· Investigation ·

Ocular biometric parameters among Han and Uyghur young adults with myopia in Xinjiang, China

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Abstract
● **AIM:** To describe ocular biometric parameters among Han and Uyghur myopic adults in Xinjiang, China.
● **METHODS:** A cross-sectional study was conducted. The different ocular biometric parameters collected using Pentacam were analyzed, including corneal curvature, corneal astigmatism (CA), horizontal corneal diameter (white-to-white, WTW), corneal volume (CV), pupil diameter (PD), anterior chamber angle (ACA), anterior chamber depth (ACD), anterior chamber volume (ACV) and axial length (AL).
● **RESULTS:** In total, 2932 participants were included in the final analysis, comprising 2310 Han and 622 Uyghur adults. Adults in the high myopia (HM) group had steeper K2, larger CA, smaller WTW and longer AL in both the Uyghur and Han adults (all $P<0.05$). The moderate myopia (MM) and HM group had deeper ACV, ACD and wider ACA than the low myopia (all $P<0.05$) in Han adults, however there were no differences in anterior chamber indices with Uyghur adults. In the Uyghur adults, we noticed that CV, WTW, and ACD were smaller, ACA was narrower, PD was larger, and AL was shorter (all $P<0.05$). We also noticed sex differences: males had flatter corneas, deeper ACD and ACV, and larger WTW than females (all $P<0.05$). In the correlation analysis, WTW was positively correlated with ACD and ACV but negatively correlated with K1, K2 and CV (all $P<0.05$). Narrower ACA was associated with larger PD (rU=-0.25, rH=-0.16, all $P<0.01$).
● **CONCLUSION:** The Han population have different biometric parameters in eyes with HM compared to the Uyghur population, and the Uyghur population may anatomically more susceptible to primary angle closure glaucoma than the Han population.
● **KEYWORDS:** ocular biometry; ocular anatomic parameter; myopia; Pentacam; Uyghur
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INTRODUCTION
Myopia has emerged as a major health issue, and its prevalence is increasing globally. A high myopia (HM) study predicted that by 2050, 4758 million people will be affected by myopia (49.8% of the global population), and 938 million people will have HM (9.8% of the global population)[1]. Myopia has emerged as a leading cause of significant visual impairment globally and is considered a risk factor and cause of other serious ocular pathologies that cause irreversible vision loss, such as myopic maculopathy, retinal detachment, cataract, and glaucoma[2]. Recent epidemiological studies show that myopia is epidemic in East Asia, especially in China, Singapore and Japan. These studies also indicated that myopia prevalence varies widely within ethnic populations with different characteristics[1,3-4]. The evaluation of Ethnic variations in normative values of ocular biometric parameters in healthy myopic adults is not only important for the pure scientific knowledge but, more importantly, because a difference between ethnicities could play a role in disease diagnosis and surgical planning.

Any imbalance in eye biometric parameter values can result in myopic refractive error due to the refractive power of the structures associated with these parameters[2]. The relationship between myopic refractive errors and longer eyes, flatter corneas, deeper vitreous chambers and thinner lenses has been documented in previous studies[5]. Individual ocular anatomy is evaluated by assessing these ocular biometric parameters and is key to understanding the determinants of ocular development and pathology changes and is also critical for preoperative refractive and other ophthalmologic surgery evaluations[6].

Ethnic variations have been discovered in ocular biometric parameters in population cohort studies[7-15]. Most studies in China have focused on the ocular biometric parameters of myopia only in Han individuals; very limited data are available for other ethnic groups. Xinjiang Uygur Autonomous Region, located in northwestern China, is inhabited by over 40 ethnic groups. The two main ethnic groups here are the Uyghur and Han populations. The Han and Uyghur populations are quite different from each other in terms of genetics and culture[16]. Previous studies have evaluated the general prevalence of myopia in Xinjiang. These studies show that the Uyghur population is less likely to be affected by myopia than the Han population[17-18]; however, there is a lack of research and comprehensive, systematic studies on the differences in related ocular biometric parameters, which may affect the difference in myopia prevalence. The fundamental purpose of this study is to further evaluate the different characteristics of ocular biometric parameters and the association between ocular parameters and myopia in the Han and Uyghur populations.

