Original
ISSN 2521-8492

Gender Determination Using Nasofacial Anthropometry in the Iranian Population

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(Submitted: 13 February 2022 – Revised version received: 12 March 2022 – Accepted: 26 March 2022 – Published online: 26 June 2022)

Abstract

Objectives: The aim of this study is to predict the gender among Iranian population by determining the facial and nasal indices.

Methods: Four hundred healthy individuals including 200 males and 200 females (age range of 20–25 years) with normal craniofacial configuration took part in the present study. Facial and nasal variables including facial length (FL), facial width (FW), facial index (FI), nasal length (NL), nasal height (NH), nasal width (NW), and nasal index (NI) measured and SPSS 22.0 software was used for statistical analysis.

Results: The mean age was 22.16 ± 2.44 years. The mean FL, FW, FI, NL, NW, and NI were 11.53 ± 0.592 cm, 12.54 ± 1.41 cm, 92.67 ± 6.24 cm, 6.02 ± 0.53 cm, 2.78 ± 0.25 cm, and 90.79 ± 8.22 cm, respectively. There were significant differences in the mean value of all nasofacial parameters ($P < 0.05$). The most prominent face and nose types were hyperleptoprosopic (46%) and platyrrhine (57.75%) among Iranian population. The highest sensitivity and specificity to predict the gender dimorphism were related to FL and FW (0.990 and 0.97) and (0.970 and 0.94), respectively.

Conclusion: Nasofacial parameters such as FL and FW that are able to sexual dimorphism with high sensitivity and specificity can be helpful in forensic medicine. Also, the nasofacial parameters are useful in reconstructive, and aesthetic surgeries.

Keywords: Anthropometry, facial index, nasal index, Iranian population

Introduction

Anthropometric measurements are quantitative assessments of the human body, used in clinical documentation, forensic identification, cosmetic and orthopedic surgery, and manufacturing industries.[1-3] In forensic medicine, identification of human biological characteristic such as height, sex, age, and race, are essential.[4,5] Among different features, sex determination of remains is an essential factor for individual identification.[6]

Gender can be inferred from the skull, pelvis, and clavicle and also pelvis is the most reliable marker for this purpose.[7-9] However, in most cases, the complete skeleton is not available due to the destruction, but the skull is composed of hard tissue and also it can be preserved and used in the forensic anthropological analysis.[10] The skull certainly demonstrates the sexual features after puberty because of the full development of secondary sexual characteristics. For example, after puberty, the male skulls exhibit definite characteristics like large muscular attachment areas with more obvious supraorbital ridges.[11] In craniofacial anthropometry, the gender of an unknown individual can be determined according to the data from the morphology and metric features of cranial and face.[12,13]

These anthropometric measurements provide valuable data about the shape and size of the face and nose and also they can be used in planning the plastic and reconstructive surgery.[14]

Facial index (FI) is determined as the percentage of the length in relation to the width of the face.[15] Based on the international standards for FI, the shape of faces has been classified as hypereuryprosopic (very large face), euryprosopic (large face), mesoprosopic (round face), leptoprosopic (long and narrow face), and hyperleptoprosopic (very long and narrow face).[16]

The shape of the nose, like the other parts of the face, varies across the human population with different races and ethnicities.[17] The nasal index (NI) is defined as a ratio of the nasal width to the nasal length multiplied by one hundred. According to the NI, human noses are classified into Hyperleptorrhine (very narrow-nosed), Leptorrhine (narrow-nosed), Mesorrhine (medium-nosed), platyrrhine (broad-nosed) and hyper platyrrhine (very broad-nosed).[18] Previous studies presented that the anthropometric parameters of the face and nose like facial height, facial width, nasal height and nasal width are different between the two genders.[19,20]

This study was conducted to determine the facial and nasal indices and their differences between males and females and find a nasofacial values with higher sensitivity and specificity to predict gender among Iranian population.

