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Gender and Stature Estimate Based on Facial Measurements: an Anthropometric Study in Southwest Iranian Population

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Abstract. This study was aimed to evaluate the facial dimensions and their relation with gender and stature in the Iranian southwest population. A cross-sectional study was conducted among 300 southwest Iranian cases age 20-50 years (150 males and 150 females). Studied variables through physical anthropometry in both genders were Upper facial height (UFH), Total facial height (TFH), Facial Height (FH), Facial Width (FW), and intercanthal width (IC) using a standard sliding caliper and Collis. Regarding the sex and age of the individuals, general descriptive analysis of facial dimensions was determined. All measurements, except TFH and FH, were different between men and women ($p \leq 0.01$). In male subjects, the Pearson's correlation coefficient (r) revealed that IC (0.72^{**}), FW (0.58^{**}) and UFH (0.18^{**}) parameters had a positive correlation with stature. In the female group, none of the facial parameters had a significant correlation with stature. Regarding the value of each facial diameter in discriminating male and female stature and gender, the highest discriminative value was specified to the FW (cutoff: 11.89, sensitivity: 89%, specificity: 11%) and IC (cutoff: 2.26, sensitivity: 98%, specificity: 0.04%) respectively. This study showed a significant association of some facial measurements with stature and gender in the southwest Iranian population. IC and FW had the most diagnostic value for gender and stature definition. It is shown a useful reference for the adult southwest Iranian population for

facial recognition and that the subject's sex should be considered during body identification procedures.

Keywords: Facial dimensions; Gender identification; Stature identification; Anthropometry.

1. Introduction

Anthropometry involves quantitative measurements of muscle, bone, and adipose tissue to evaluate the composition of the body¹. Anthropometric data are demanding to provide information about body dimension, human profile estimation, Medical anthropology, malnutrition, criminology, and forensic anthropology^{2,3}. Nowadays there are very careful techniques to measure standard identification criteria in different populations⁴. Various methods have been evolved for live human identification, including fingerprints, DNA profiling, retina scan, facial features, and many others⁵. But body identification can be achieved based on anthropometric data, skin analysis, dental records, and genetics. The principal elements of anthropometry are gender, height, and age estimate in physical examination⁶. Based on different studies, these elements reveal proportional biological ratios with different body segments which varies between different racial groups⁷⁻¹⁰.

Facial anthropometry is a practical measurement of facial soft and bony tissue for scientific and practical goals: from biometry up to medicine, genetics, pattern recognition, and criminology¹¹. This uncomplicated, economical, valid, and non-invasive method effectual for facial morphology analysis and it involves getting direct clinical measurements just as linear distances, dimensions, angles, and ratios¹². Given the differences based on hereditary, environmental factors, diet quality, and ethnicity between the nation's, performance of specific measurements in each region are necessary to create usable database¹³. Beside these reasons, we designed this research to elucidate the norms of facial dimensions in the southwest Iranian population to provide database for estimation of gender and stature. Amongst the anthropometrical research methods, morphological and anthropological approaches which rely on the examinations of the bones and bone measurements respectively, we selected anthropological assay which presents less costly with high-rate validity³.

2. Methods

This prospective cross-sectional study was conducted on the 300 native subjects of southwest Iran (F/M: 150/150; age range: 20-50). The inclusion criteria included: systematic health, normal growth of maxilla and mandible. The exclusion criteria included: history of trauma and accident, history of plastic, reconstructive surgeries, history of congenital craniofacial deformity, history of craniofacial tumor, history of facial deformity, and history of orthodontics and prosthodontics treatments. Variables studied through physical anthropometry in both the genders were Total facial height (TFH): Nasion to Menton(Me) linear distance, Upper facial height (UFH): distance from Nasion to Prosthion, Facial height (FH): Anterior nasal spine and Menton(Me) point linear distance, Facial width (FW): distance between the left and right zygion and intercanthal width (IC) distance between medial canthi of the eye. All participants were measured by the same investigator three times (between 10 am and 12 pm) when asked to maintain a neutral, relaxed facial posture expression with the help of a standard spreading caliper and Collis (Figure 1).



Figure 1: (A) Standard spreading caliper, (B) Associating measurements of the face: N: Nasion Z: Zygion, M: Menton and P: Prosthion.