PARTICIPANTS AND METHODS

Ethical Approval This retrospective, cross-sectional study was approved by the First Affiliated Hospital of Xinjiang Medical University Institutional Review Board (approval number: K202204-39), and the study was conducted according to the tenets of the Declaration of Helsinki. Due to the retrospective nature of the study, and since the data were analyzed anonymously, the First Affiliated Hospital of Xinjiang Medical University Institutional Review Board determined that it was not necessary to obtain the participants' consent.

Participants Ocular biometric data for eyes of 2932 myopia patients were acquired at the Refractive Surgery Center of the First Affiliated Hospital of Xinjiang Medical University from October 2013 to March 2022 and evaluated comprehensively. Among these 2932 myopic patients, 2310 were of Han ethnicity, and 622 were of Uyghur ethnicity. The ethnic background was determined by the information provided by the patient. The following inclusion criteria for the patients in the study group were applied. 1) Adult patients between the ages of 18 and 44y (identified as young people)[19] were included to moderate ocular effects of aging; 2) Myopic patients with a spherical equivalent (SE, -10.00 D<SE≤-0.50 D); 3) Patients who exhibited normal corneal tomotomographical pattern and had stopped wearing soft contact lenses for ≥2wk or rigid contact lenses for ≥4wk; 4) Corneal topographies of both eyes were recorded on the same day. Patients with keratoconus, suspected keratoconus, coexisting corneal diseases, severe dry eye, nonaxial myopia (such as that caused by spherophakia), previous ocular trauma or surgery, uveitis, or glaucoma were excluded. Only the right eyes were included for analysis considering the significant interocular symmetry differences in corneal biometrics[20].

Clinical Examinations Data from eligible participants were collected by experienced technicians using a Pentacam ocular anterior segment analysis system with high resolution (HR, OCULUS, Wetzlar, Germany). The natural pupil state of the participants was analyzed in a dark room, with the participants in a sitting position with their head kept steady by chin and forehead rests. The patients were asked to keep their eyes open and watch circles in a blue-ribbon indicator after blinking their eyes twice. The instrument automatically captured 50 rotational Scheimpflug images of the cornea within 2s. Simultaneously, corneal curvature (K1 for the flat axis, K2 for the steep axis), corneal astigmatism (CA), horizontal corneal diameter (white-to-white, WTW), corneal volume (CV) within the 7 mm areas, pupil diameter (PD), anterior chamber angle (ACA), anterior chamber depth (ACD), and anterior chamber volume (ACV) were obtained. Each eye was successfully scanned three times, and the instrument displayed the "OK" to the tester if the results met the requirements of the quality specification (QS) system. Noncycloplegic autorefraction was performed using an autorefractor (Topcon KR8800; Topcon Corp, Tokyo, Japan), and AL was measured by IOLMaster 500 (Carl Zeiss Meditec, Inc., Dublin).

The SE was defined as "spherical error+1/2 cylindrical error". Then, all the measured biometric parameters were divided into the following three groups according to SE: low myopia (LM, -3.00 D<SE≤-0.50 D), moderate myopia (MM, -6.00 D<SE≤ -3.00 D) and HM (-10.00 D<SE≤-6.00 D)[21].

Statistical Analysis Analyses were conducted using SPSS version 26.0 (SPSS, Inc., Chicago, IL, USA), and data normality was explored using a Kolmogorov-Smirnov test and Q-Q plots/histograms. All the values were calculated and expressed as the mean±standard deviation (SD) or interquartile range of continuous variables. Two-sample t tests were used to compare variations among different ethnicities and sexes for different myopia groups, while the rank sum test was used to compare nonparametric variables. The values of clinical characteristics among different myopia subgroups were compared by using ANOVA with Bonferroni and Tamhane T2 tests and the Kruskal-Wallis test. The correlation analyses were performed using the Pearson method or Spearman method

