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Expanding the Classic Facial Canons: Quantifying Intercanthal Distance in a Diverse Patient Population

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Background: The intercanthal distance (ICD) is central to our perception of facial proportions, and it varies according to gender and ethnicity. Current standardized reference values do not reflect the diversity among patients. Therefore, the authors sought to provide an evidence-based and gender/ethnicity-specific reference when evaluating patients' ICD.

Methods: As per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a systematic search of PubMed, Medline, and Embase was carried out for studies reporting on the ICD. Demographics, study characteristics, and ICDs were extracted from included studies. ICD values were then pooled for each ethnicity and stratified by gender. The difference between men and women, and that across ethnicities and measurement types were compared by means of independent sample t-test and one-way ANOVA (SPSS v.24).

Results: A total of 67 studies accounting for 22,638 patients and 118 ethnic cohorts were included in this pooled analysis. The most reported ethnicities were Middle Eastern (n = 6629) and Asian (n = 5473). ICD values (mm) in decreasing order were: African 38.5 ± 3.2, Asian 36.4 ± 1.6, Southeast Asian 32.8 ± 2.0, Hispanic 32.3 ± 2.0, White 31.4 ± 2.5, and Middle Eastern 31.2 ± 1.5. A statistically significant difference ($P < 0.05$) existed between all ethnic cohorts, between genders among most cohorts, and between most values stratified by measurement type.

Conclusions: Our standards of craniofacial anthropometry must evolve from the neoclassical canons using White values as references. The values provided in this review can aid surgeons in appreciating the gender- and ethnic-specific differences in the ICD of their patients. *(Plast Reconstr Surg Glob Open 2022;10:e4268; doi: 10.1097/GOX.0000000000004268; Published online 22 April 2022.)*

INTRODUCTION

Anthropometric facial measurements, first analyzed by the ancient Greeks, served as the foundation upon which the neoclassical canons were established.[1,2] These canons define the ideal facial aesthetic proportions, and are continually referenced by the modern-day plastic surgeon. However, neoclassical canons do not reflect the anatomic variations attributed to age, gender, or ethnicity. With the continued trend of globalization in health-care, the patient population treated by the craniofacial surgeon has become increasingly diversified.[3,4] The unique facial characteristics of different ethnicities must be accounted for to implement tailored treatment plans.

Although initially measured with modalities such as cephalography, two-dimensional photogrammetry, and direct measurement, recent technological advancements have allowed for more accurate and reliable periocular anthropometric assessment.[5,6] The intercanthal distance (ICD), as defined by the distance between both medial canthi, is a central measurement of the face, and has been postulated to influence the assessment of almost all other facial morphologic variables.[1,7] It has even been shown to significantly impact perceived beauty and personality.[8]

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The ICD should be approximately equivalent to each palpebral fissure length, allowing for a golden 1:1:1 ratio.[8] Having objective references for this measurement is especially useful in the reconstructive setting for the proper evaluation and correction of congenital and posttraumatic craniofacial deformities. Specifically, restoring the ICD is paramount in the reduction of naso-orbito-ethmoidal fractures and in the correction of hypertelorism and telecanthus. It has even been postulated that the ICD can be a reliable predictor of maxillary central incisor width.[9,10]

Although a multitude of studies have reported on gender- and ethnic-specific anthropometric measurements of intercanthal distance, the literature is devoid of a high level of evidence synthesis to support these claims. Therefore, the goal of this review is to provide plastic surgeons with an evidence-based and gender/ethnicity-specific reference when evaluating patients' ICD. The authors hope this will help in providing better individualized care to patients, and to raise awareness of the role biological gender and ethnicity play in our potentially biased standards.

MATERIALS AND METHODS

A systematic search of the literature was carried out in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guidelines.[11] PubMed, Medline, and Embase were queried using combinations of the following search terms: "Intercanthal distance," "Intercanthal width," "Cephalometry [Mesh]," Anthropometry [Mesh], Face [Mesh], and Population Groups [Mesh]. The search was confined to the English language, and articles from all years were considered. Following duplicate removal, the resultant 298 articles were assessed for inclusion by two independent reviewers, according to strict inclusion and exclusion criteria (Fig. 1). Discrepancies were resolved by means of consensus. All studies describing the ICD of adults (greater than 16 years old) of a specified ethnic cohort and stratified by gender were included. Articles with fewer than 10 patients, pediatric cohorts, that did not mention exclusion of patients with prior craniofacial surgery and/or pathology, or with unspecified ethnicity, age, or gender of participants were excluded from this review. Studies included in the review were assessed for methodological quality through the National Institute of Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.[12] Demographics (age, gender, male-to-female ratio, ethnicity), study characteristics (number of patients in each cohort, method of ICD measurement used), and ICD (reported as mean ± SD in millimeters) were extracted from all included articles. Although some studies utilized different terms for the ICD (ie, intercanthal width, inner-intercanthal distance), the authors defined the intercanthal distance as the linear distance between the medial angles of the palpebral fissures, often referred to as "en-en" in terms of anthropometrics.[13] Studies were classified according to the following ethnic categories: African, Asian, White, Hispanic, Middle Eastern, and South/Southeast Asian.[14,15]

Takeaways

Question: Provide plastic surgeons with an evidence-based and gender/ethnicity-specific reference when evaluating patients' ICD.

