DISTANT AND NEAR INTERPUPILLARY DISTANCE IN 3448 MALE AND FEMALE SUBJECTS: FINAL RESULTS

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Aim: To establish the normal standards for distant and near interpupillary distance (IPD) specific for age and sex in 3448 urban Turkish subjects from 7 to 40 years of age.

Methods: Turkish male (n=1852) and female (n=1596) subjects were investigated for anatomical IPD. Subjects were divided into three age groups; 7 to 15 year-old children (mean, 10.86±2.69), 16 to 25 year-old young adults (mean, 20.57±2.88), 26 to 40 year-old adults (mean, 30.87±4.55). The normative mean values at each age for 7 to 25 year-old group were determined. The average values for IP measurements with 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles were presented for 7 to 15 year-old group. The values were compared with standards derived from other ethnic populations.

Results: In all groups, the mean age difference between males and females was not significant. The overall anatomical FIPD is on the average 2.92 mm wider than NIPD. The male IPD were, on the average, wider than the female IPD in either distances, with greater differences in the advanced ages. The FIPD and NIPD differences were significant for all ages. Mean values for IPD's in our study for both sex were found to be similar with Arabian, Hong Kong and British children, larger than those of Chinese, Black, Indian and Caucasians and smaller than those of Mexican children and mixed European population.

Conclusion: Beside providing local reference standards at each age and sex, we believe that this investigation will contribute to normative IPD values used in the diagnosis of hyper-hypotelorism, various syndromes and some craniofacial deformities. These data are also useful for the industry of optical frames and lenses.

Key words: Interpupillary distance, anthropometry, hypertelorism, hypotelorism

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3448 bireyde uzak ve yakın interpupiller mesafeler: son veriler

Amaç: Yedi ile 40 yaş arasındaki 3448 kişide yaş ve cinsiyete özel uzak ve yakın interpupiller mesafe (İPM) normal standartlarını belirlemek.

Yöntem: Anatomik İPM için 1852 erkek ve 1596 kadın çalışma kapsamına alındı. Kişiler üç yaş grubuna ayrıldı; 7 ile 15 yaş arası çocuklar (ortalama yaş, 10.86±2.69), 16 ile 25 yaş arası genç erişkinler (ortalama yaş, 20.57±2.88) ve 26 ile 40 yaş arası erişkinler (ortalama yaş, 30.87±4.55). Yedi ile 25 yaş arasında her yaş için ayrı ayrı ortalama normatif değerler belirlendi. Yedi ile 15 yaş arasındaki çocuklarda ayrıca İPM'ler için 3., 10., 25., 50., 75., 90. ve 97. persentiller hesaplandı. Bizim verilerimiz diğer etnik popülasyonlardaki verilerle karşılaştırıldı.

Bulgular: Tüm gruplarda erkek ve kadınlar arasındaki yaş farkı anlamsızdı. Ortalama uzak İPM yakın İPM'den 2.92 mm daha genişti ve yaş ilerledikçe bu fark artmaktaydı. Tüm yaşlarda uzak ve yakın İPM farkları anlamlı idi. İPM ortalamalarımız her iki cinsiyette de Arap, Hong Kong ve İngiliz çocuklarındaki sonuçlarla benzer; Çin, Hint, Siyah ve Kafkasyalı çocuklardan daha büyük; Meksikalı ve karışık Avrupa çocuklarınkinden ise daha küçük idi.

Sonuç: Her yaş ve cinsiyet için yerel referans standartları sağlaması yanında biz bu çalışmanın hiper-hipotelorizm, değişik sendromlar ve bazı kraniofasiyel deformitelerin tanısında katkı sağlayacağı inancındayız. Bu veriler ayrıca gözlük çerçevesi ve lens sektöründe de kullanışlı olacaktır.

Anahtar kelimeler: İnterpupiller mesafe, antropometri, hipertelorizm, hipotelorizm

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In diagnosing certain anomalies and syndromes, abnormal facial features such as ocular hypertelorism or hypotelorism are taken into consideration by many clinicians, geneticists and maxillo-facial surgeons. Measurement become stable have been reached adult levels in mid to late twenties.[1,2] Mostly visual impression is being used to describe the anatomical IPD. However, this description is not enough because of the variations in the facial features such as wide nasal bridge, epicanthus and telecanthus. When comparing normative population values, groups must be matched for age, sex and race. This is especially important in the early ages of life.