Table 1 Baseline demographic characteristics of Han and Uyghur populations

Demographics	Uyghur			Han		
	LM	MM	HM	LM	MM	HM
Age, y, (mean±SD)	26.42±6.55	25.20±5.39	25.47±5.54	26.68±6.82	26.07±6.38	26.15±6.39
SE, (M, IQR)	-2.250 (1.750, 2.625)	-4.437 (3.750, 5.000)	-7.000 (6.375, 8.250)	-2.375 (1.875, 2.750)	-4.500 (3.750, 5.250)	-7.125 (6.500, 8.000)
Male, *n*	43	116	46	128	450	291
Female, *n*	72	217	128	149	699	593
Total, *n*	115	333	174	277	1149	884

LM: Low myopia group; MM: Moderate myopia group; HM: High myopia group; SD: Standard deviation; SE: Spherical equivalent; D: Diopters; *n*: Number of participants. SE described as median and 25%/75% quantiles.

depending on the normality assumption, to evaluate the correlation between the ocular biometric parameters. $P<0.05$ was considered statistical significance.

RESULTS

Demographic Distribution A total of 2932 healthy eyes from 2310 Han and 622 Uyghur adults were assessed. The patients' age ranged from 18 to 44y; mean patient age was 25.95±6.29y, and 1074 (37%) were male. The aforementioned data were obtained from patients as they prepared for corneal refractive surgery, and the statistics were included in the final analysis. Of the 2932 eyes, 2189 were selected for AL value analysis, 233 representing the Uyghur population and 1956 representing the Han population. The ocular biometric parameter values for each group are shown in Table 1. The only significant difference found at baseline between the Uyghur and Han adults was the mean SE of the MM group (P=0.02).

Ethnic Differences Table 2 showed significant differences between the Han and Uyghur adults ($P<0.05$) in CV, WTW, ACA, ACD, and AL. The values of all five parameters were significantly lower in the eyes of Uyghur adults than in those of Han adults. However, PD was wider in the Uyghur adults ($P<0.05$). In the HM group, the Uyghur adults were characterized by steeper corneal K1 and K2 values and smaller ACVs than the Han adults ($P<0.05$). However, no significant difference was found in CA.

Differences in Myopia Groups Patients in the HM group had steeper K2 values, larger CA values, smaller WTW values and longer AL values in both the Uyghur and Han adults (Table 2). Other interesting trends in the biometric parameters among Han adults were narrower ACA values, shallower ACD values and smaller ACV values in the LM group and larger CV values in the HM group (all $P<0.05$). The anterior chamber (ACA, ACD, and ACV) values gradually increased as the extent of myopia increased in the Han adults but not in the Uyghur adults.

Gender Variation in Ocular Biometric Parameters The differences in the values of ocular biometric parameters between female and male patients are shown in Table 3. Male patients seem to have flatter corneal values, larger WTW values, deeper ACD values and larger ACV values than female

Table 2 The difference in ocular biometry between the two ethnic groups and the three myopia groups