Findings: This systematic review and pooled analysis demonstrate that the ICD varies significantly across different ethnicities and genders. Patients from African or Asian backgrounds had higher ICD values than their counterparts, and men had higher ICD values than women across ethnicities. The type of measurement used can play a significantly confounding role in the reporting of the ICD.

Meaning: Rather than using White measurements as the aesthetic ideal and comparator, health professionals can now rely on gender- and ethnic-specific standards to guide their operative planning and assessments regarding the ICD.

Statistical Analysis

Following data extraction, ICDs were separated into groups according to the aforementioned ethnicities. Data were then pooled for each ethnicity through a weighted average and stratified by gender. Weighted SDs were also computed for each. All data were rounded to the first decimal. Pooled ICDs were then compared according to gender and measurement modality within each ethnic group, as well as across ethnic groups. Analysis was performed by means of an independent sample *t*-test and a one-way ANOVA. A Bonferroni post-hoc correction was applied to all tests with more than three groups. All statistical tests were carried out using SPSS v.24 (IBM Corp, Armonk, N.Y.), with statistical significance set at a P value less than 0.05.

RESULTS

Search Outcome

The search yielded 505 articles, of which 67 met the inclusion criteria. All studies received either "good" (n = 53) or "fair" (n = 14) quality assessments. Included studies represented a total of 22,638 patients and 118 ethnic cohorts (Fig. 1). These cohorts included African (n = 15),[1,16–26] Asian (n = 22),[1,6,19,24,27–41] White (n = 37),[1,16,24,33,34,38,42–52] Hispanic (n = 6),[53–55] Middle Eastern (n = 21),[1,9,10,42,56–67] and Southeast Asian (n = 17)[1,33,37,68–77,78] participants. The majority (n = 52/67, 77.6%) of studies strictly included participants between the ages of 16 and 40, with a homogeneous distribution between men (49.8%) and women (50.2%). The largest represented cohorts consisted of Middle Eastern (n = 6629) and Asian (n = 5473) patients. ICD measurement was recorded by direct anthropometry with a caliper (n = 30), through linear dimensions on calibrated 2D photographs (n = 22), or with the use of 3D photography-based software (n = 9). Six studies did not disclose their method measurement. Demographics (ethnicity, age group, male-to-female ratio) and study characteristics (number of patients in each cohort, method of measurement used) can be found in Table 1.