Similar ethnic studies have been performed previously[1-9], but most of these have evaluated only distant IPD without considering changes of NIPD and FIPD over time. Since IPD is known to be well correlated with temple width,[5] normative values are also important in the industry of optical spectacle frames and lenses. Because of the differences in distant and near IPD between races, sex and ages, we considered that the measurements of IPD should cover these parameters with normal standard values.

MATERIALS AND METHODS

Measurements of IPD were performed on 3448 healthy urban Turkish male (n=1852) and female (n=1596) subjects with normal craniofacial configuration. The subjects were aged from 7 to 40 years. The measurement of IPD's was performed with a ruler. Subjects were divided into three age groups: the first group included children aged from 7 to 15 years (mean, 10.86±2.69), the second group included young adults aged from 16 to 25 years (mean, 20.57±2.88) and the third group included adults aged from 26 to 40 years (mean, 30.87±4.55). The subjects were also divided into nine subgroups (7-9, 10-12, 13-15, 16-18, 19-21, 22-24, 25-27, 28-30 and 31-40 year-old) to determine the statistical changes for the parameters over time.

All measurements were performed by two expert ophthalmologists. After practicing with the ruler and standardizing our techniques on normal subjects of various ages, the distant and near IP measurements were obtained from the subjects of eight public school and college, the university, the hospital and from the police academy. Distant and near IPD measurements were performed according to Victorin method described by Victorin.[10]

The subject was seated comfortably in a chair and the examiner stood at 40 cm in front of the subject. The subject's head was at the same level as the examiner's head. The subject's face was well illuminated. The millimeter ruler was held tightly against the subject's nose. The examiner closed his right eye first and asked the subject to look at the examiner's open left eye. The zero mark on the ruler was placed at the outer limbus margin of the subject's right eye while the examiner sighted with his open left eye the point of the ruler that corresponded to the inner limbus of the subject's left eye. This measurement is equivalent to the NIPD. Then the examiner closed his left eye and asked the subject to look at the examiner's open right eye. Still maintaining the zero mark on the ruler at the outer limbus of the subject's right eye, the examiner sighted the point on the ruler that corresponded to the nasal limbus of the subject's left eye. This measurement is equivalent to FIPD. The same procedure was repeated from right to left and the average was recorded. Statistical analysis of the data was performed using paired-*t*-test and unpaired-*t*-test.[11]

RESULTS

A total of 3448 (1852 male, 1596 female) subjects were investigated in this study. The first to third groups included 2044 (1104 male, 940 female), 1103 (582 male, 521 female) and 301 (166 male, 135 female) subjects in 7 to 15, 16 to 25 and 26 to 40 year-old groups, respectively. The overall mean age was 15.71±7.09 years (15.78±7.13 for males, 15.63±7.05 for females). In all three groups,

Table 1. Comparison of age, NIPD, FIDP and FNDIFF between males and females in all groups.

		MALE			FEMALE		
	n	Mean±SD	SE-Mean	n	Mean±SD	SE-Mean	p
AGE							
7-15	1104	10.92±2.70	0.08	940	10.78±2.66	0.08	0.228*
16-25	582	20.69±2.91	0.12	521	20.43±2.83	0.12	0.129*
26-40	166	30.84±4.44	0.34	135	30.90±4.68	0.40	0.918*
7-40	1852	15.78±7.12	0.16	1596	15.63±7.05	0.17	0.542*
NIPD							
7-15	1104	56.01±3.32	0.10	940	55.31±3.29	0.10	<0.0001
16-25	582	60.20±2.54	0.11	521	58.41±2.60	0.11	<0.0001
26-40	166	60.91±3.04	0.24	135	59.16±2.55	0.22	<0.0001
7-40	1852	57.77±3.74	0.08	1596	56.65±3.42	0.08	<0.0001
FIPD							
7-15	1104	58.73±3.49	0.10	940	58.03±3.31	0.10	<0.0001
16-25	582	63.59±2.60	0.11	521	61.30±2.66	0.11	<0.0001
26-40	166	64.25±3.00	0.23	135	62.24±2.65	0.23	<0.0001
7-40	1852	60.75±4.03	0.09	1596	59.45±3.51	0.08	<0.0001
FNDIFF							
7-15	1104	2.72±0.59	0.02	940	2.71±0.58	0.02	0.905*
16-25	582	3.39±0.59	0.02	521	2.88±0.57	0.02	<0.0001
26-40	166	3.34±0.55	0.04	135	3.08±0.64	0.06	<0.0001
7-40	1852	2.98±0.67	0.02	1596	2.80±0.59	0.02	<0.0001