Parameters	Group LM	Group MM	Group HM	*P*
K1 (D)				
Uyghur	42.58±1.92	42.5 (1.90)	42.81±1.33	0.09
Han	42.45±1.33	42.6 (2.00)	42.57±1.33	0.42
P	0.36	0.97	0.03	
K2 (D)				
Uyghur	43.65±1.57[a]	43.59±1.59[a]	44.10±1.51	0.002
Han	43.51±1.42[a]	43.61±1.47[a]	43.80±1.44	<0.001
P	0.38	0.85	0.03	
CA (D)				
Uyghur	0.90 (0.80)[a]	0.90 (0.70)[a]	1.20 (1.00)	<0.001
Han	0.90 (0.80)[a]	1.00 (0.80)[a]	1.20 (1.00)	<0.001
P	0.30	0.12	0.96	
CV (mm^3)				
Uyghur	59.76±3.30	59.90 (4.30)	60.40 (4.60)	0.18
Han	60.95±3.07[a]	61.10 (4.40)[a]	61.60 (3.80)	0.002
P	<0.001	<0.001	<0.001	
ACA (°)				
Uyghur	36.79±6.50	38.01±5.79	37.53±5.44	0.19
Han	38.30±4.87	39.66±5.15[b]	39.68±5.30[b]	<0.001
P	0.03	<0.001	<0.001	
ACD (mm)				
Uyghur	3.06 (0.26)	3.10 (0.40)	3.08±0.29	0.19
Han	3.16 (0.40)	3.21 (0.37)[b]	3.20±0.28[b]	0.002
P	0.02	<0.001	<0.001	
ACV (mm^3)				
Uyghur	185.50 (37.90)	191.23±34.68	187.45±34.79	0.26
Han	191.40 (42.63)	194.26±32.49[b]	198.06±30.47[b]	<0.001
P	0.29	0.14	<0.001	
PD (mm)				
Uyghur	3.22 (0.70)	3.22 (0.84)	3.28 (0.71)	0.89
Han	3.06 (0.67)	3.05 (0.69)	3.07 (0.70)	0.21
P	0.002	<0.001	<0.001	
WTW (mm)				
Uyghur	11.50 (0.50)	11.50 (0.60)[a]	11.40 (0.60)	0.012
Han	11.60 (0.60)	11.60 (0.60)[a]	11.60 (0.50)	0.05
P	0.03	<0.001	<0.001	
AL (mm)				
Uyghur	24.25±0.89	25.19 (1.18)	25.81 (1.13)	<0.001[c]
Han	24.67±0.78	25.42 (1.14)	26.38 (1.23)	<0.001[c]
P	<0.05	<0.05	<0.001	

Data are presented as the mean±SD or median (interquartile range). LM: Low myopia group; MM: Moderate myopia group; HM: High myopia group; K1: Corneal curvature for the flat axis; K2: Corneal curvature for the steep axis; CA: Corneal astigmatism; CV: Corneal volume; ACA: Anterior chamber angle; ACD: Anterior chamber depth; ACV: Anterior chamber volume; PD: Pupil diameter; WTW: Corneal diameter; AL: Axial length. [a]The difference from HM was statistically significant; [b]The difference from LM was statistically significant; [c]The groups significantly differed from each other.

Table 3 The difference between females and males

Parameters	LM		MM		HM	
	Uyghur	Han	Uyghur	Han	Uyghur	Han
K1 (D)						
Male	42.24±1.20	42.11±1.29	42.15±1.38	42.20 (1.90)	42.13±1.34	42.10 (1.60)
Female	42.79±1.45	42.74±1.29	42.80±1.43	42.80 (2.00)	43.05±1.25	42.75 (1.70)
P	0.04	<0.001	<0.001	<0.001	<0.001	<0.001
K2 (D)						
Male	43.23±1.33	43.25±1.39	43.25±1.55	43.30±1.50	43.53±1.46	43.47±1.38
Female	43.91±1.66	43.72±1.41	43.77±1.59	43.81±1.41	44.31±1.48	44.01±1.43
P	0.03	0.006	0.004	<0.001	0.002	<0.001
CA (D)						
Male	0.85 (0.77)	1.00 (0.80)	0.90 (0.80)	1.00 (0.90)	1.25 (1.35)	1.2 (0.9)
Female	0.85 (0.78)	0.80 (0.80)	0.90 (0.60)	0.90 (0.70)	1.20 (0.98)	1.2 (0.9)
P	0.62	0.04	0.22	<0.001	0.78	0.39
CV (mm^3)						
Male	60.13±2.99	60.86±2.91	59.70±3.33	61.00 (5.02)	59.85 (3.75)	61.56±3.40
Female	59.65±3.49	61.02±3.20	60.03±3.09	61.20 (4.00)	60.50 (4.70)	61.64±2.92
P	0.46	0.66	0.37	0.81	0.19	0.72
ACA (°)						
Male	35.25 (8.20)	39.30±4.89	38.54±5.53	39.89±5.45	38.70 (5.43)	40.04±5.36
Female	37.30 (9.25)	37.44±4.64	37.73±5.92	39.50±4.95	37.05 (7.85)	39.49±5.27
P	0.45	0.001	0.23	0.23	0.42	0.15
ACD (mm)						
Male	3.13 (0.34)	3.23±0.26	3.21±0.29	3.28 (0.32)	3.24 (0.34)	3.30 (0.36)
Female	3.03 (0.31)	3.05±0.29	3.06±0.27	3.14 (0.38)	3.03 (0.37)	3.15 (0.35)
P	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
ACV (mm^3)						
Male	191.40 (39.82)	200.56±28.13	203.90 (50.55)	208.20 (40.50)	206.07±36.55	209.49±30.28
Female	179.35 (40.02)	177.07±28.88	182.40 (44.50)	185.20 (43.30)	180.75±31.70	192.35±28.92
P	0.03	<0.001	<0.001	<0.001	<0.001	<0.001
PD (mm)						
Male	3.31 (0.84)	3.07 (0.65)	3.17 (0.84)	3.06 (0.68)	3.33±0.60	3.05 (0.70)
Female	3.21 (0.64)	3.05 (0.65)	3.24 (0.83)	3.05 (0.70)	3.31±0.52	3.08 (0.70)
P	0.43	0.93	0.09	0.63	0.78	0.92
WTW (mm)						
Male	11.70 (0.57)	11.80 (0.60)	11.60 (0.55)	11.70 (0.50)	11.70 (0.55)	11.70 (0.60)
Female	11.50 (0.50)	11.50 (0.53)	11.40 (0.50)	11.60 (0.50)	11.30 (0.63)	11.50 (0.50)
P	0.03	<0.001	<0.001	<0.001	<0.001	<0.001