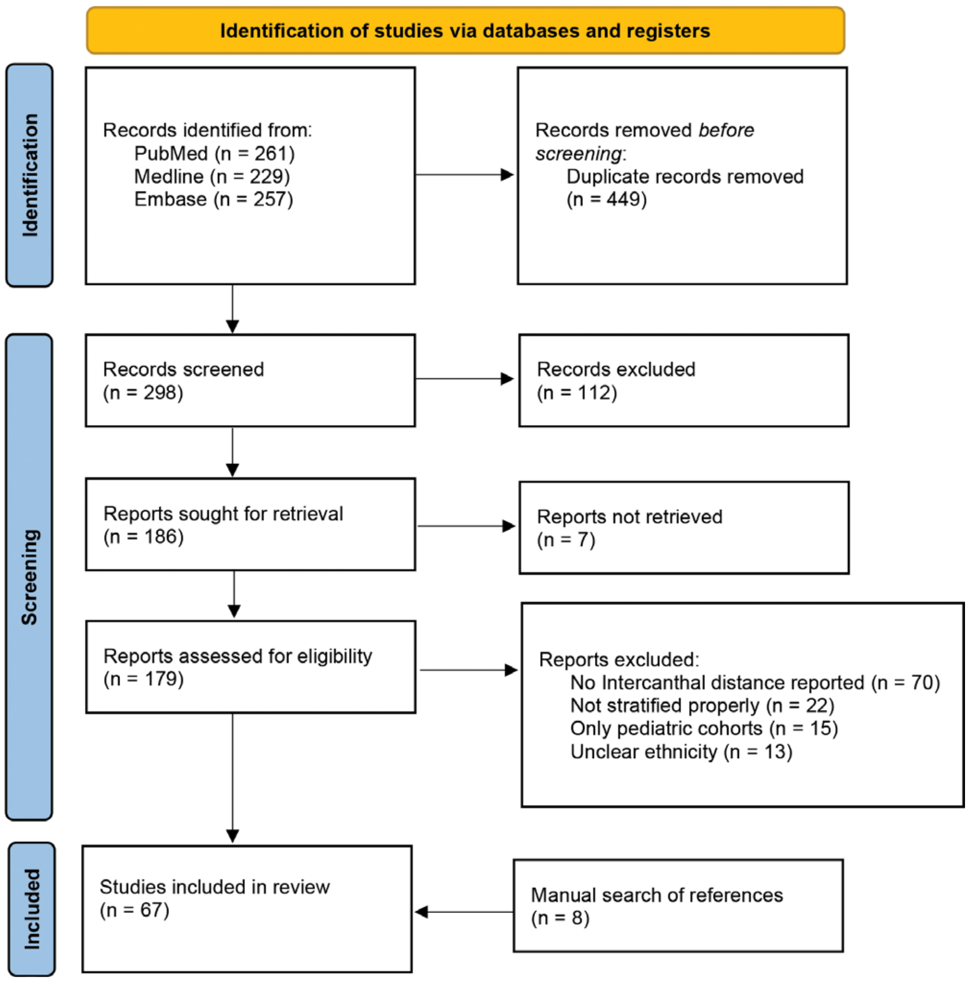

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart for systematic review.

Data Analysis

The overall pooled ICD was first compared by gender within the same ethnicity. A statistically significant difference was observed for all ethnicities (except Hispanic, $P = 0.277$) when comparing men with women ($P < 0.001$) (Table 2). The ICD was also compared between ethnicities, stratified by gender. Statistically significant differences were observed for each comparison among men (Table 3) and women (Table 4). One-way ANOVA of ICD measurement modality (direct, 2D, or 3D photography) showed statistically significant differences for all but two comparisons (Fig. 2, Table 5).

From the 15 cohorts included under the African ethnic category, the majority were either African American (n = 7) or Nigerian (n = 5). (**See table 1, Supplemental Digital Content 1,** which displays primary studies reporting intercanthal distance for African ethnicity. **http://links.lww.com/PRSGO/B998**.)

These yielded 1524 men with a mean ICD of 39.8 ± 2.9 mm (range: 35.7–44.4) and 1444 women with a mean ICD of 37.1 ± 2.9 mm (range: 31.4–41.8) ($P < 0.001$) (Table 2). Almost all (n = 12/15) ICD values obtained by direct measurement yielded a statistically significant difference when compared with values measured using either 2D or 3D photography ($P < 0.001$). No difference was observed when comparing 2D with 3D photography ($P = 0.627$) (Table 5).

From the 22 Asian cohorts, the majority were either Chinese (n = 13/22) or Korean (n = 5/22). (**See table 2, Supplemental Digital Content 2,** which displays primary studies reporting intercanthal distance for Asian ethnicity. **http://links.lww.com/PRSGO/B999**.) These yielded 2447 men with a mean ICD of 37.1 ± 1.8 mm (range: 33.4–44.9) and 3026 women with a mean ICD of 35.9 ± 1.3 mm (range: 32.0–41.9) ($P < 0.001$) (Table 2). Image-based measurements resulted in the highest pooled averages. A statistically significant difference was observed when comparing the three methods of measurements ($P < 0.001$) (Table 5).

Of the 37 White cohorts, participants were almost exclusively (n = 32/37) of European origin, and most commonly (n = 11/37) Italian. (**See table 3, Supplemental Digital Content 3,** which displays primary studies reporting intercanthal distance for White ethnicity. **http://links.lww.com/PRSGO/B1000**.) These resulted in 2375 men with a mean ICD of 31.9 ± 2.2 mm (range: 27.8–42.9) and 1525 women with a mean ICD of 30.7 ± 2.6 mm (range: 27.4–39.3) ($P < 0.001$) (Table 2). Similar to the Asian

Table 1. Included Articles in the Meta-analysis and Their Corresponding Demographic Information