NIPD; near interpupillary distance, FIPD; distant interpupillary distance, FNDIFF; the difference between distant and ar ne interpupillary distance SD; standard deviation, SE-Mean; standard error of mean
p= "independent-*t*-test"
*p>0.05

Table 2. Near and distant interpupillary distance in all groups.

GROUP			N I P D		F I P D		
7-40	n=	Age (Mean)	Mean±SD	range	Mean±SD	range	p=*
Combined	3448	15.71	57.25±3.65	46-71	60.15±38.6	48-75	<0.0001
Male	1852	15.78	57.77±3.75	46-71	60.76±4.04	48-75	<0.0001
Female	1596	15.63	56.65±3.43	46-66	59.46±3.51	49-69	<0.0001
7-15							
Combined	2044	10.86	55.70±3.33	46-66	58.41±3.43	48-69	<0.0001
Male	1104	10.93	56.02±3.33	46-66	58.73±3.49	48-69	<0.0001
Female	940	10.78	55.32±3.30	46-65	58.03±3.31	49-69	<0.0001
16-25							
Combined	1103	20.57	59.36±2.72	51-67	62.51±2.87	53-71	<0.0001
Male	582	20.70	60.20±2.54	52-67	63.60±2.60	55-71	<0.0001
Female	521	20.43	58.41±2.61	51-66	61.30±2.67	53-69	<0.0001
26-40							
Combined	301	30.87	60.13±2.96	50-71	63.36±3.02	53-75	<0.0001
Male	166	30.85	60.91±3.05	52.5-71	64.26±3.00	56-75	<0.0001
Female	135	30.90	59.17±2.55	50-65	62.25±2.66	53-68	<0.0001

NIPD; near interpupillary distance, FIPD; distant interpupillary distance, SD; standard deviation
*p= "independent-*t*-test"

the difference for the mean age was not significant between males and females (Table 1).

In male subjects, the overall mean values for distant and near IPD were found to be 60.76±4.04 and 57.77±3.75 mm, respectively. In female subjects, the overall mean values of these distances were 59.46±3.51 and 56.65±3.43 mm, respectively. The measured distant IPD was significantly different from the

measured near anatomical IPD at each year (p<0.0001) (Table 2).

In 7 to 15 year-old age group, the mean±SD for NIPD and FIPD were 56.01±3.32 and 58.73±3.4 mm for the males, respectively. In the females, these values were 55.31±3.29 and 58.03±3.31 mm, respectively. In 16-25 year-old age group, these values were 60.20±2.54 and 63.59±2.60 mm respectively for the males and 58.41±2.60 and 61.30±2.66

Table 3. Average NIPD and FIPD of male and female subjects from 7 to 25 years of age.