Data are presented as the mean±SD or median (interquartile range). LM: Low myopia group; MM: Moderate myopia group; HM: High myopia group; K1: Corneal curvature for the flat axis; K2: Corneal curvature for the steep axis; CA: Corneal astigmatism; CV: Corneal volume; ACA: Anterior chamber angle; ACD: Anterior chamber depth; ACV: Anterior chamber volume; PD: Pupil diameter; WTW: Corneal diameter; AL: Axial length.

patients in both the Uyghur and Han adults. Only male Han adults had higher CA values in the LM and MM groups and larger ACA values in the LM group.

Correlation Among Ocular Biometric Parameters The correlation analysis revealed significant correlations among ocular parameters (Table 4).

The results showed strong significantly positive correlations between K2 and K1 (rU=0.88, rH=0.88, all P<0.01) in Han and Uyghur adults, as well as the CA (rU=0.48, rH=0.34, all P<0.01). Moreover, when the K1 (rU=0.23, rH=0.23, all P<0.01) and K2 (rU=0.25, rH=0.27, all P<0.01) was high, the CV was large. ACD was significantly positively correlated

Table 4 Correlation matrix in Uyghur and Han

Parameters	K2		CA		CV		ACA		ACD		ACV		PD		WTW		AL		SE	
	U	H	U	H	U	H	U	H	U	H	U	H	U	H	U	H	U	H	U	H
K1	$0.88^{b,c}$	0.88^{b}	-0.06	-0.09^{b}	0.23^{b}	0.23^{b}	0.10	0.14^{b}	-0.03^{c}	-0.06^{b}	$-0.26^{b,c}$	-0.25^{b}	-0.03	-0.12^{b}	-0.42^{b}	-0.46^{b}	0.01^{c}	0.03	0.08^{a}	0.03
K2	–	–	0.48^{b}	0.34^{b}	0.25^{b}	0.27^{b}	0.10	0.11^{b}	-0.05^{c}	-0.05	$-0.27^{b,c}$	-0.23^{b}	-0.07	-0.12^{b}	-0.36^{b}	-0.40^{b}	0.07^{c}	0.06^{b}	0.12^{b}	0.08^{b}
CA	–	–	–	–	0.15^{b}	0.12^{b}	-0.01	-0.03	-0.02	0.03	-0.07	0.03	-0.07	-0.03	-0.01	-0.08^{b}	0.03	0.09^{b}	0.13^{b}	0.12^{b}
CV	–	–	–	–	–	–	0.06	0.01	-0.02	-0.06	-0.25^{b}	-0.21^{b}	-0.09^{a}	-0.07^{b}	-0.26^{b}	-0.25^{b}	0.02	0.01	0.08	0.06^{b}
ACA	–	–	–	–	–	–	–	–	0.28^{b}	0.32^{b}	0.11^{b}	0.16^{b}	-0.25^{b}	-0.16^{b}	0.05	0.05	0.12	0.03	0.03	0.05^{a}
ACD	–	–	–	–	–	–	–	–	–	–	$0.83^{b,c}$	0.81^{b}	0.15^{b}	0.21^{b}	0.50^{b}	0.45^{b}	-0.09^{c}	0.02	0.02	0.04
ACV	–	–	–	–	–	–	–	–	–	–	–	–	0.22^{b}	0.24^{b}	0.61^{b}	0.55^{b}	-0.06^{c}	0.04	0.01	0.07^{b}
PD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.13^{b}	0.14^{b}	-0.1	-0.03	0.02	0.02
WTW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	-0.12	-0.04	-0.1^{a}	-0.05^{a}
AL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.34^{b}	0.62^{b}

U: Uyghur ethnicity; H: Han ethnicity; K1: Corneal curvature for the flat axis; K2: Corneal curvature for the steep axis; CA: Corneal astigmatism; CV: Corneal volume; ACA: Anterior chamber angle; ACD: Anterior chamber depth; ACV: Anterior chamber volume; PD: Pupil diameter; WTW: Corneal diameter; AL: Axial length. $^{a}P<0.05$; $^{b}P<0.01$. ^{c}Pearson correlation coefficients, the rest are Spearman correlation coefficients.