Author	Ethnicity	Population (N)	Age (y), Mean ± SD (Range)	Male: Female Ratio	Method of Measurement
Abdullah[9]	Middle Eastern	229	21.46 (19–24)	1.1:1	Direct anthropometry, manual caliper
Al-Jassim et al[42]	Middle Eastern (3 different cohorts)	759 132 109	>18	1.06:10.71:1 0.35:1	Direct anthropometry, manual caliper
Al-Qattan et al[56]	Middle Eastern	209	22 (18–27)	0.99:1	Calibrated photographs, linear dimensions using photograph software (Adobe Photoshop CS4)
Al-Sebaei[57]	Middle Eastern	168	20–24	1.24:1	Direct anthropometry, manual caliper
Al-Wazzan[10]	Middle Eastern	443	19–55	0.85:1	Direct anthropometry, manual caliper
Amini et al[58]	Middle Eastern	100	23.7 ± 3.4 (18–30)	1:1	Direct anthropometry, digital caliper
Amra et al[59]	Middle Eastern	96	48.69 ± 12.31	2.1:1	Calibrated photographs, linear dimensions using photograph software (image J)
Banu et al[68]	Southeast Asian	120	(20–30)	1:1	Direct anthropometry, manual caliper
Baretto and Mathog[16]	African, White	6165	—	1.18:11.09:1	Direct anthropometry, ruler
Borman et al[60]	Middle Eastern	1050	(20–30)	1:1	Direct anthropometry
Bozkir et al[61]	Middle Eastern	500	(18–25)	0.84:1	Direct anthropometry, millimetric compass
Bukhari et al[62]	Middle Eastern	668	33.8 (15–75)	0.7:1	Direct anthropometry, linear dimensions
Celebi et al[53]	Hispanic (2 different cohorts)	131 92	(18–30)	0.93:10.92:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3dMD face system)
Charles et al[17]	African	435	(22–40)	1.35:1	Direct anthropometry, manual caliper
Choe et al[27]	Asian	72	25 (18–35)	—	Calibrated photographs, linear dimensions using photograph software (Mirror Image)
Dong et al[28]	Asian	289	Men: 22–29 Women: 20–31	1.02:1	3D stereo photogrammetry (3DSS-II)
Egwu et al[18]	African	460	22.46 ± 3.34	1.35:1	Direct anthropometry, plastic ruler
Evereklioglu et al[63]	Middle Eastern	1103 301	(16–25) (26–40)	1.12:11.23:1	Direct anthropometry, plastic ruler
Fariaby et al[64]	Middle Eastern	100	20	1:1	Calibrated photographs, linear dimensions using photograph software
Farkas et al[1]	African, White, Middle Eastern, Asian, Southeast Asian	360	(18–30)	1:1	Direct anthropometry, manual caliper
Ferrario et al[43]	White	79	Young adults: 23 (18–30) Middle age: 37.8 (31–56)	1.22:1 1.08:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3 Draw)
Freihofer[44]	White	100	42	1.13:1	Not specified
He et al[29]	Asian	119	22.7 (18–25)	0.89:1	Direct anthropometry, digital caliper + calibrated photographs, angles using photograph software (Image-Pro Plus 5.0)
Husein et al[69]	Southeast Asian	102	(18–30)	—	Calibrated photographs, linear dimensions
Jayaratne et al[6]	Asian	103	(18–35)	0.98:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3 Draw)
Kim et al[30]	Asian	2065	21.6 (18–29)	1.2:1	Calibrated photographs, linear dimensions using photograph software (Image-Pro Plus 5.0)
Kim et al[31]	Asian	199	Parents: 55.2 ± 13.9 Offspring: 36.0 ± 17.4	0.66:1	Calibrated photographs, linear dimensions using photograph software (image J)
Kim et al[32]	Asian	43 48	Pageant: 22.3 ± 3 Normal: 25 ± 5 (20–30)	—	3D photography (Morpheus)
Kunjur et al[33]	Asian, White, Southeast Asian	78	(18–25)	1:1 (each)	Calibrated photographs, linear dimensions
Laestadius et al[45]	White	50	>19	1:01	Direct anthropometry, manual caliper
Leong and White[34]	Asian, White	54 50	(18–55)	1.08:1 0.92:1	Calibrated photographs, linear dimensions
Li et al[35]	Asian	900	(17–24)	0.8:1	Direct anthropometry, manual caliper
Li et al[36]	Asian	162	25 (20–30)	0.95:1	Calibrated photographs, linear dimensions using photograph software (Adobe Photoshop)
Liu et al[19]	Asian, African	72 117	(18–30)	0.8:1 0.95:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3dMD face system)
Lu et al[37]	Asian, Southeast Asian	97 103	25.62 ± 4.26 (20–39)	1.02:1 0.81:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (VECTRA)
Mehta et al[70]	Southeast Asian	1000	35.1	1:1	Calibrated photographs, linear dimensions
Milgrim et al[54]	Hispanic (3 different cohorts)	37 32 28	37.5 (25–56)	—	Not specified

(*Continued*)

Table 1. (*Continued*)