Materials and Methods

Four hundred healthy individuals including 200 males and 200 females (with mean age of 22.40 ± 2.45 years) with normal craniofacial configuration took part in the present study. The inform consent were given from all individuals. The participants with abnormalities in face and history of trauma and surgery in craniofacial part were excluded from the study. All of the parameters were measured twice by two professional anthropologists to eliminate the errors of the measurement. In this study, several definitions and

measurements of anthropometry were used as mentioned below:

Nasion (n): Midpoint of nasofrontal suture

Gnathion (gn): Midpoint on the lower border of the mandible

Zygions (zy): Most lateral point of the zygomatic arch

subnasale (sn):

Facial length (FL): Distance between nasion (n) and gnathion (gn)

Facial width (FW): Distance between two zygions (zy)

Nasal width (NW): Distance between the two ala (al) of the nose

Nasal length (NL): Distance between the nasion and the subnasale (sn)

Facial index (FI) and Nasal index (NI) calculated using the following formula:[21,22]

$$FI = \frac{FL}{FW} \times 100 \quad (1)$$

$$NI = \frac{NW}{NL} \times 100 \quad (2)$$

Then, and face and nose of cases were classified based on Table 1.[23,24]

Statistical Analysis

SPSS 22.0 software was used for statistical analysis. Statistical analysis was performed using an independent *t*-test for exhibiting the differences between the two genders. ROC curve analysis was performed to calculate the cut-off point, sensitivity and specificity of nasofacial variables. The *P* values less than 0.05 were considered statistically significant.

Results

In this study, 400 volunteers (200 males and 200 females) with mean age of 22.40 ± 2.45 years from Iranian population were investigated. The results consisting of the statistical analysis with respect to the measurement of nasofacial variables such as FL, FW, FI, NL, NW, and NI of males and females summarized in Table 2. Significant differences were reported in the facial measurements including FL (P = 0.0001), FW (P = 0.0001), and FI (P = 0.0001) bases on sex groups. Additionally, there were significant differences in the NL (P = 0.001), NW (P = 0.0001) and NI (P = 0.0001) of sex groups as shown in Table 3. The nasal and facial shapes were

Table 1. **Face classification based on facial index and nose classification based on nasal index**

Face classification	Facial index
Hypereuryprosopic	40–54.9
Euryprosopic	Less than 70
Mesoprosopic	70–84.9
Leptoprosopic	85–99.9
Hyperleptoprosopic	100 or more
Nose classification	**Nasal index**
Hyperleptorrhine	40–54.9
Leptorrhine	Less than 70
Mesorrhine	70–84.9
Platyrrhine	85–99.9
Hyperplatyrrhine	100 or more

Table 2. **Summary of the nasofacial anthropometric measurements among Iranian population**

Variables	Mean	SD	Min	Max
Age (year)	22.16	2.44	18.00	41.00
FL (cm)	11.53	0.592	9.800	12.600
FW (cm)	12.54	1.41	9.80	19.80
FI	92.67	6.24	60.10	105.88
NL (cm)	6.02	0.53	4.80	7.00
NW (cm)	2.78	0.25	2.10	3.20
NI	90.79	8.22	70.00	114.81

Table 3. **Comparing the nasofacial anthropometric measurements of male and females among Iranian population**

Parameters	Sex groups								*P*-value
	Male				Female				
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Age (year)	22.40	2.45	18.00	41.00	22.60	2.42	18.00	34.00	0.121
FL (cm)	12.077	0.212	10.900	12.600	10.995	0.261	9.800	11.500	0.0001
FW (cm)	13.73	0.82	11.90	19.80	11.35	0.66	9.80	15.10	0.0001
FI	88.21	4.18	60.10	98.35	97.12	4.56	72.19	105.88	0.0001
NL (cm)	6.13	0.44	5.10	7.00	5.91	0.59	4.80	7.00	0.001
NW (cm)	2.77	0.26	2.10	3.10	2.5	0.23	2.10	3.20	0.0001
NI	88.56	7.24	70.00	111.11	93.02	8.56	70.97	114.81	0.0001

SD, standard deviation; Min, Minimum; Max, Maximum; NL, Nasal length; NW, Nasal width; NI, Nasal index; FL, Facial length; FW, Facial width; FI, Facial index.