Age	Parameter	n=	MALE Mean±SD	range	n=	FEMALE Mean±SD	range
7	NIPD	169	52.67±2.18	46-58	144	51.85±1.87	47-57
	FIPD		55.28±2.28	48-61		54.58±1.87	50-60
8	NIPD	110	53.40±2.27	48-60	103	53.32±2.47	46-60
	FIPD		55.96±2.22	51-63		55.95±2.36	49-63
9	NIPD	110	54.62±2.54	50-63	97	53.39±2.30	47-58
	FIPD		57.22±2.62	53-65.5		56.07±2.23	50-62
10	NIPD	119	55.88±2.74	49-64	101	54.94±2.48	50-62
	FIPD		58.53±2.88	52-67		57.63±2.47	53-65
11	NIPD	100	56.38±2.98	51-64	112	55.69±2.40	50-62
	FIPD		59.04±3.19	53-68		58.43±2.48	52-66
12	NIPD	116	57.21±2.72	51-63	96	56.88±2.77	51-62
	FIPD		59.88±2.89	54-66		59.49±2.82	54-65
13	NIPD	122	57.76±2.58	54-65	90	57.75±2.27	52-64
	FIPD		60.50±2.70	56-68		60.30±2.25	55-66
14	NIPD	129	58.11±2.42	51-63	89	58.06±2.88	53-65
	FIPD		60.97±2.63	53-66		60.78±2.86	55-68
15	NIPD	129	58.86±2.73	53-66	108	57.90±2.57	53-65
	FIPD		61.92±2.73	56-69		60.90±2.62	56-69
16	NIPD	46	59.00±2.59	54-66	47	58.24±2.77	53-65
	FIPD		62.09±2.58	57-69		60.98±2.84	55-68
17	NIPD	40	59.34±2.70	52-65	55	57.65±2.49	53-63.5
	FIPD		62.66±2.82	55-68		60.20±2.74	56-67
18	NIPD	90	60.01±2.36	53-66	59	58.72±2.78	51-64.5
	FIPD		63.38±2.38	57-69		61.54±2.83	53-67.5
19	NIPD	71	60.73±2.67	54-67	49	58.71±2.75	52-64
	FIPD		64.09±2.68	57-71		61.72±2.83	55-67.5
20	NIPD	48	60.24±2.28	56-64	60	58.61±2.15	53-63
	FIPD		63.64±2.29	59-68		61.62±2.12	56-66
21	NIPD	35	59.69±2.19	56-67	54	58.37±2.54	53-66
	FIPD		63.25±2.21	59.5-70		61.19±2.58	56-69
22	NIPD	38	60.56±2.73	56-67	46	58.61±2.58	55-64
	FIPD		64.11±2.74	60-70		61.65±2.77	57-66.5
23	NIPD	73	60.12±2.38	55-65	56	58.47±2.42	52-65
	FIPD		63.59±2.42	59-69		61.46±2.44	55-68
24	NIPD	74	60.68±2.75	56-67	43	58.30±2.50	52-64.5
	FIPD		64.16±2.86	60-70		61.40±2.38	56-67.5
25	NIPD	67	60.83±2.34	56-65	52	58.39±3.10	51-65
	FIPD		64.21±2.45	58-69		61.28±2.98	54.67

NIPD; near interpupillary distance, FIPD; distant interpupillary distance, SD; standard deviation

mm respectively for the females. In 26 to 40 year-old age group, these values were 60.91±3.04 and 64.25±3.00 mm, respectively, for males and 59.16±2.5 and 62.24±2.65 mm, respectively, for females. The differences between males and females in either distance were significant in all three groups (p<0.0001).

The mean±SD value at each year for distant and near IPD for male and female subjects in 7 to 25 year-old age group is presented in Table 3. The third, 10th, 25th, 50th, 75th, 90th and 97th percentile values of the measured distances at each year for distant and near IPD in both sex are presented in

Table 4. The progressions of NIPD, FIPD and the difference between near and distant IPD (FNDIFF) over time are presented in Table 5. Table 6 presents the comparison of our study with other ethnic populations.

DISCUSSION

Various ocular adnexial changes and somato- metric traits of the face like epichantus, telechantus, strabismus, flat nasal bridge, widely placed eyebrows and blepharophimosis may create an illusory error in the identification of certain craniofacial syndromes.[1,12] Therefore, normal values for

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Table 4: Percentile norms of NIPD and FIPD in males and females from 7 to 15 years of age.

M A L E

		NIPD (percentile)								FIPD (percentile)				
3	10	25	50	75	90	97	Age	3	10	25	50	75	90	97
48.1	50	51	52	55	55	56	**7**	51.1	52	53.5	55	57	58	59
49.3	51	52	54	55	55	58.6	**8**	52	53	54	56	57	58	60.6
50	52	52	55	56	58	60	**9**	53	54	55	57	59	61	63
50.6	52	54	55.5	58	60	61.4	**10**	53	55	57	58	60	62.5	64.4
51	53	55	56	58	60	61.9	**11**	54	55	57	59	61	63	65
52.5	54	55	57.5	59	61	62	**12**	54	56	58	60	62	64	65.2
54	55	55	58	60	61	62.3	**13**	56.7	57	58	60	63	64	65.3
54.5	55	56	58	60	61	62.5	**14**	57	58	59	61	63	65	65.5
54.5	55	56	59	61	62	64	**15**	57	58	60	62	64	65	67