Author	Ethnicity	Population (N)	Age (y), Mean ± SD (Range)	Male: Female Ratio	Method of Measurement
Murphy et al[20]	African	100	46	0.41:1	Direct anthropometry, manual caliper
Ngeow & Aljunid[71]	Southeast Asian	100	(18–25)	1:1	Direct anthropometry, manual caliper
Oladipo et al[21]	African	1000	(18–65)	1:1	Direct anthropometry, plastic ruler
Olusanya et al[22]	Nigerian	101	23.9 (16–31)	0.98:1	Direct anthropometry, digital caliper
Onakpoya et al[23]	African	204	23.6 ± 3.2 (17–38)	2:01	Direct anthropometry, manual caliper
Othman et al[72]	Southeast Asian	109	Men: 22.4 ± 2.4 Women: 23.2 ± 2.4 (20–30)	0.98:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (VECTRA-M5 360)
Ozdemir et al[65]	Middle Eastern	228	19.18 (18–24)	0.33:1	Calibrated photographs, linear dimensions
Ozturk et al[66]	Middle Eastern	353	(12–68)	0.99:1	Direct anthropometry, plastic ruler
Packiriswamy et al[73]	Southeast Asian (3 different cohorts)	600	(17–25)	1:1	Calibrated photographs, linear dimensions using photograph software (image J)
Parciak et al[24]	African, Asian, White	360	Not specified	1:1 (each)	Calibrated photographs, linear dimensions using photosoftware (AutoCad 2006)
Patil et al[74]	Southeast Asian	216	Subgroups: 16–30, 31–45, 45+	1.04:1	Calibrated photographs, linear dimensions
Pivnick et al[25]	African	52	(16–24)	0.93:1	Direct anthropometry, plastic ruler
Porter and Olson[26]	African	108	25 (18–30)	—	Calibrated photographs, linear dimensions
Prasetyono et al[75]	Southeast Asian	126	(18–25)	—	Calibrated photographs, linear dimensions
Pryor[38]	Asian, White	149 391	(17–22)	0.8:1 0.91:1	Direct anthropometry, manual caliper
Quant and Woo[39]	Asian	243	Men: 25 Women: 29	0.98:1	Direct anthropometry, manual caliper
Raposo do Amaral et al[55]	Hispanic	126	Men: 22–64 Women: 18–59	1:1	Not specified
Ritz-Timme et al[46]	White (3 different cohorts)	300 (each)	(20–31)	—	Direct anthropometry, manual caliper
Santos et al[47]	White	100	32.6 ± 9.9	0.56:1	Calibrated photographs, linear dimensions
Sforza et al[48]	White	353	Subgroups: 18–30, 31–40, 41–50, 51–64, 65–80	1.78:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3 Draw)
Sforza et al[67]	Middle Eastern	142	22.5 ± 3.3 (18–30)	0.92:1	3D landmarks, portable laser scanner (FastSCAN Cobra)
Sforza et al[49]	White	126	20	0.37:1	3D landmarks, three-dimensional computerized electromagnetic digitizer (3 Draw)
Singh et al[76]	Southeast Asian	100	(30–40)	1:1	Direct anthropometry, digital caliper
Staka et Al[50]	White	204	(18–30)	0.98:1	Direct anthropometry, digital caliper Taken three times and the average values were utilized for the analysis.
Torsello et al[51]	White	50	(16–25)	—	Calibrated photographs, linear dimensions
Packiriswamy et al[78]	Southeast Asian	300	(18–26)	1:1	Calibrated photographs, linear dimensions using photograph software (image J)
Vasanthakumar et al[77]	Southeast Asian	200	(18–26)	1:1	Calibrated photographs, linear dimensions using photograph software (image J)
Weilang et al[40]	Asian	430	21.5 (18–30)	—	Direct anthropometry, digitalcaliper + calibrated photographs, angles using photograph software (Image-Pro Plus 5.0)
Wu et al[41]	Asian	102	22.8 (18–25)	1.08:1	Calibrated photographs, linear dimensions using photograph software (Image-Pro Plus 6.0)
Zacharopoulos et al[52]	White	152	22.5 (18–30)	1.05:1	Not specified

cohort, image-based measurements resulted in the highest pooled ICD averages (Table 5). Statistically significant differences were observed between the three measurement methods ($P < 0.001$).

The Hispanic ethnicity was the least represented among cohorts (n = 6), with half of the patients from South America. (**See table 4, Supplemental Digital Content 4,** which displays primary studies reporting intercanthal distance for Hispanic ethnicity. **http://links.lww.com/PRSGO/C2.**)

These yielded 170 men with a mean ICD of 32.4 ± 2.4 mm (range: 29.3–35.1) and 276 women with a mean ICD of 32.2 ± 1.7 mm (range: 29.6–34.1) ($P < 0.001$) (Table 2). The majority (n = 4/6) of studies did not specify which measurement type was used, rendering statistical analysis unfeasible (Table 5).

Middle Eastern ethnicity accounted for 21 cohorts, with Turkish (n = 7/21) and Iranian (n = 6/21) being the most prevalent. (**See table 5, Supplemental Digital Content 5,** which displays primary studies reporting intercanthal distance for Middle Eastern ethnicity. **http://links.lww.com/PRSGO/C3.**)

These yielded 3243 men with a mean ICD of 31.5 ± 1.7 mm (range: 27.3–41.1) and 3386 women with a mean ICD of 30.9 ± 1.3 mm (range: 24.6–39.3) ($P < 0.001$) (Table 2). Statistically significant differences were observed for all measurement types ($P < 0.001$), except for direct versus 2D images ($P = 0.361$) (Table 5).