2.1 Statistical analysis

Data were evaluated in Stata 14 software using independent t-test, chi-square, logistic regression, and receiver operating characteristics (ROC) curve analysis. The mean distance was reported for the t-test; the odds ratio (OR) for logistic regression; and the area under the curve for the ROC analysis (AUC). The coefficient of regression and 95% confidence intervals (CIs) for each independent variable were measured. p -value < 0.05 was considered as the significance level.

3. Results

In this study, 50.5% and 49.5% of the participant were male and female respectively. The mean ages of the subjects (male: 32.34 ± 2.03 , female: 33.43 ± 2.28) were not significantly different between the two genders. Average facial measurements in the total population base on gender were calculated, the summary of which is illustrated. All measurements, except TFH and FH, were different between both gender ($p < 0.01$) (Table 1).

Table 1. Mean & Standard Deviation of Facial measurements base on gender.

Measurements		$\mu \pm \delta$	F	p-value
FW	man	12.52 \pm 0.66	2.47	0.000
	women	10.78 \pm 1.23		
TFH	man	11.51 \pm 0.75	0.01	0.59
	women	11.59 \pm 1.26		
FH	man	18.47 \pm 1.89	0.85	0.19
	women	18.19 \pm 0.99		
IC	man	2.91 \pm 0.31	0.03	0.000
	women	1.74 \pm 0.28		
UFH	man	5.49 \pm 0.44	0.44	0.007
	women	5.27 \pm 0.66		

The Pearson's correlation coefficient (r) has been shown that IC (0.72^{**}), FW (0.58^{**}), UFH (0.18^{**}) parameters had a positive correlation with stature. While TFH and FH didn't have a significant correlation with stature (Table 2).

In male subjects IC (0.72^{**}), FW (0.58^{**}), UFH (0.18^{**}) parameters has shown significant correlation with stature. But FH and IC didn't have a significant correlation with stature (Table 2).

Table 2. Correlation of stature with facial measurements in male subjects.

	FW	TFH	FH	IC	UFH
Height	0.58^{**}	0.03	0.06	0.72^{**}	0.18^{**}

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

In female subjects, none of the facial parameters had a significant correlation with stature (Table 3).

Table 3. Correlation of stature with facial measurements in female subjects.

	FW	TFH	FH	IC	UFH
Height/ man	0.24^{*}	0.32^{**}	0.01	0.006	0.20^{*}
Height/women	0.09	-0.05	-0.09	0.15	-0.04

* Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

The points with significant association were considered for ROC curve analysis. According to this, area under the curve was 94% (p -value=0.000) that has been shown the higher recognition power of FW in stature estimation (Figure 2).

The area under the curve was 99% (p -value=0.000) that has been shown the higher recognition power of IC in gender estimate (Figure 3).

When the UHF is higher than 5.32 represents the person be a boy and when the UHF is lower than 5.32 represents the person be a girl (Figure 4).