Table 4. **Distribution of facial and nasal classifications in Iranian population based on sex groups among Iranian population**

Parameters		Total		Sex				*P*-value
				Male		Female		
		N	%	*N*	%	*N*	%	
Face classification	Hypereuryprosopic	11	2.8	1	0.2	10	2.5	
	Euryprosopic	17	4.2	5	1.2	12	3	
	Mesoprosopic	86	21.5	35	8.8	51	12.8	0.0001
	Leptoprosopic	102	25.5	69	17.2	33	8.2	
	Hyperleptoprosopic	**184**	**46.0**	**90**	**22.5**	**94**	**23.5**	
Nose classification	Mesorrhine	97	24.25	60	1 5	37	9.25	
	Platyrrhine	**231**	**57.75**	**118**	**29.5**	**113**	**28.25**	0.0001
	Hyperplatyrrhine	72	18	22	5.5	50	12.5	

Table 5. **Sensitivity and specificity for cut-off point value of FL to predict gender among Iranian population**

FL values	Sensitivity	Specificity
10.45000	1.000	0.03
10.55000	1.000	0.04
10.65000	1.000	0.07
10.75000	1.000	0.09
10.85000	1.000	0.18
10.95000	0.990	0.43
11.05000	0.990	0.56
11.15000	0.990	0.77
11.25000	0.990	0.84
11.40000	0.990	0.97
11.60000	0.990	1
11.75000	0.970	1
11.85000	0.900	1
11.95000	0.760	1
12.05000	0.630	1
12.15000	0.290	1
12.25000	0.220	1
12.35000	0.050	1
12.45000	0.020	1
12.55000	0.010	1
13.60000	0.000	1

Table 6. **Sensitivity and specificity for cut-off point value of FW to predict gender among Iranian population**

FW values	Sensitivity	Specificity
10.9500	1.000	0.22
11.0500	1.000	0.29
11.1500	1.000	0.42
11.2500	1.000	0.5
11.3500	1.000	0.57
11.4500	1.000	0.64
11.5500	1.000	0.65
11.6500	1.000	0.69
11.7500	1.000	0.82
11.8500	1.000	0.86
11.9500	0.990	0.87
12.0500	0.990	0.89
12.1500	0.970	0.94
12.3000	0.960	0.96
12.5000	0.950	0.96
12.6500	0.950	0.97
12.7500	0.950	0.98
12.8500	0.920	0.99
12.9500	0.860	0.99
13.0500	0.840	0.99
13.2000	0.800	0.99
13.3500	0.780	0.99
13.4500	0.710	0.99

described according to the nasal and facial indices and their distribution in total population and according to the sex groups were demonstrated in Table 4. The most nasal shape frequency was related to platyrrhine type and the most frequent of facial shape was related to hyperleptoprosopictypes, equally. The cut-off point as well as sensitivity and specificity of all variables were calculated to predict the dimorphism among Iranian population and the highest sensitivity and specificity were related to FL (Cut-off point = 11.4, 0.99 & 0.97, respectively) and FW (Cut-off point = 12.15, 0.97 & 0.94, respectively) (Tables 5–9, Figure 1).

Discussion

Measuring nasofacial dimensions provides valuable information to scientists in archeology, anthropology, forensic

Table 7. **Sensitivity and specificity for cut-off point value of FI to predict gender among Iranian population**

FI values	Sensitivity	Specificity
89.59093	0.28	0.05
89.85614	0.26	0.05
90.12329	0.26	0.06
90.19475	0.26	0.07
90.26204	0.24	0.07
90.36984	0.2	0.07
90.64044	0.19	0.07
90.87439	0.18	0.07
91.19098	0.18	0.08
91.50566	0.15	0.08
91.637	0.14	0.08
91.96152	**0.14**	**0.11**
92.21778	0.13	0.11
92.30724	0.11	0.11
92.43321	0.09	0.11
92.73438	0.09	0.13
93.04926	0.08	0.13
93.14608	0.07	0.13
93.21985	0.07	0.14
93.53788	0.07	0.15
93.88198	0.06	0.15
93.99131	0.06	0.17
94.04245	0.06	0.18