with ACA and ACV, indicating shallower anterior chamber values resulting in narrower ACA values (rU=0.28, rH=0.32, all $P<0.01$) and smaller ACV values (rU=0.83, rH=0.81, all $P<0.01$). In addition, narrower ACA values were significantly correlated with larger PD (rU=-0.25, rH=-0.16, all $P<0.01$).

WTW was significantly negatively correlated with K1 (rU=-0.42, rH=-0.46, all $P<0.01$) and K2 (rU=-0.36, rH=-0.40, all $P<0.01$) and positively correlated with ACD (rU=0.50, rH=0.45, all $P<0.01$) and ACV (rU=0.61, rH=0.55, all $P<0.01$). Thus, a larger cornea may result in flatter topography and a deeper anterior chamber. Notably, there were significant positive correlation between AL and SE, and this correlation is much stronger in Han adults (r=0.34, $P<0.01$) than in Uyghur adults (r=0.62, $P<0.01$).

DISCUSSION

This research analyzed the effects of varying degrees of myopia on ocular biometric parameters. We measured K1, K2, CA, WTW, and CV as representative parameters of the cornea, ACA, ACD, ACV, and PD as representative parameters of the anterior chamber, and AL as the primary structure correlated with myopia progression[5]. We first assessed the ocular biometric parameters of myopia in young Uyghur adults and compared them with young Han adults.

The values of ocular biometric parameters changed with the degree of myopia. Patients in the HM group had steeper K2 values, larger CA values, smaller WTW values and longer AL values in both the Uyghur and Han adults, consistent with the results of other studies[21-23]; these findings indicated that the steeper cornea neutralizes the longer AL. The decrease in WTW may be due to posterior traction of the limbus caused by elongation of the eyeball in the HM group. Further investigations are required to reveal the exact mechanisms underlying this finding. However, changes in the anterior chamber related indicators occurred only in the Han adults, *i.e.*, those with moderate and HM had deeper ACV and ACD values and wider ACA values than those with LM. The assessment of ACA and ACD values is critical for screening, diagnosing, classifying and managing glaucoma. Research[24] has shown that myopia is correlated with an increased prevalence of primary open angle glaucoma (POAG); each 1-D reduction in SE results in a 22% decrease in the odds of PACG, and there are ethnic differences in the correlation of myopia with the risk of POAG. According to the mechanical tension theory, during the spherical enlargement of the eyeball, equatorial ocular expansion is restricted by mechanisms that result in an ellipsoidal eyeball shape; in this case, corneal curvature becomes steeper, and the anterior chamber becomes deeper[25]. The results of the ocular biometry distribution are consistent with this theory among Han adults; however, such anterior chamber compensatory changes were not observed in