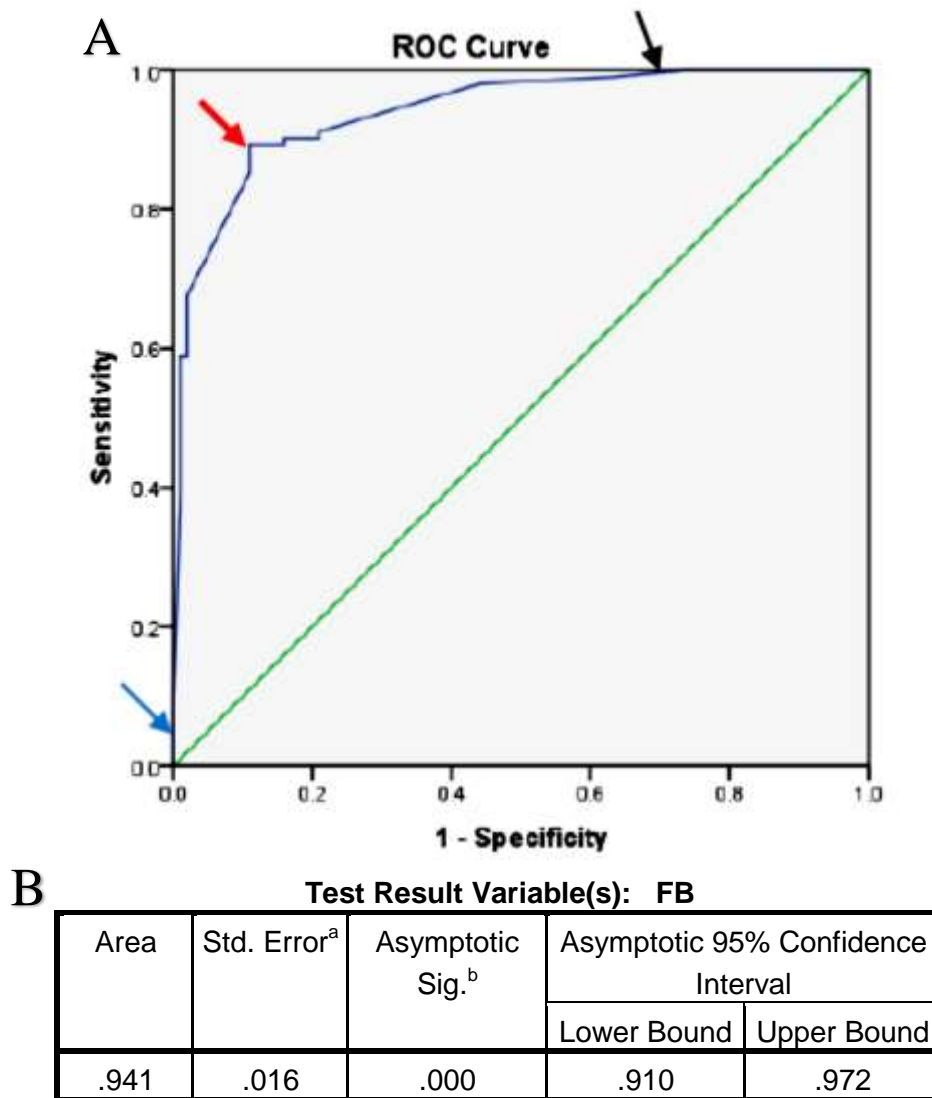


Figure 2. Logistic regression sigmoid diagram to determine the probability of FW in stature estimate. (A) Blue arrow: maximal specialty amount, Red arrow: most accurate cutoff point, Black arrow indicate maximal sensitivity amount. Cutoff point of these parameters was 2.26 with a sensitivity of 0.98 and specialty 0.04. (B) Area under the curve was 94% (p-value=0.000) that has been shown the higher recognition power of FW in stature estimation.

4. Discussion

The study ahead aimed to estimate the association of gender and stature with facial measurements when incomplete and fragmentary skull materials gleaned during forensic exploration. Concerning having the baseline data for gender, age and stature identify that would be helpful in reduction of identification procedures^{7,8}.

