

A comparison of interpupillary distances between Turkish and Azerbaijani populations

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Research article

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Abstract

Background: Differences in far interpupillary distance (IPD) in Turkish and Azerbaijani adults of the same ethnic background from different age groups were examined to investigate the effects of ethnicity, genetics, geography, and environmental factors on IPD.

Methods: A total of 1,400 healthy individuals aged ≥ 18 years were enrolled. The far IPD of each individual was determined in both communities. IPD data for 700 subjects in Azerbaijan and 700 subjects in Turkey was analyzed. Males and females were divided into six age ranges: 18–24, 25–34, 35–44, 45–54, 55–64, and ≥ 65 years. Far IPD data in Turkey and Azerbaijan was collected using two types of autorefractometers: Topcon RM 8800 and Topcon TRK-2P.

Results: The mean age of the 700 subjects in Turkey was 44.5 ± 17.6 years. The mean IPD was 62.1 ± 3.7 mm. The mean IPD in females was 61 mm, which was less than males (63 mm) ($P < 0.05$). The mean age of the 700 Azerbaijani subjects was 44.0 ± 15.6 years. The mean IPD of the subjects was 65.0 ± 3.1 mm. The mean IPD (64 mm) in females was significantly lower than the mean IPD (66 mm) in males ($P < 0.05$). Differences in IPD between age groups in both communities were statistically significant ($P < 0.05$). The mean IPD in all age groups in the Azerbaijani population was greater than that of the Turkish population. Compared with other ethnic groups, the mean IPD in the Azerbaijani population was remarkably high.

Conclusions: When mean far IPD values in individuals aged ≥ 18 years in the Azerbaijani and Turkish populations were compared, statistically significant differences were observed. In Azerbaijani Turks, mean IPD values in both males and females were greater than those observed in the Turkish population in all age groups. The mean IPD values of the Azerbaijani population were greater than those of other ethnic groups when classified by both age and sex. As well as ethnicity, geographical and environmental factors influenced far IPD values.

1. Background

The normal distribution of craniofacial anthropometric measurements in communities shows some differences. Recognition of normal facial anthropometric data is important as it is used in many applications [1]. Interpupillary distance (IPD) is an oculofacial parameter that is routinely measured in ophthalmology. The distance between the center of one pupil and the other on the line of sight (i.e., IPD) is an important clinical measure in ophthalmology [2, 3].

Craniofacial and ocular biometric measurements are frequently used in ophthalmology; optometry; opticianry; plastic surgery; forensic medicine; mouth, teeth, and facial surgeries; and genetic, anthropological, and ethnic research. IPD is an important parameter that is related to the eyes. Ethnicity, genetics, gender, age, and environmental and geographic differences are thought to be determining factors in facial anthropometric dimensions [4, 5].

In craniofacial anthropometric measurements, research shows that the largest differences exist in the orbitonasal region [1]. Even among individuals of the same ethnicity, differences in IPD depend on age and gender. Another factor is the effect of geographical conditions on IPD [4]. Identifying differences in IPD between Turkish and Azerbaijani populations of the same ethnic background may provide a contribution to knowledge in this area. This study, which measures IPD in Turkish and Azerbaijani populations, is one of the few studies showing that geographical factors can be an effective factor in this regard.

Measurement of IPD is an integral part of the optometric examination and one of the most important components of the optical design process [6]. IPD is one of the important reference points in the horizontal plane of the head, and it is used in facial, mouth, and dental surgery [7].

Different methods can be used to measure IPD; some are manual, while others are automatic. Three-dimensional (3D) photographic measurements can also be produced. Manual measurements use a range of tools and techniques such as rulers, as shown in Fig. 1.

Another commonly used method that can be used to measure IPD is the digital pupillometer (Fig. 2). Other optical tools that can be used to measure IPD include 3D digital photoshoots, the Optical Vernier PD Ruler (Fig. 3), and infrared eye trackers [8, 9, 10, 11].

Digital measurement devices are commonly used today. These devices measure eye refraction defects. We used digital autorefractometers in our study, as shown in Fig. 4.

IPD measurements are used in different fields of study including plastic surgery, oral and dental applications, forensic science, genetic science, anthropology, facial surgery, optical devices, and the contact lens and glasses industries. Ethnicity is one factor that influences differences in IPD in humans, but IPD may also differ depending on one's geographic location. IPD varies throughout life, starting from birth. In the period of growth and development, a rapid increase in IPD is observed. Changes in IPD vary by age, ethnicity, and gender [12, 13].

There are two definitions of IPD; anatomical IPD and physiological IPD are measured with units of distance. The difference between the two measurements is negligible [14]. In addition, two separate measurements can be made: far IPD and close IPD. In the present study, far IPD measurements were evaluated in line with previous studies.