Finally, 17 Southeast Asian cohorts were included, with the majority being of Malaysian (n = 7) or Indian (n = 7) origin. (**See table 6, Supplemental Digital Content 6,** which displays primary studies reporting intercanthal

Table 2. Pooled Intercanthal Distances among All Ethnicities and Stratified according to Gender, and the Results of Statistical Analysis Comparing Differences between Men and Women

Ethnicity	No. Patients	Mean (mm) ± SD	P
African	2968	38.5 ± 3.2	
Men	1524	39.8 ± 2.9	<0.001
Women	1444	37.1 ± 2.9	
Asian	5473	36.4 ± 1.6	
Men	2447	37.1 ± 1.8	<0.001
Women	3026	35.9 ± 1.3	
White	3900	31.4 ± 2.5	
Men	2375	31.9 ± 2.2	<0.001
Women	1525	30.7 ± 2.6	
Hispanic	446	32.3 ± 2.0	
Men	170	32.4 ± 2.4	0.277
Women	276	32.2 ± 1.7	
Middle Eastern	6629	31.2 ± 1.5	
Men	3243	31.5 ± 1.7	<0.001
Women	3386	30.9 ± 1.3	
Southeast Asian	3222	32.8 ± 2.0	
Men	1493	33.0 ± 2.2	<0.001
Women	1729	32.7 ± 1.8	

distance for Southeast Asian ethnicity. **http://links.lww.com/PRSGO/C4.**)

These accounted for 1493 men with a mean ICD of 33.0 ± 2.2 mm (range: 30.1–37.2) and 1729 women with a mean ICD of 32.7 ± 1.8 mm (range: 29.836.2) ($P < 0.001$) (Table 2). Similarly, a comparison of the three types of measurements used to obtain ICDs yielded statistically significant differences ($P < 0.001$) (Table 5).

DISCUSSION

This review represents the largest evidence-based analysis of intercanthal distances to date. The results of this pooled analysis demonstrate that the ICD varies significantly across different ethnicities and genders. Plastic surgeons should be aware of this when evaluating their patients' intercanthal distance and can now refer to the values presented in this review as a reference. Patients from African or Asian backgrounds had higher ICD values than their counterparts, and men had higher ICD values than women across ethnicities. This review also highlights the confounding role that the type of measurement used can play in the reporting of the ICD.

In the largest multicentric study on anthropometric measurements by Farkas et al,[1] the Middle Eastern cohort showed similar values for ICD when compared with North American White patients, as also demonstrated in our pooled analysis. However, although Farkas et al[1] claimed that African and Asian patients had similar ICDs when compared with North American White patients, our results show they are in fact significantly larger. As shown in our analysis, this might be attributed to the variability between mifferenttanthropometric measurement methods. When attempting to mitigate this possible bias by solely using values obtained by direct anthropometry, as done by Farkas et al,[1] the African and Asian cohorts in our review still have clearly higher values for the ICD than their White counterparts (Table 5). Furthermore, our study analyzed Asian and Southeast Asian patients separately. Because our data demonstrate that the Southeast Asian cohort had significantly lower values than their Asian counterparts, the fact that Farkas et al[1] pooled these may explain why they found lower values for their Asian cohort. In fact, many studies have found discrepancies with the values reported by Farkas et al.[1] and their own findings,[58] which highlight the need for a meta-analysis of the ICD, and the importance of taking into account each values' respective SD and the ranges provided.

According to our data, men consistently had larger ICDs than women across all ethnicities. Despite this largely being known, this pooled analysis now confers greater power to this conclusion and provides gender- and ethnic-specific references. This may even have important implications for the growing field of facial feminization surgery.[53,78,79] It is worth highlighting that the authors pooled all participants regardless of adult age, with 77.6% of studies providing patients between the ages of 16 and 40. Although one might think age may play an important role in anthropometric proportions, the literature suggests that the ICD stabilizes as the craniofacial skeleton matures (at the latest around 16 years of age), and that no real difference arises throughout adulthood until

Table 3. Statistical ANOVA Analysis Comparing Mean Intercanthal Distances of Men across Different Ethnicities

	African	Asian	White	Hispanic	Middle Eastern	Southeast Asian
African	—	<0.001	<0.001	<0.001	<0.001	<0.001
Asian	<0.001	—	<0.001	<0.001	<0.001	<0.001
White	<0.001	<0.001	—	0.011	<0.001	<0.001
Hispanic	<0.001	<0.001	0.011	—	<0.001	0.002
Middle Eastern	<0.001	<0.001	<0.001	<0.001	—	<0.001
Southeast Asian	<0.001	<0.001	<0.001	0.002	<0.001	—