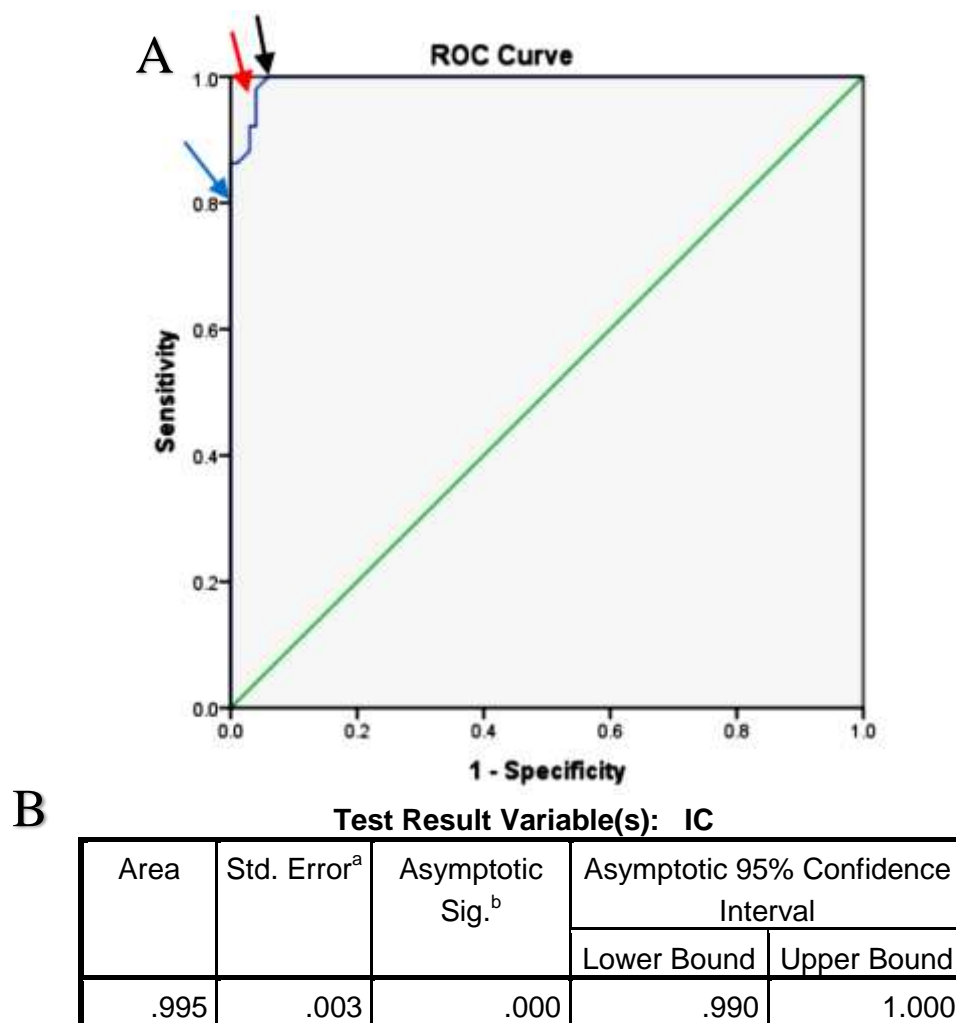


Figure 3. Logistic regression sigmoid diagram to determine the probability of IC in gender estimate. (A) Blue arrow: maximal specialty amount, Red arrow: most accurate cutoff point Black arrow: maximal sensitivity amount. Cutoff point of these parameters was 11.89 with a sensitivity of 0.89 and specialty 0.11. (B) Area under the curve was 99% (p-value=0.000) that has been shown the higher recognition power of IC in gender estimate.

In Iran, despite notable research in this field, less attention has been allotted on gender and stature prediction based on facial dimensions in divers diverse races that dwelled in different regions⁹⁻¹¹.

To the best of our knowledge, this is the first study to assess facial dimensions in the southwest of Iran. Average facial measurements in the total population base on gender were calculated, all measurements, except TFH and FH, were different between males and females. Effects of genetics, age, nutrition, and sex hormones on facial features during maturation could explain these differences¹².