2. Methods

A total of 1,400 participants of Turkish ethnic origin residing in Turkey and Azerbaijan were included in the study. Eye examination data from 700 subjects at Dunya Goz Hospital in Istanbul, Turkey; and 700 subjects at Dunya Goz Hospital in Baku, Azerbaijan, were analyzed. The necessary permissions were obtained from the ethics committee of Uskudar University and studies were carried out in accordance

with the tenets of the Declaration of Helsinki (B.08.06.YÖK.2.ÜS.0.05.0.06/2018/604). Written and verbal informed consent was obtained from all participants.

The ethnic origin and family tree of each individual were assessed; all participants were confirmed to be of Turkish origin. In addition, adults aged ≥ 18 years were included in the study. Individuals with facial pathologies or previous surgery were excluded. Those with congenital or acquired pathologies of the head and face (e.g., macrocephaly) were evaluated within the exclusion criteria.

A total of 1,400 participants underwent a complete eye examination, which was carried out by the same ophthalmologist in each case. Eye measurements were confirmed twice. Far IPD measurements were performed using two autorefractometers: Topcon RM 8800 and Topcon Auto Kerato-Refractor/Tonometer TRK-2P.

During IPD measurements, care was taken to ensure that participants' sitting positions were appropriate. Particular attention was paid to ensure that the head and chin were correctly positioned during the measurement. The IPD values measured using autorefractometers comprised far IPD measurements.

The data found in Turkey and Azerbaijan by separating the males and females. Data from the two groups was divided into six groups by age range: 18–24, 25–34, 35–44, 45–54, 55–64, and ≥ 65 years.

The mean, standard deviation, median (lowest and highest), frequency, and ratio were used as descriptive statistics of the data. Distribution of the variables was measured using the Kolmogorov–Smirnov test. To analyze quantitative independent data, the Mann–Whitney U test was applied. The chi-squared test was used to analyze qualitative independent data. SPSS 22.0 (IBM Corporation, Armonk, NY, USA) was used to perform statistical analyses. A P value of < 0.05 was considered statistically significant.

3. Results

In the present study, which applied exclusion criteria for subject selection, 1,400 randomly selected subjects were enrolled. Of the 1,400 subjects, 733 (52.4%) were female and 667 (47.6%) were male.

The mean age of the subjects was 17.6 ± 44.5 years for the Turkish population and 44.0 ± 15.6 years for the Azerbaijani population; the overall age range was 18–80 years. There was no significant difference in the mean age of males and females between the Turkish and Azerbaijani populations ($P = 0.363$). Mean IPD in the Turkish population was 62.1 ± 3.7 mm (median = 62.0 mm), while mean IPD in the Azerbaijani population was 65.0 ± 3.1 mm (median = 65.0 mm).

Table 1 and Table 3 show age, sex, and IPD measurements. In 1,400 subjects, IPD was significantly greater in males compared with females in both populations ($P = 0.000$). Mean IPD values by age group are shown in Table 2.

Table 1

	Turkish population		Azerbaijani population		P-value	
	Mean age ± SD	Median	Mean age ± SD	Median		
Overall	44.5 ± 17.6	46.0	44.0 ± 15.6	44.0	0.716	
Age (years)	18-24	126	34.1%	125	33.8%	0.127
	25-34	127	34.3%	129	34.9%	
	35-44	95	25.7%	119	32.2%	
	45-54	133	35.9%	151	40.8%	
	55-64	126	34.1%	103	27.8%	
	≥65	93	25.1%	73	19.7%	
Sex	Female	375	101.4%	358	96.8%	0.363
	Male	325	87.8%	342	92.4%	

^m Mann-Whitney U test/^{X²} chi-squared test

Table 2

	Turkish population		Azerbaijani population		P-value ^m	
	Mean ± SD	Median	Mean ± SD	Median		
<i>IPD (mm)</i>						
Overall	62.1 ± 3.7	62.0	65.0 ± 3.1	65.0	0.000	
18-24	60.3 ± 3.9	60.0	65.8 ± 2.5	65.0	0.000	
25-34	60.7 ± 3.0	61.0	66.0 ± 3.1	66.0	0.000	
35-44	63.2 ± 3.3	63.0	64.6 ± 2.9	65.0	0.001	
45-54	63.4 ± 3.6	64.0	64.5 ± 3.4	64.0	0.004	
55-64	62.7 ± 3.6	63.0	64.6 ± 3.5	65.0	0.000	
Age ≥65	62.4 ± 3.6	62.0	64.2 ± 2.7	64.0	0.001	
Sex	Female	61.1 ± 3.4	61.0	64.1 ± 2.9	64.0	0.000
	Male	63.1 ± 3.7	63.0	66.0 ± 3.1	66.0	0.000