F E M A L E

		NIPD (percentile)								FIPD (percentile)				
3	10	25	50	75	90	97	Age	3	10	25	50	75	90	97
48	50	51	52	53	54	55	**7**	51	53	53	55	56	57	58
48	50	52	53	55	56	56.5	**8**	52	53	54	56	57	58	60.5
48	50	52	54	55	56	57	**9**	52	53	55	56	57	58.2	61
50.1	52	53	55	57	58	61	**10**	53	55	56	57.5	59	60.8	63.9
51.3	53	54	55.5	57	58	61	**11**	54	55	57	58.2	60	61	64
51.9	54	55	57	59	61	62	**12**	54	56	57	59.5	61.5	63	65
52.7	55	56	57	59.2	60	62.2	**13**	55.7	57	59	60	62	63	65.2
53	55	56	57	60	62	63.3	**14**	56	57	59	60	63	65	66.3
54	55	56	57	60	61	63	**15**	57	57.9	59	61	63	65	66

NIPD; near interpupillary distance, FIPD; distant interpupillary distance

Table 5. The progressions of NIPD, FIPD and FNDIFF in males and females from 7 to 27 years of age and the statistical analysis.

M A L E

Groups➔		7-9 n=389 Mean±SD		10-12 n=335 Mean±SD		13-15 n=380 Mean±SD		16-18 n=176 Mean±SD		19-21 n=154 Mean±SD		22-24 n=185 Mean±SD		25-27 n=119 Mean±SD		28-30 n=45 Mean±SD		31-40 n=69 Mean±SD
Age		7.84±0.83		10.99±0.83		14.01±0.81		17.25±0.84		19.76±0.79		23.19±0.75		25.65±0.81		28.82±0.80		35.44±2.95
	p=		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
NIPD		53.42±2.44		56.48±2.85		58.24±2.61		59.59±2.52		60.34±2.46		60.43±2.60		60.62±2.49		60.91±3.44		61.33±3.00
	p=		<0.0001		<0.0001		<0.0001		0.007		0.736*		0.536*		0.554*		0.487*	
FIPD		56.01±2.49		59.15±3.02		61.14±2.74		62.87±2.58		63.75±2.46		63.92±2.66		63.99±2.52		64.35±3.38		64.59±3.00
	p=		<0.0001		<0.0001		<0.0001		0.002		0.550*		0.818*		0.462*		0.689*	
FNDIFF		2.59±0.53		2.66±0.58		2.89±0.62		3.28±0.56		3.41±0.53		3.49±0.59		3.37±0.64		3.44±0.59		3.26±0.55
	p=		0.086*		<0.0001		<0.0001		0.043		0.044		0.059*		0.527*		0.095*	

F E M A L E

Groups➔		7-9 n=344 Mean±SD		10-12 n=309 Mean±SD		13-15 n=287 Mean±SD		16-18 n=161 Mean±SD		19-21 n=163 Mean±SD		22-24 n=145 Mean±SD		25-27 n=92 Mean±SD		28-30 n=38 Mean±SD		31-40 n=57 Mean±SD
Age		7.86±0.82		10.98±0.80		14.06±0.83		17.07±0.81		20.03±0.79		22.97±0.78		25.56±0.71		28.71±0.71		35.59±3.35
	p=		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001	
NIPD		52.71±2.30		55.81±2.65		57.90±2.57		58.21±2.70		58.56±2.46		58.46±2.48		58.71±2.89		58.75±2.03		59.46±2.82
	p=		<0.0001		<0.0001		0.224*		0.234*		0.732*		0.483*		0.935*		0.185*	
FIPD		55.40±2.23		58.50±2.68		60.67±2.59		60.92±2.84		61.50±2.50		61.50±2.50		61.70±2.96		61.79±2.16		62.54±2.78
	p=		<0.0001		<0.0001		0.350*		0.051*		0.983*		0.569*		0.861*		0.167*	
FNDIFF		2.69±0.52		2.68±0.58		2.77±0.69		2.70±0.57		2.94±0.54		3.03±0.54		2.99±0.67		3.04±0.65		3.07±0.58
	p=		0.950*		0.100*		0.268*		<0.0001		0.147*		0.584*		0.694*		0.776*	

NIPD; near interpupillary distance, FIPD; distant interpupillary distance, FNDIFF; the differece between distant and near interpupillary distance, SD: standard deviation, p= ''independent-*t*-test, *p>0.05

distant and near IPD are integral measurements in the evaluation of ocular hypotelorism (decreased IPD) or hypertelorism (increased IPD). For these purposes, standards based on local data are desirable, since these standards reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic and sexual differences.