Table 8. **Sensitivity and specificity for cut-off point value of NL to predict gender among Iranian population**

NL values	Sensitivity	Specificity
3.8000	1.000	0
4.8500	1.000	0.01
4.9500	1.000	0.02
5.0500	1.000	0.16
5.2000	0.990	0.18
5.3500	0.990	0.19
5.4500	0.940	0.23
5.6000	0.900	0.28
5.7500	0.770	0.39
5.8500	0.680	0.44
5.9500	0.680	0.45
6.0500	**0.640**	**0.63**
6.1500	0.410	0.7
6.2500	0.360	0.74
6.3500	0.340	0.77
6.4500	0.210	0
6.6000	0.170	0.01
6.7500	0.080	0.02
6.8500	0.070	0.16
6.9500	0.060	0.18
8.0000	0.000	0.19

Table 9. **Sensitivity and specificity for cut-off point value of NI to predict gender among Iranian population**

NI values	Sensitivity	Specificity
84.1875	0.730	0.11
84.7801	0.720	0.14
85.2397	0.720	0.15
85.5042	0.660	0.17
85.9606	0.650	0.17
86.4368	0.650	0.18
86.8817	0.650	0.19
87.2984	0.580	0.23
87.6894	0.570	0.24
88.0570	0.550	0.25
88.3484	0.520	0.31
88.6752	0.520	0.32
89.0873	0.510	0.36
89.4704	0.510	0.37
89.9889	0.500	0.38
90.4738	**0.430**	**0.45**
90.7670	0.400	0.49
91.0428	0.400	0.51
91.7421	0.310	0.53
92.4501	0.300	0.53
92.8480	0.300	0.54
93.2184	0.260	0.57
93.4409	0.260	0.6
93.6492	0.130	0.63
93.8447	0.130	0.64
95.1178	0.110	0.66
96.4240	0.110	0.67
96.6092	0.090	0.71

medicine and surgery.[14,25-27] This variable may be influenced by criteria such as natural selection, climate, nutritional condition, race, gender, age, and genetic factors in different populations.[28-30] According to the fact that nasofacial variables alter during adolescent,[15,31] in this study, mature men and women were selected to the evaluated nasofacial variables.

In the present study, we calculated the nasofacial elements of 400 individuals from Iranian population. Our findings showed that in the studied population, the predominant facial shape was hyperleptoprosopic type mostly frequent in male and female (22.5 and 23.5, respectively). In addition, in the case of nasal shape, platyrrhine (57.75%) type was the most frequent one in men and women. Although our results were consistent with findings of Rahimi Jaberi et al.,[16] Amini et al. by measuring craniofacial morphologic parameters in Persian population showed that leptoprosopic faces and leptorrhine noses were the most nasofacial shapes in Iranian ethnics.[32] Also, another research was carried out by Heidari et al.