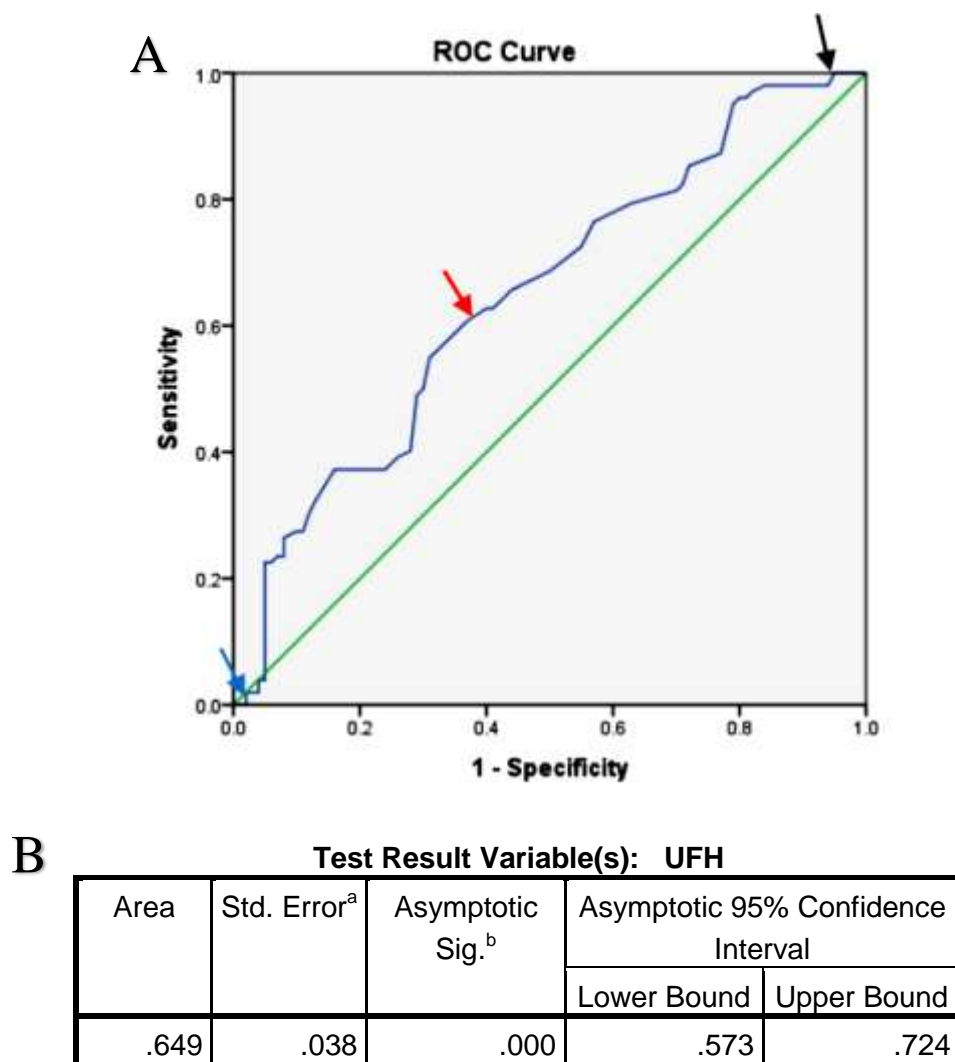


Figure 4. Logistic regression sigmoid diagram to determine the probability of UFH in gender estimate. (A) Blue arrow: maximal specialty amount, Red arrow: most accurate cutoff point, Black arrow: maximal sensitivity amount. Cutoff point of these parameters was 5.32 with a sensitivity of 0.62 and specialty 0.4. (B) Area under the curve was 64% (p-value=0.000) that has been shown the lower recognition power of UFH.

Identification of these variations is effective in the exploration of morphological preference between human populations. Lots of articles have been published to show this gender diversity for facial dimensions in different ethnicities¹³⁻¹⁷. Among the 5 measurements, 3 were associated with male stature with significant Pearson's correlation coefficient. In female subjects, none of the facial parameters had a significant correlation with stature. Aligned with our study Navaei found a highly positive correlation between stature, FB, TFH, and UFH in an Iranian population, both males and females¹¹. Rahimi *et al.*, indicated sexual dimorphism in the facial and nasal measurement of the Iranian population¹⁹. In a survey by Omotoso *et al.*, they explained the relevance

of nasofacial measurements in the description of gender base variations, which are consistent with our findings²⁰.

In the present research, the higher recognition power of FW and IC in stature and sex estimation with acceptable diagnostic values has been shown.

Many studies exhibit that several populations had a remarkable difference in facial recognition parameters. The most often quoted studies were conducted by Franklin *et al.*²⁰, for the Australian population, Sight²¹ for in Lucknow population, Agnihotri for the Indo-Mauritian population²².

Gender and stature are two factors that play an essential role in forensic identification. Sagar *et al.*²³, by reviewing the different methods of sex estimate, found that sex estimate becomes one of the priorities in the process of identification of a person by a forensic investigator.

The result of present anthropometric research of the adult population of the southwest of Iranian population could provide the basic data for formulating standards cephalic dimensions and stature. It will help in gross anatomy educations, archeological and anthropological research projects. Forensic scientists and basic medical researchers can use these findings in establishing individual identification when only the skull remains of the body are found in mass disasters, accidents, etc. Must be considered using larger samples with non-contact measurements will be useful in determining craniofacial anthropometric profiling of the adult Iranian population.

5. Conclusion

The present study findings indicated that measuring facial parameters in the studied samples could accurately estimate gender and stature.

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Author's contributions

Investigation and data collecting: Kimia Pirzad; Writing, original draft preparation, editing: Forouzan Absalan, Alireza Eftekhari Moghadam and Jafar Rezaian; Data analyzing: Atefeh Zahedi.

Conflict of interest

All authors certify that this manuscript has neither been published in whole or in part nor is it being considered for publication elsewhere. The authors have no conflict of interest to declare.

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