Table 4. Statistical ANOVA Analysis Comparing Mean Intercanthal Distances of Women across Different Ethnicities

	African	Asian	White	Hispanic	Middle Eastern	Southeast Asian
African	—	<0.001	<0.001	<0.001	<0.001	<0.001
Asian	<0.001	—	<0.001	<0.001	<0.001	<0.001
White	<0.001	<0.001	—	<0.001	0.019	<0.001
Hispanic	<0.001	<0.001	<0.001	—	<0.001	<0.001
Middle Eastern	<0.001	<0.001	0.019	<0.001	—	<0.001
Southeast Asian	<0.001	<0.001	<0.001	<0.001	<0.001	—

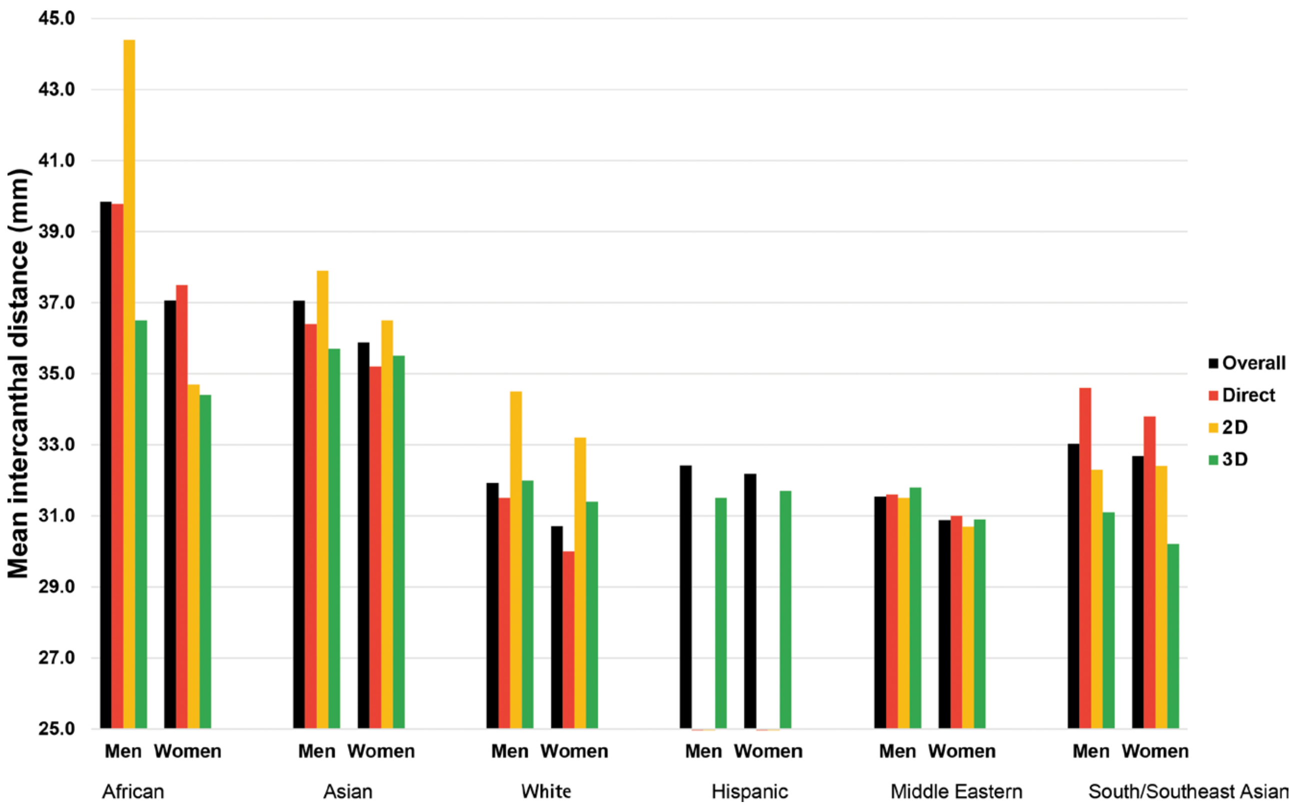

Fig. 2. Mean intercanthal distance stratified by gender, ethnicity, and measurement type.

potentially after 60 years of age.[9,45,76,81,82] Following rapid growth within the first two years of life, orbital parameters reach greater than 86% of adult size by the age of 8 years.[83]

It is also important to emphasize that when stratifying by measurement type, almost all values showed significant differences. Measurement type was thus a major confounding factor in our analysis. No trends as to which measurement method yielded the highest or lowest values could be identified. However, image-based measurements were most often (n = 5/10 cohorts compared) the highest in their respective gender-specific category, and 3D-based measurements were most often (n = 5/10 cohorts compared) the lowest (Table 5). Many previous studies have investigated the reliability of 2D and 3D imaging techniques in relation to direct anthropometry, as well as in relation to each other.[84–88] Nonetheless, results regarding differences between techniques are mixed, likely a reflection of the instrument bias inherent to anthropometric studies. Adding measurement type as another layer of classification between studies clearly highlights its role as a confounder, which is why the authors found providing such values (Table 5) to be of utmost importance. Although we were not able to control for such in our analysis, these results make it clear that a standardized reporting method is the key to precise anthropometrics. Given the mixed opinions regarding which technique is the best, authors should strive to report their results in at least two ways, which would pave the way to better assess the effect of measurement methods in future reviews.