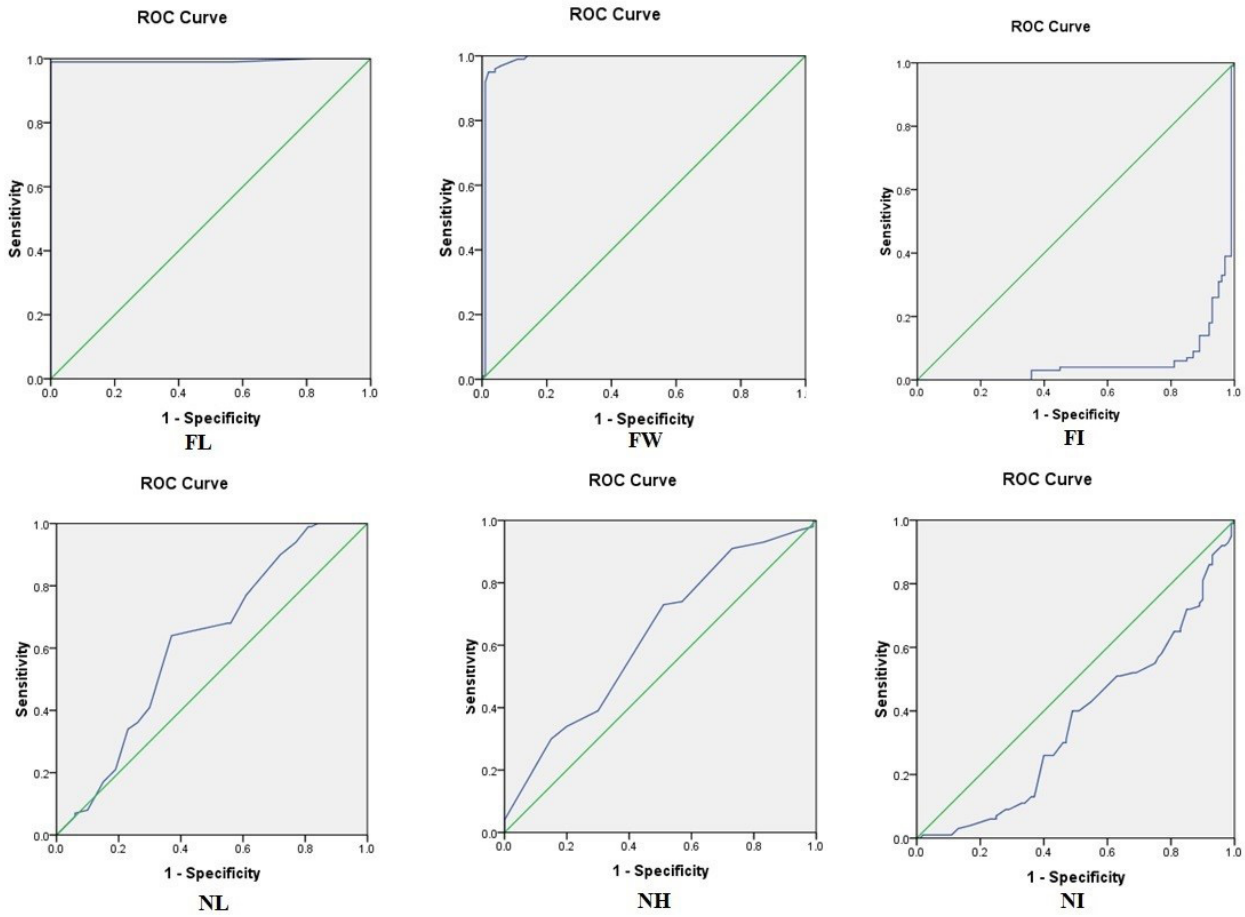

Fig. 1 **ROC curves of nasofacial variables in prediction of gender. FL, facial length; FW, facial width; FI, facial index; NL, nasal length; NW, nasal width; and NI, nasal index.**

demonstrated that the most prevalent type of face and nose in Sistani and Baluch aborigine women were leptoprosopic and leptorrhine, respectively.[31] Azizi et al. in a study conducted on ethnic populations of Qazvin indicated that hyperleptoprosopic facial type had the highest frequency among both of the groups.[15] This controversy may be justified with the impact of ethnic, climate condition and genetic factors.[15,33]

In addition, based on our data nasofacial variables have a significant difference between the men and women. These results are in line with the researches done in Iran and other countries.[16,17,34] Despite the significance of all evaluated parameters in this study, the sensitivity and specificity of FL and FW are more than 0.94 in determining gender. However, NL can differentiate sexual dimorphism with sensitivity (0.64 and 0.73, respectively) and specificity (0.63 and 0.49, respectively). These are the powerful and inexpensive tools among the methods available in sex diagnosis. These findings suggest that the nasofacial parameters can be consider as the reliable tools in sexual dimorphism in forensic medicine and as the surgical criteria in craniofacial and aesthetic surgeries which is approved by other researchers.[14,35]