Uyghur adults. The Han population may have different pattern of eye for HM compared to the Uyghur population (Figure 1). The difference in ocular biometric parameters may cause differences in the subtypes of glaucoma associated with HM among Uyghur and Han adults, and Uyghur adults might have a higher prevalence of PACG. More work is required to test this hypothesis.

Uyghur individuals represent the main ethnic group in Xinjiang; Uyghur individuals have different ocular biometric parameter characteristics, including overall narrower ACA, shallower ACD, smaller CV, shorter WTW, shorter AL, and larger PD than Han adults in each myopia group, and the corneas of Uyghur adults demonstrated steeper K values compared to those of Han adults in the HM group. Our results are consistent with those described in Shi *et al*'s[17] study, in which Uyghur children had shorter AL values and smaller AL/CR values than Han children. These characteristics have also been observed in college-age students with emmetropia[26]. The most important contributory effect on refractive error was AL[3,27-30], and the differences in myopia prevalence corresponded with ethnic variations across ocular parameters, with Han adults having longer ALs. It is known that if the AL is longer, the risk for fundus lesions is higher; however, further research is required to evaluate whether the fundus readily develops pathological changes related to myopia in the Han population. Our previous research has shown that the cornea is thinner in the Uyghur adults than in the Han adults[26], and these may cause results in our findings that Uyghur adults have a smaller CV; the cornea shape readily changes when myopia increases with cornea sagittal lengthening[25], which can result in steeper cornea values in HM Uyghur adults than Han adults. These results showed that the effects of ethnic backgrounds on the cornea must be considered when choosing refractive surgery. Further research is needed to evaluate corneal biomechanics between Uyghur and Han adults.

Our results revealed that Uyghur adults have significantly narrower ACA and ACD and shorter WTW than Han adults, indicating that Uyghur adults may more susceptible to anterior chamber closure. Previous studies have shown that shallower anterior chambers, a small corneal diameter and a shorter AL are risk factors for PACG[11,31-32]. The overall prevalence of glaucoma in the elderly Chinese Uyghur population in Xinjiang[33] was 3.79%, with PACG being the most predominant type (2.22%). Related research[34] has revealed that the prevalence of PACG is more than twice as high in the Uyghur population than in the Han population (60.3% *vs* 27.3%, $P<0.05$). Another study[35] revealed that alleles in two PACG susceptibility SNPs protect against refractive errors, representing a potential reason for the lower prevalence of myopia in the Uyghur population[17-18,36]. Considering a strong correlation between ocular biometric parameters and refraction[3,37], the difference in the prevalence of myopia could be due to genetic differences between the two ethnicities contributing to the regulation of ocular biometry independent from education intensity, socioeconomic conditions, and climate. Further studies are required to validate this theory.

