

Anisometropia		Anisometropia severity (Diopter)			Proportion	Total prevalence
		≥1 to < 2	≥2 to < 3	≥3		
Types	Myopic	29.1 (14.5–43.7)	36.2 (1.1–71.3)	32.6 (1.0–66.2)	30.5 (17.7–43.3)	0.3 (0.2–0.5)
	Hyperopic	45.1 (30.1–60.2)	57.5 (21.9–93.1)	40.4 (4.4–76.4)	46.0 (33.6–58.4)	0.5 (0.3–0.7)
	Antimetropia	25.8 (12.7–38.9)	6.3 (6.5–19.1)	26.9 (5.8–59.7)	23.5 (13.1–33.9)	0.3 (0.1–0.4)
Proportion		73.5 (62.3–84.8)	12.5 (4.0–21.1)	13.9 (4.8–23.0)	100	

Table 3. The prevalence of amblyopia severity according to the severity and type of anisometropia.

Ansiometropia		Amblyopia [% (95% (Confidence Intervals)]			
		No	Grade 1*	Grade 2**	Grade 3***
Severity	0 to < 1	99.6 (99.4–99.9)	0.4 (0.2–0.6)	0.0	0.0
	≥1 to < 2 diopter	87.7 (77.7–97.6)	9.8 (1.0–18.6)	2.6 (2.4–7.5)	0.0
	≥2 to < 3 diopter	57.5 (22.8–92.2)	42.5 (7.8–77.2)	0.0	0.0
	≥3 diopter	26.9 (5.0–58.9)	53.9 (18.5–89.3)	13.5 (11.2–38.1)	5.7 (5.6–17.0)
Type	Myopic anisometropia	76.4 (56.7–96.1)	21.04 (1.8–40.3)	0.0	2.6 (2.6–7.7)
	Hyperopic anisometropia	70.4 (53.1–87.7)	21.5 (6.2–36.7)	8.2 (2.7–19.0)	0.0
	Antimetropia	84.1 (63.8–104.3)	16.0 (4.3–36.2)	0.0	0.0

*Defined as a visual acuity of 0.2 to 0.3 logMAR, **Defined as a visual acuity 0.31 to 0.8 logMAR, ***Defined as a visual acuity worse than 0.81 logMAR.

Table 4. Mean and 95% confidence intervals of asymmetry in ocular biometry components in anisometropic and non-anisometropic children.

	Two-eye differences [Mean (95%CI)]		
Ocular biometrics	Non-anisometropic	Anisometropic	p-value
Axial length (mm)	0.09 (0.08–0.09)	0.63 (0.52–0.74)	<0.001
Central corneal thickness (micron)	4.44 (4.33–4.55)	6.86 (5.35–8.37)	<0.001
Corneal white to white (mm)	0.14 (0.13–0.14)	0.13 (0.10–0.17)	0.688
Lens thickness (mm)	0.04 (0.04–0.04)	0.04 (0.03–0.06)	0.897
Anterior chamber depth (mm)	0.04 (0.04–0.04)	0.06 (0.04–0.07)	0.011
Mean-keratometry (diopter)	0.21 (0.21–0.22)	0.29 (0.20–0.37)	0.055

35.4, $p < .001$) higher in anisometropic children after adjusting for the effect of strabismus.

Table 4 presents the mean asymmetry of biometric components in children with and without anisometropia ≥ 1.00 D. The asymmetry in axial length, central corneal thickness, anterior chamber depth, and keratometry were significantly higher in anisometropic children compared to those without anisometropia (independent samples t-tests). Figure 1 shows the mean anisometropia according to quartiles of axial length asymmetry. The mean anisometropia increased with the increase in the average axial length asymmetry.

($p < .001$; ANOVA test).

According to the multiple logistic regression analysis, axial length asymmetry, myopia and hyperopia were significantly associated with anisometropia equal to or greater than 1.00 D (Table 5).

Discussion

This study was conducted to evaluate the prevalence of anisometropia and its associated demographic and biometric risks factors. The prevalence of anisometropia ≥ 1D was 1.1%. Various definitions of anisometropia have been used, which makes it difficult to compare the results with other studies. Table 6 presents the results of other studies using similar definitions for anisometropia (SE ≥ 1 D).