The ability to determination of gender from human remains and bones can markedly reduce the percentage of criminal defendants.[16,30] Measurements of face and nose can also be useful in surgeries such as reconstructive, craniofacial, rhinoplastic and aesthetic surgery.[31,36] Nowadays, different methods such as DNA testing, radiology and anthropology studies are used to determine gender.[16,29] Among the conventional methods, a manual measurement of nasofacial is easy, accessible, fast and inexpensive. The sex differences in the nasofacial parameters of different populations were summarized in Table 10.

Conclusion

According to the fact that gender recognition is one of the complicated topics in determining unidentified bodies in criminal events, parameters that are able to distinguish between the sexes with high sensitivity and specificity can be helpful in detecting cadavers. On the other hand, nasofacial measurement may be useful in craniofacial surgeries especially in reconstructive, oral and maxillofacial, rhinoplastic and aesthetic surgery.

Conflicts of Interest

None.

Table 10. **Different values of facial index, nasal index, and prominent face and nose shape in various populations**

Number	Author(s)	Population	FI			NI			Prominent face shape			Prominent nose shape		
			Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
1	Present study	Iran	92.67 ± 6.24	88.21 ± 4.18	97.12 ± 4.56	90.79 ± 8.22	88.56 ± 7.24	93.02 ± 8.56	Hyperlepto-prosopic	Hyperlepto-prosopic	Hyperlepto-prosopic	Platyrrhine	Platyrrhine	Platyrrhine
2	Amini et al.[37]	North American whites	–	–	86.2 ± 4.6	–	65.1 ± 5.8	59.8 ± 7.9	–	–	Meso-prosopic	Leptorrhine	Leptorrhine	Leptorrhine
		Iran	–	90.3 ± 4.4	91.4 ± 5	–	63.1 ± 7	57.9 ± 5.1	–	–	Lepto-prosopic	Leptorrhine	Leptorrhine	Leptorrhine
3	Heidari et al.[38]	Sistani	–	–	–	–	–	69.7 ± 3.5	–	–	–	–	–	Leptoprosopic
		Baluch (Iran)	–	–	–	–	–	59.2 ± 3.3	–	–	–	–	–	Leptorrhine
4	Azizi et al.[15]	Qazvin (Iran)	–	102.88 ± 10.28	96.69 ± 7.67	–	–	–	Hyperlepto-prosopic	Hyperlepto-prosopic	Hyperlepto-prosopic	–	–	–
5	Jaberi et al.[39]	Iran	92.00 ± 6.00	88.4 ± 4.5	97.1 ± 4.1	90.2 ± 8	88.2 ± 7.1	93.1 ± 8.1	Hyperlepto-prosopic	Meso-prosopic	Hyperlepto-prosopic	Platyrrhine	Platyrrhine	Platyrrhine
6	Mohammed et al.[17]	Nigeria	–	–	–	71.99 ± 7.17	74.08 ± 6.92	69.9 ± 6.83	–	–	–	Mesorrhine	Mesorrhine	Leptorrhine
7	Al-Qattan et al.[40]	Saudi Arabian descent	–	–	–	–	70.4 ± 7.2	70.2 ± 7.8	–	–	–	–	–	–
8	Mane et al.[41]	India	–	–	–	–	–	–	Hyperlepto-prosopic	Hyperlepto-prosopic	Hyperlepto-prosopic	–	–	–
9	Choe et al.[42]	Korean American	–	–	–	–	–	69.0 ± 8.7	–	–	–	–	–	–
		North American White	–	–	–	–	–	61.4 ± 5.1	–	–	–	–	–	–
10	Madadi et al.[30]	Iran	–	87.53 ± 8.81	89.25 ± 10.09	–	–	–	–	Meso-prosopic	Europro-sopic	–	–	–

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