^m Mann-Whitney U test

Table 3

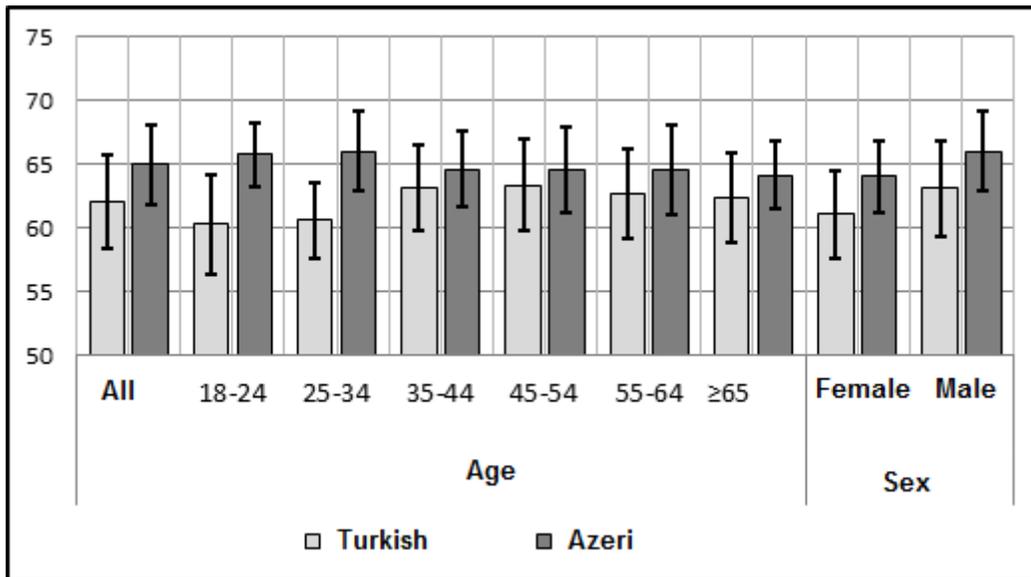
Min-Max age Median age Mean age ± SD

	Min-Max age	Median age	Mean age ± SD
Overall	18 - 80	45.0	44.3 ± 16.6
Age (years)	18-24		251 17.9%
	25-34		256 18.3%
	35-44		214 15.3%
	45-54		284 20.3%
	55-64		229 16.4%
	≥65		166 11.9%
Sex	Female		733 52.4%
	Male		667 47.6%
IPD (mm)	49.0 - 82.0	64.0	63.5 ± 3.7

The age and gender distribution of the patients did not differ significantly between the Turkish and Azerbaijani populations ($p > 0.05$) (Table 2).

When the mean IPD of the Azerbaijani population was compared with the mean IPD of the age group, for all age groups (18–24, 25–34, 35–44, 45–54, 55–64, and ≥65 years), the IPD was significantly greater in the Azerbaijani population ($p \leq 0.05$) than the Turkish population. When grouped by gender, the IPD was significantly greater ($p \leq 0.05$) in females in the Azerbaijani population compared with females in the Turkish population. In males, the IPD in the Azerbaijani population was significantly greater ($p \leq 0.05$) compared with the Turkish population (Table 3).

In the present study, the mean IPD in every age and sex group in subjects in the Azerbaijani population (≥18 years) was significantly greater than the mean IPD in the Turkish population.



When considering age-related differences in IPD, changes in IPD in six different age groups in the Turkish population were as follows. IPD gradually increased by 3.1 mm in the 18–54-year age group. A reduction in IPD was observed with an increase in age; specifically, a reduction in IPD of 1.0 mm was observed in the 45–65-year age group. In the Azerbaijani population, there was an increase of 0.2 mm in age-related IPD in the 18–34-year age group, and a decrease of 1.5 mm in the 25–34-year and 45–54-year age groups. IPD decreased by 0.4 mm in the 55–64-year and ≥65-year age groups.

4. Discussion

Normally distributed facial anthropometric and ocular biometric measurements by age and gender are used to produce industrial and medical prostheses and devices for the face and eyes; they are also used in medical and surgical applications [15].

Normal IPD, which is one of the facial anthropometric measurements, is one of the important measurement points on the face; it is considered in genetics, anthropology, forensic medicine, ophthalmology, and dental and facial surgeries [16].

Different methods can be used to measure IPD when carrying out eye examinations. IPD can be determined using manual and automatic measurements. IPD measurements are based on the values found when looking away. It performs both refraction and IPD distance measurements in autorefractometers in eye examinations. In our study, an autorefractometer was used to obtain far IPD measurements.