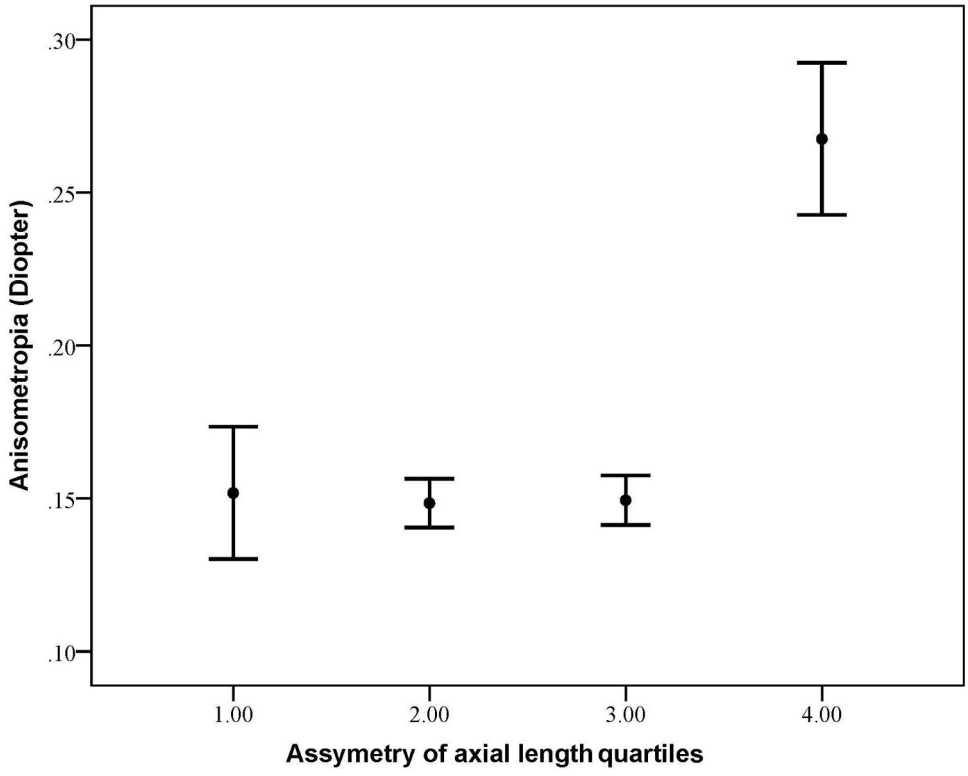

Figure 1. Mean and 95% confidence intervals of anisometropia according to quartiles of axial length asymmetry.

Table 5. The association of anisometropia (≥1 diopter) with other independent variables in simple and multiple logistic regression models.

		Simple logistic regression		Multiple logistic regression	
Independent variables		Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
	Residence place (rural/urban)	1.3 (0.7–2.7)	0.435		
	Sex (female/male)	1.3 (0.8–2.1)	0.322		
	Age (year)	1.2 (1.0–1.4)	0.022		
Asymmetry of ocular biometrics	Axial length >0.07 mm*	52.1 (13.0–209.2)	<0.001	40.9 (10.2–164.1)	<0.001
	Central corneal thickness (micron)	1.1 (1.0–1.1)	0.194		
	Corneal white to white (mm)	0.9 (0.4–2.0)	0.717		
	Lens thickness (mm)	0.8 (0.0–22.6)	0.906		
	Anterior chamber depth >0.03 mm*	16.4 (4.1–65.7)	<0.001		
	Mean Keratometry (Diopter)	7.1 (2.1–24.0)	0.002		
Refractive errors	Emmetropia	1		1	
	Myopia	20.6 (11.0–38.6)	<0.001	17.9 (9.4–33.9)	<0.001
	Hyperopia	12.8 (6.8–24.3)	<0.001	10.1 (5.1–19.7)	<0.001

*Median value; CI: Confidence Intervals.

Table 6. Summary of studies on the prevalence of anisometropia (≥1 diopter) in different countries in children.

First author	Country	Age(year)	Sample size	prevalence
Deng[34]	USA	5	395	1.27
Slaveykov[35]	Bulgaria	3–6	596	1.34
Fotouhi[36]	Iran	6–17	3481	1.5
O'Donoghue[37]	Irland	6–7	389	8.5
O'Donoghue[37]	Irland	12–13	661	9.4
Jiménez[38]	Africa	6–8	48	2.1
Jamali[39]	Iran	6	815	2.2
Yekta[21]	Iran	7–15	1872	2.58
Ostadimoghaddam[18]	Iran	6–15	639	2.7
Jiménez[38]	Africa	12–16	156	3.2
Gupta[40]	India	4–12	310	3.5
Jiménez[38]	Africa	6–16	315	3.5
Aldebasi[6]	Saudi Arabia	6–13	5176	3.6
Tong[41]	Singapore	7–9	1979	3.6
Hashemi[12]	Iran	5–15	808	3.8
Rajavi[42]	Iran	7–12	2410	3.9
Lee[43]	Taiwan	9	23114	5.3
Jiménez[38]	Africa	9–11	111	5.4
Deng[34]	USA	12–15	312	5.77
Flitcroft[24]	Ireland	6–7	362	6.9
Hu[13]	China	4–18	6364	7
Ferraz[23]	Brazil	>1	7654	13.2

The highest prevalence of anisometropia was reported in the US, Brazil, and Saudi Arabia (9.8–20%).[6,7,10,23,34,44,45] The prevalence of anisometropia was lower in the present study, even when compared with other studies in similar age groups from Iran, which could be due to ethnic and racial differences.[12,18,21,26,36,42,46] Although the prevalence of anisometropia was low in the present study, 24.6% and 6.2% of the children had amblyopia and strabismus respectively, which are important disorders and can cause visual and social problems. Previous studies also found an association between anisometropia with amblyopia and strabismus.[5,8,21,47] Although not confirmed, it is hypothesized that anisometropia causes amblyopia.[8] However, recent studies have shown the increasing contribution of strabismus to amblyopia, indicating the success of amblyopia screening programs and correction of anisometropia.[36,48]