Table 6: Comparison of near and distant IPD of males and females with other ethnic populations.

Investigator	Population	D/N	Age (mean)	n=	Mean±SD†	Range	Method
M A L E							
Osuobeni EP, Al Musa K[7]	Arabic	N	5-15 (**)	310	55.68±2.52	48-60	Ruler
Osuobeni EP, Al Musa K[7]	Arabic	D	5-15 (**)	310	57.96±2.63	51-64	Ruler
Evereklioğlu et al.*	Turkish	N	7-15 (10.93)	1104	56.07±3.32	46-66	Ruler
Evereklioğlu et al.*	Turkish	D	7-15 (10.93)	1104	58.83±3.48	48-69	Ruler
Pryor HB[1]	Japanese	D	16-24 (**)	47	66.00±3.40	59-75	Calculation
Pryor HB[1]	White	D	16-24 (**)	391	62.00±3.50	58-75	Calculation
Osuobeni EP, Al Musa K[7]	Arabic	N	16-25 (**)	272	60.18±2.67	56-72	Ruler
Osuobeni EP, Al Musa K[7]	Arabic	D	16-25 (**)	272	63.25±2.94	58-75	Ruler
Evereklioğlu et al.*	Turkish	N	16-25 (20.70)	582	60.20±2.54	52-67	Ruler
Evereklioğlu et al.*	Turkish	D	16-25 (20.70	582	63.60±2.60	55-71	Ruler
Singh JR, Banerjee[4]	Indian	D	13.5-15 (**)	48	5.80±0.32‡	**	Calculation
Evereklioğlu et al.*	Turkish	D	13-15 (14.01)	404	6.11±0.27‡	53-69	Ruler
Lucas WP, Pryor HB[20]	White	D	15	270	5.90±0.52‡	52-65	Calculation
Pryor HB[1]	Mexican	D	15	49	6.50±0.20‡	59-68	Calculation
Evereklioğlu et al.*	Turkish	D	15	129	6.19±0.27‡	56-69	Ruler
Quant and Woo[5]	HK Chinese	D	25	120	64.59±2.87	57-71.5	CRP
Evereklioğlu et al.*	Turkish	D	25	67	64.21±2.45	58-69	Ruler
F E M A L E							
Osuobeni EP, Faden F[6]	Arabic	N	7-15 (**)	352	55.32±3.29	47-65	Ruler
Osuobeni EP, Faden F[6]	Arabic	D	7-15 (**)	352	57.55±3.29	49-68	Ruler
Evereklioğlu et al.*	Turkish	N	7-15 (10.78)	955	55.27±3.25	46-65	Ruler
Evereklioğlu et al.*	Turkish	D	7-15 (10.78)	955	57.99±3.28	49-69	Ruler
Pryor HB[1]	Japanese	D	16-24 (**)	83	64.00±3.40	55-74	Calculation
Pryor HB[1]	White	D	16-24 (**)	391	60.00±3.40	54-72	Calculation
Osuobeni EP, Faden F[6]	Arabic	N	16-25 (**)	311	58.03±2.78	52-68	Ruler
Osuobeni EP, Faden F[6]	Arabic	D	16-25 (**)	311	60.27±2.80	54-71	Ruler
Evereklioğlu et al.*	Turkish	N	16-25 (20.43)	521	58.41±2.61	51-66	Ruler
Evereklioğlu et al.*	Turkish	D	16-25 (20.43)	521	61.30±2.67	53-69	Ruler
Osuobeni EP, Faden F[6]	Arabic	N	26-40 (**)	353	58.70±3.01	50-69	Ruler
Osuobeni EP, Faden F[6]	Arabic	D	26-40 (**)	353	60.90±3.03	52-71	Ruler
Evereklioğlu et al.*	Turkish	N	26-40 (30.90)	135	59.17±2.55	50-65	Ruler
Evereklioğlu et al.*	Turkish	D	26-40 (30.90)	135	62.25±2.66	53-68	Ruler
Singh JR, Banerjee[4]	Indian	D	13.5-15 (**)	48	5.49±0.27‡	**	Calculation
Evereklioğlu et al.*	Turkish	D	13-15 (14.06)	274	6.06±0.25‡	55-69	Ruler
Lucas WP, Pryor HB[20]	White	D	15	270	5.90±0.44‡	43-64	Calculation
Pryor HB[1]	Mexican	D	15	49	6.40±0.18‡	62-69	Calculation
Evereklioğlu et al.*	Turkish	D	15	100	6.09±0.25‡	56-59	Ruler