In both the Turkish and Azerbaijani populations, IPD values were greater in males than in females, which is in agreement with previously published studies. In a study conducted in adult males and females in Iran, the mean IPD in males was 63.6 ± 3.9 mm, while the mean IPD in females was 61.1 ± 3.5 mm [12].

In another study conducted in Pakistan, the mean IPD values reported in adults were 62.7 ± 6.8 mm in males and 60.7 ± 5.03 mm in females. In the same study, the mean IPD values of different ethnic groups were 62.5 ± 6.7 mm (Urdu), 60.9 ± 5.5 mm (Sindhi), 61.2 ± 6.5 mm (Punjabi), and 62.5 ± 6.6 mm (Pathan) [17].

In a study that enrolled Malay and Chinese participants, the mean IPD values were 62.44 ± 2.66 mm in adult females and 66.03 ± 2.96 mm in adult males (Malay), and 61.31 ± 2.76 mm in adult females and 64.37 ± 2.59 mm in adult males (Chinese)[9]. Murray et al. conducted a study on 416 subjects in the USA; the mean IPD value was 65.32 mm in males and 61.53 mm in females [10]. In another study conducted in Nepal, the mean IPD values were 61.92 ± 5.85 mm (Arians) and 57.50 ± 7.23 mm (Mongoloids) (18). In a study conducted in India, the mean IPD was 61.1 mm in males and 58.2 mm in females [19]. In a study conducted in Nigeria, it was emphasized that racial factors and environmental factors may influence ocular biometric characteristics, which differ between societies [20]. Facial anthropometric differences were statistically significant in a study conducted between four different ethnic groups in the USA, including White, African–American, Hispanic, and Asian [4].

Considering the comparison of the IPD results, the mean IPD of the Azerbaijani population was greater than that of the Turkish population and was also generally greater than that of other populations [9, 10, 12, 17, 19, 21].

Conclusion

To the best of our knowledge, the present study is the first oculofacial anthropometric study conducted on Turkish and Azerbaijani populations to compare IPD. Significant differences were observed, which were greater in all age and sex groups. Although both populations were of the same ethnic background, it is thought that differences in geography may have contributed to the observed differences in IPD. Although ethnicity, age, and gender influence IPD, geographic differences may also contribute. Our study shows normal IPD values by both age and gender in both Turkish and Azerbaijani populations. This data may contribute to future studies, particularly those carried out in the sectors of surgery and optometrics.

It is noteworthy that the mean IPD value in the Azerbaijani population was greater than that observed in the Turkish population, particularly in Turkish females; and greater than many other ethnic groups, as reported by previous studies. Further studies should be conducted in different ethnic groups in the future to clarify the findings of the present study.

Abbreviations

IPD: Interpupillary distance

Declarations

-Ethics approval and consent to participate: The study followed the tenets of the Declaration of Helsinki and has been approved by the local ethics committee. Written informed consent was obtained from all participants.

Ethics Committee of Üsküdar University (SAYI: B.08.6.YÖK.2ÜS.0.05.0.06/2018/604)

-Consent for publication: Not applicable

-Availability of data and material: The data in this study could be obtained from the corresponding author upon reasonable request.

-Competing interests: The authors declare that they have no competing interests

-Funding: Non-financial

-Authors' contributions: Corresponding author. Author read and approved the final manuscript.

-Acknowledgements: Not applicable

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Figures

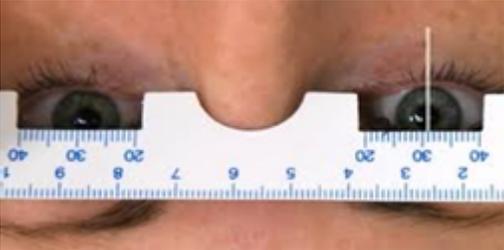


Figure 1

Measuring IPD using a ruler



Figure 2

Pupillometer

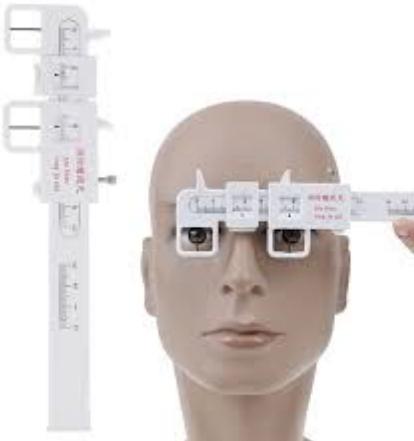


Figure 3

Optical Vernier PD Ruler



Figure 4

Autorefractometer