Anisometropia was not different between boys and girls. It first appears that there are inter-gender differences in biometric parameters, especially axial length; however, the results of multiple regression analysis, after adjusting for asymmetry of other biometric components, showed again that it was an independent finding.[49] Previous studies found no association between anisometropia and gender[10,12,16,21,34] although a few studies found higher anisometropia in females.[15,16,44]

The cohort effect in our study showed that anisometropia did not change significantly over time;

in fact, we observed that anisometropia was not different in children with ages between 6 to 12 years old. The literature is inconsistent in this regard.[23,34] However, due to the limited age range of the participants in the present study, this finding was expected.

The highest prevalence of anisometropia was seen in myopic individuals compared to emmetropic and hyperopic subjects. This finding was consistent with previous studies.[5,50–52] A possible reason for the higher prevalence of anisomyopia compared to anisohyperopia is the natural difference in the etiology of these two refractive errors.[8]

Based on all anisometropia cut points, anisohyperopic cases had a higher prevalence of amblyopia compared to anisomyopic children. This is an expected finding as in anisohyperopia the less hyperopic eye is preferred for both near and far distances, while in anisomyopia each eye is preferred for one particular distance (the more myopic eye for near and the less myopic eye for far). A notable finding of the present study is the significant prevalence of amblyopia in anisomyopia above 2 D, so that the prevalence of amblyopia increased sharply from 12.5% in anisomyopia of 1 to 2 D to 41.3% in anisomyopia of 2 to 3 D, and 58.7% in anisomyopia of more than 3 D. This finding is clinically important and indicates the importance of correction in cases with anisomyopia above 2 D.[53]

Axial length asymmetry had a significant relationship with anisometropia. Moreover, an increase in axial length asymmetry was associated with an increase in the severity of anisometropia. Few studies have been conducted in this regard so far[14,19,26,37,41] and axial length has been found to be associated with anisometropia in children and adults. A study conducted in the adult population of Shahroud showed that in addition to axial length asymmetry, keratometry asymmetry also played a role in anisometropia.[26] Although the mean keratometry asymmetry was higher in anisometropic eyes in the present study, the association was not significant in the final model. It seems that since the cornea is changing in children and biometric components are compensating for other factors in the process of emmetropization,[48] the non-significant association between keratometry asymmetry and anisometropia can be attributed to its compensation by other factors, especially axial length.[26] Tong et al.[41] and Huynh et al.[14] did not find a correlation between keratometry asymmetry and anisometropia while Hu et al.[13] reported a significant relationship.[13,14,41] The age range of the participants of these studies underlines the role of compensation in this process. The participants were above 40 years old in the study by Hu et al.[13] while Tong et al.[19,41] and Huynh et al.[14] studied children and students. Therefore, since axial length changes more than corneal curvature in children, it may be responsible for a higher percentage of refractive error compared to corneal power.

The highest prevalence of strabismus (exotropia) was observed in children with anisometropia equal to and above 3 D, which indicates a direct association between the severity of anisometropia and the odds of strabismus. In explaining this association, it should be said that high anisometropia severely disrupts sensory fusion and weakens the fusional control of deviation.[54] On the other hand, a significant association was found between anisometropia and amblyopia after adjusting for the effect of strabismus. Therefore, it can be concluded that the nature of amblyopia in cases with strabismus is mainly anisometropic in our study population. Since the strabismic cases in the present study were only of exotropia type and exotropia is usually intermittent or alternating in nature, therefore the underlying mechanism of amblyopia in these cases is anisometropia.

Stereopsis was significantly reduced in anisometropic children. This finding was expected, and several studies reported a similar result since anisometropia has a direct effect on binocular vision.[9,55] Considering the fact that sensory fusion is affected in anisometropia due to aniseikonia,[54] all binocular vision components are expected to be affected, which should receive attention in amblyopia treatment.

Conclusion

The present study provides a comprehensive description of anisometropia in Shahroud students. Although the prevalence of anisometropia was not high in the present study, the results showed

a considerably higher risk of amblyopia and strabismus in anisometropic eyes. Axial length was the most important biometric factor in anisometropia.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Shahroud School Children Eye Cohort Study is funded by the Noor Ophthalmology Research Center and Shahroud University of Medical Sciences [Grant Number: 960351].

ORCID

Hassan Hashemi MD http://orcid.org/0000-0002-6086-1537
Mehdi Khabazkhoob PhD http://orcid.org/0000-0003-0801-8793
Carla Lança PhD http://orcid.org/0000-0001-9918-787X
Mohammad Hassan Emamian MD, PhD http://orcid.org/0000-0002-1994-1105
Akbar Fotouhi MD, PhD http://orcid.org/0000-0002-6438-6833

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