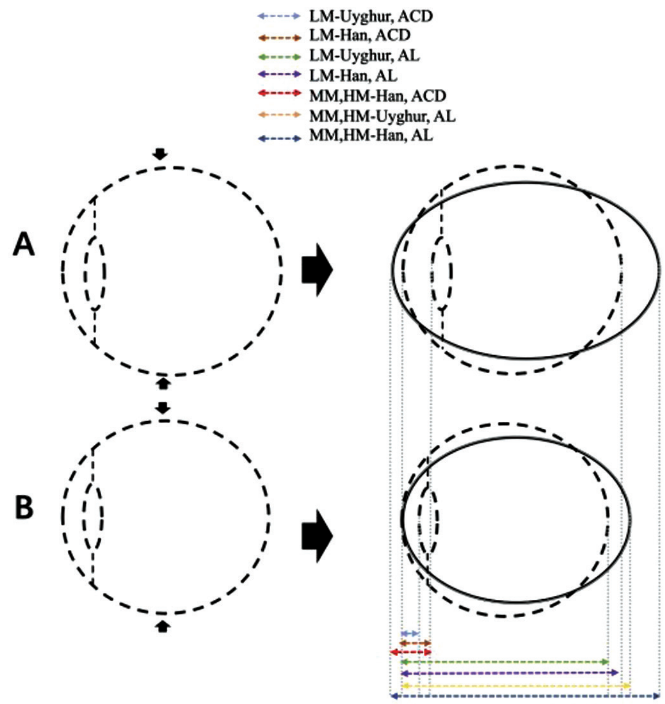

Figure 1 Possible pattern of eye in Han adults (A) and Uyghur adults (B) Adults in the moderate and HM group had deeper ACV and ACD values and wider ACA values than those with LM only in the Han adults. Compared to Han adults, Uyghur adults have smaller eyes with a smaller WTW, thinner cornea, narrower anterior chamber, and a shorter AL. LM: Low myopia; MM: Moderate myopia; HM: High myopia; ACV: Anterior chamber volume; ACD: Anterior chamber depth; WTW: White-to-white; AL: Axial length.

Our study also revealed flatter corneas, a deeper ACD and ACV, and a larger WTW in males than females in both the Han and Uyghur adults. Ocular biometric characteristics can help to explain the increased prevalence of PACG in females[38]. This conclusion is in line with previous studies of young Chinese adults, children and elderly individuals[21-22,39-40]. These results are also consistent with international research[41]. Some studies[5,42-45] have shown that taller persons tend to have a deeper ACD than shorter people, and males are generally taller than females[46]. The differences presented in this research related to the sex of the patients can be attributed to the correlation between ocular dimensions and stature.

Interestingly, we found that WTW and ACD showed a moderate positive correlation. This result is consistent with other Chinese studies in which people with myopia and cataracts were analyzed[21,39]. These studies revealed that when WTW is larger, the ACD is deeper. This is crucial, as

ACD and WTW are important factors for accurately sizing the implantable collamer lens (ICL) in refractive surgery[47]. We found that the ACD of Uyghur adults did not change with increasing myopia; nonetheless, Uyghur adults in the HM group showed steeper K values and narrower ACD than Han adults; thus, ICL implantation in patients from the Uyghur population with HM must be undertaken with caution. Another important aspect is that ACA is correlated not only with the ACD but also with the PD; thus, if the pupil is larger, the peripheral iris is crowded and the ACA is narrower. This finding validates the results of research on the ocular biometric determinants of ACA width, and that study suggests that ACD and iris curvature (IC) are the strongest determinants of angle width[12,48], and IC is closely related to PD. We found that Uyghur adults have a larger PD and smaller ACA, which can result in a higher occurrence of PACG in the Uyghur population than in the Han population. As other similar studies have shown[3,28], there is also a correlation between AL and SE, but the correlation is higher in adults of Han ethnicity than in adults of Uyghur ethnicity. Combined with the larger corneal curvature of adults from the Uyghur population, our results indicated that the extension of the ocular axis was compensated by increasing the corneal refractive power in Uyghur adults.

There are also some limitations of this study that must be noted. The first limitation is the uneven distribution, as the number of subjects in the two groups was not equal, which can cause over or underestimation and might have affected the results. Second, some potential influencing factors have not been considered, such as anthropometry (body weight and height), socioeconomic status and habits (smoking and alcohol consumption).

Finally, we can conclude that ethnicity influences ocular biometric parameters in different population sections. The Han population may have different pattern of eye for HM from the Uyghur population, and the Uyghur population may be anatomically more susceptible to PACG than the Han population. These findings provide normative values of the distribution of ocular biometry among Han and Uyghur myopic adults in Xinjiang, which is valuable for preventing and controlling ocular disease in Northwest China.

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