D; distant interpupillary distance, N; near interpupillary distance, SD; standard deviation, CRP; corneal reflex pupilometer, HK; Hong Kong, *present study, **data not available, † mm, ‡ cm

Lakshminarayana et al[13] demonstrated that IPD increased from birth to 5 years of age, but after this age the changes were negligible. Fledelius and Stubgaard[2] found that the rate of IPD change was higher in subjects below 20 years of age than in those above 20 years of age. Pryor[1] reported that IPD increased with age from birth to 24 years. Brückner et al.[14] showed that the increase of IPD was continuous until 30 years of age. Chen and O'leary[15] revealed a significant difference in IPD growth rate between males and females. Osuobeni and Faden[7] put forward that increases in IPD slowed down from the mid twenties to late thirties and stopped increasing in the fourth decade of life.

In our study, there was a significant increase in near and distant IPD measurements with age until 19 years in male subjects (Table 3 and Table 5). On the other hand, this increase for both distances was observed until 14 years of age in females. This represents the earlier maturation of females than males. Our results were consistent with the study of Fledelius and Stubgaard[2] which was performed on FIPD. Furthermore, age-related increase in IPD was small but continuous until mid-thirties in our study. We also observed that IPD in males was significantly grater than females starting from

childhood. The average total growth increments for near and distant IPD for 7 and 35 years old males were 8.66 and 9.31 mm, respectively. In females, these increments were on the average 7.61 and 7.96 mm, respectively. In addition, FNDIFF slowly increased over time in either sex.

The overall Turkish male subjects had average 1.12 and 2.01 mm near and distant IPD greater than those for females, respectively. The difference was statistically significant. Across all subjects, the average difference between distant and near IPD was 2.98 mm for males and 2.80 mm for females.

Feningold and Bossert[16] obtained the normal values of distant IPD from individuals without regarding age, sex and race. Juberg et al.[17] obtained distant IPD regarding age, sex and race but only for 5 to 11 year-olds. Osuobeni et al.[6,7] obtained the normal values for both distant and near IPD without regarding the age differences. However, we have done the comparisons regarding sex and comparisons for each age separately from 7 to 25 year-olds.

The overall distant IPD obtained in our study was 60.75±4.03 mm for males and 59.45±3.51 mm for females. These values were similar with the results of Lucas and Pryor[18] (59.00±4.4 mm for males, 59.00±5.2 mm for females) and lower than those of the mixed European population investigated by Waardenberg's[19] (65.3 mm and 62.7 mm on the average, respectively). In 7 to 11 year-old age group, the IPD was greater in our population (mean, 54.5 to 59 mm) than Chinese (mean, 52 mm)[20], Black (mean, 53.1 to 57.5 mm)[17] and Caucasian children (mean, 52 to 56 mm).[1] Our values are very close to Hong Kong (mean 54 to 59 mm)[5] and British children (mean, 55 to 60 mm).[21] In 7 to 15 year-old females, our distant and near IPD values (mean±SD, 58.03±3.31 and 55.32±3.30 mm respectively) were quite similar with those of Osuobeni and Faden[7] who investigated Arabic children (mean±SD, 57.55±3.29 and 55.32±3.29 mm., respectively) (Table 6). In this investigation in female subjects, they

reported the normal FIPD values as 60.27±2.80 and 60.90±3.03 mm in 16 to 25 and 26 to 40 year-old groups, respectively. In our study, these values (61.30±2.67 and 62.25±2.66 mm, respectively) were generally higher than these data (Table 2).

In conclusion, when making the clinical determination of ocular hypo- or hypertelorism in some craniofacial malformations and various syndromes, it should not be enough to rely on impression on physical features of the face. Therefore, besides providing standard norms, this investigation comprises a wide range of group compared with the normative data specific for age, sex and race of the population. These normative data will also be useful for the industry of spectacle frames and lenses.

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