Within the modern scope of plastic surgery, the ICD, similarly to other facial metrics, is more often than not useful as a proportion rather than as a stand-alone measure. For example, the balance between the ICD and alar base width is often relied upon for both aesthetic and reconstructive facial assessments, and the ICD relative to cranio-orbital morphology in the context of hypertelorism is usually most indicative. Nonetheless, a study of

Table 5. Comparison of Three Measurement Methods of ICD between Genders and Ethnicities

	Mean ICD (mm)			
Ethnicity	Direct	2D Image	3D Image	*P*
African				
Men	39.8	44.4	36.5	<0.001
Women	37.5	34.7*	34.4*	<0.001
Asian				
Men	36.4	37.9	35.7	<0.001
Women	35.2	36.5	35.5	<0.001
White				
Men	31.5	34.5	32.0	<0.001
Women	30.0	33.2	31.4	<0.001
Hispanic				
Men	N/A	N/A	31.5	N/A
Women	N/A	N/A	31.7	N/A
Middle Eastern				
Men	31.6†	31.5†	31.8	0.479
Women	31.0	30.7	30.9	<0.001
South/Southeast Asian				
Men	34.6	32.3	31.1	<0.001
Women	33.8	32.4	30.2	<0.001

*Denotes a nonsignificant difference when comparing 2D with 3D measurement modalities in African women.

†Denotes a nonsignificant difference when comparing direct with 2D measurements in Middle Eastern men.

proportions is beyond the scope of this review. To be able to study proportions, individual craniofacial landmarks must first be thoroughly assessed, hence the intrinsic worth of this review.

Limitations and Future Directions

This review is not without its limitations. Firstly, although the authors could not completely eliminate the confounding effect of measurement methods, the presentation of measurement-specific values serves to somewhat mitigate this. When taking a closer look at our data, there were no clear trends as to which method yielded higher or lower values. This has important implications moving forward, as surgeons should be mindful of this bias when reporting their results and should strive to devise a standardized reporting method for anthropometric measurements. Secondly, this review demonstrates the clear paucity of data regarding the Hispanic ethnicity, which may have underpowered this specific analysis. Considering this ethnic group now represents almost 20% of the US population, the literature is in dire need of a more comprehensive report of anthropometric measurements for this cohort.[89] Furthermore, publishing bias from developing nations or governmentally unstable regions may result in the underrepresentation of certain demographics in the included studies due to economic, political, or governmental limitations. It is worth mentioning that some studies included cohorts from beauty pageant contestants, which may have introduced a small pre-selection bias in our analyses.[32,51] Finally, although some might argue that pooling different populations from the same ethnicity can lead to unrepresentative results, this was done to facilitate reporting for the purpose of this pooled analysis. Nevertheless, readers may refer to the Supplemental Digital Content should they desire ICD values reported in a population-specific manner, as reported in each of the primary studies. Although a reflection of the primary source data, it is also important to stress that there is no universal consensus as to the exact classification between ethnic categories. In addition, given the high worldwide migratory trends in the last 50 years, these classifications are less clearly defined. Nonetheless, this has been mitigated by relying on classifications set forth by the National Institute of Health[14] and the United Nations[15], although even these are conflicting with each other. Agreed upon standards should be developed regarding this endeavor. Given the heterogeneity among studies related to measurement methods and populational pooling, a formal meta-analysis was not possible. Therefore, the continuous nature of the studied data was best compared through weighted means, among which heterogeneity was mitigated through formal assessment of included studies.

CONCLUSIONS

With the ever-increasing diversity of their treated patient populations, plastic surgeons should strive to tailor their facial reconstructive goals based on ethnicity/race. This is especially true for the ICD, as it may be a potential determinant of facial aesthetic harmony.[1,7,8] This pooled analysis provides an evidence-based and gender/ethnicity-specific reference for the ICD. Rather than using White measurements as the aesthetic ideal and comparator, health professionals can now rely on gender- and ethnic-specific standards to guide their preoperative planning and postoperative assessment of results. This is especially true for patients from Asian/African descent, who may have larger ICDs than their counterparts. Surgeons should also be cognizant of the confounding role that the type of measurement used can play in the reporting of the ICD. We hope that this article encourages awareness of the range of facial aesthetic standards that exist and fosters better individualized patient care.

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