ORIGINAL RESEARCH

Nasal Morphology in a Young Adult Middle-Eastern Population: A Stereophotogrammetric Analysis

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Abstract

Aim: This study aimed to describe gender-specific three-dimensional morphology of the soft-tissue nose in Lebanese young adults and to explore the associations between nasal morphology with age and body mass index (BMI).

Materials and methods: Three-dimensional photographs were captured for 176 young healthy Lebanese adults (75 males and 101 females) aged 18.1–37.68 years. Linear and angular nasal measurements were computed and compared between genders, in addition to other established norms. Associations with age and BMI were also assessed.

Results: All linear measurements were greater in males than in females, and only the nasolabial angle was significantly larger in females by 2.97 degrees on average. Most of the measurements were found to be larger than the Caucasian norms. A few significant correlations were found between the measurements and age or BMI.

Conclusion: This study is the first to present the sex-specific norms for nasal morphology in the Lebanese population and highlights the presence of gender dimorphism in the majority of measurements. Additional studies are needed to validate our data and expand the associations with age and BMI.

Clinical significance: The data offered in this study could help enhance the accuracy of facial reconstructive surgery and aid in personalized treatment planning for both medical and cosmetic nasal interventions.

Keywords: 3D anthropometry, Lebanon, Nasal morphology, Stereophotogrammetry.

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Introduction

Centered in the face, the nose plays an important role in facial esthetics.[1–4] Being the most prominent structure in the face, its configuration characterizes a person and its size, shape, and proportions contribute remarkably to a person's appearance.[5] Disparities in nasal morphology have been related to age, sex, ethnicity, and ecogeographic variations.[6–13]

Given the esthetic significance, information on the morphology of the nose is of benefit to numerous scientific fields including anthropometry, esthetic and reconstructive surgery, orthodontics, and maxillofacial surgery.[5] These measurements drive and facilitate the diagnoses, treatment planning, and post-treatment evaluation of patients undergoing treatment with esthetic consequences.[14] Variations in nasal morphology have also been considered among the best indices for sexual and ethnic identification in the fields of anthropology and forensic medicine.[15,16]

Various methodologies for the evaluation of the nose have been described. Apart from the established method of direct anthropometric measurements, the most common indirect anthropometric techniques are based on cephalometric radiographs, profile photographs, cone-beam computed tomography (CBCT), laser scanning, and stereophotogrammetry.[14,17] Analyses based on lateral cephalometric radiographs, which are taken in profile view, are limited by recording the most anterior outline of the structures involved and tend to evaluate the nose with reference to the lips and chin rather than as a separate entity.[14] Facial profile photographs, although easier to present to patients in the clinical setting and avoid patient exposure to radiation, still pose the same limitations as their radiographic counterparts due to their two-dimensionality and information being limited to the profile view.

The limitations inherent to 2D-based methods have driven the development of methods based on 3D images such as CBCT and stereophotogrammetry. Additionally, studies across various populations have demonstrated a large variability in the accuracy

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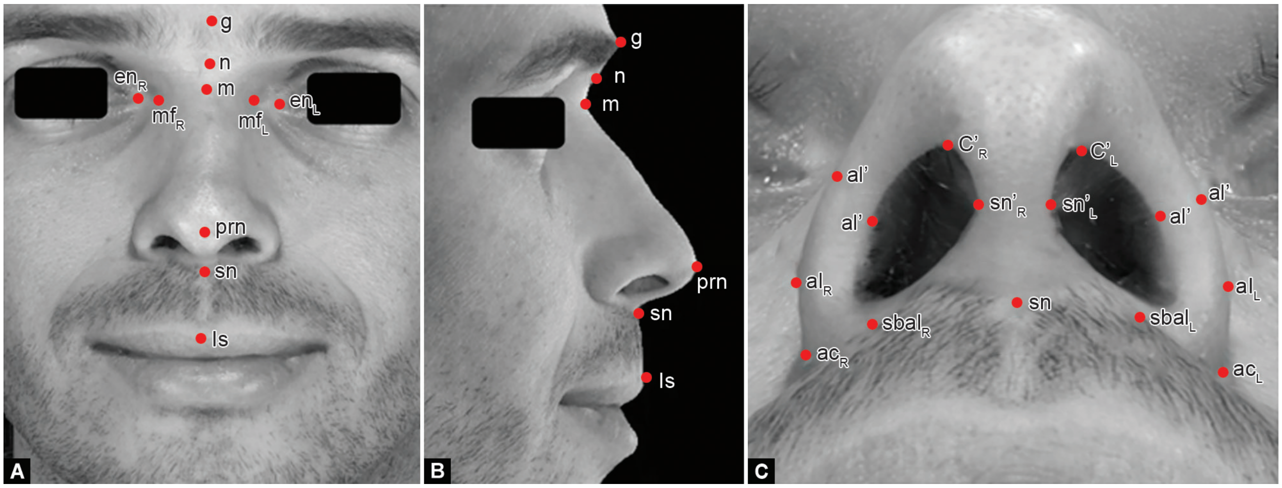

Figs 1A to C: Facial and nasal landmarks in frontal, (A) Lateral; (B) Inferior; (C) Views: glabella (g), nasion (n), median (m), pronasale (prn), subnasale (sn), labiale superius (ls), maxillofrontale (mf), endocanthion (en), alare (al), subalare (sbal), alar curvature (ac), top of nostril (c'), midpoing of ala (al'), and midpoint of columella crest (sn')

of this method.[18–20] Stereophotogrammetry is not only radiation-free, but is also a more reliable technique of assessment that could overcome the disadvantages of the other methods. It provides accuracy that approximates that of direct anthropometry at a fraction of the clinical time and effort and provides a permanent record for research and database purposes.[21,22]

Significant differences in nasal measurements among populations have been reported.[23–26] In the Mediterranean region, studies on nasal soft tissue morphology are scarce and have demonstrated great variability among countries.[14,16,27,28] In addition, the majority of these studies assessed the nose by its correlation with the face (angular).

The aim of this study was to measure and investigate the external nasal soft tissue morphology in the young, healthy, Lebanese adult population in addition to the comparison between males and females and correlation with age and body mass index (BMI). The null hypotheses tested for this current study were that there would be,

- No difference in nasal morphology measurements between males and females
- No correlation between these measurements
- No correlation between these measurements and BMI

Materials and Methods

Study Population

In this cross-sectional study, 176 adult healthy Lebanese subjects (75 males and 101 females) were assessed. Their age ranged between 18.1 and 37.68 years (mean age 23.18 ± 4.03) years.

Included were non-growing healthy individuals (females >16 years and males >18 years) presenting a balanced profile and normal occlusion (class I molar and canine relationship and normal overjet and overbite). Subjects with craniofacial anomalies and a history of nasal or facial surgical intervention were excluded.

The participants provided a written consent form prior to participation. The study was approved by the Institutional Review Board of the Lebanese University (CUEMB 36/AA).

Collection of Nasal Landmarks

The Vectra M3 3D Imaging was used to capture a stereophotogrammetry image of the face, with a 1.2 mm resolution (Vectra M3, Canfield Scientific Inc. USA).

Participants were seated in natural head position with lips gently closed and in neutral expression. The image was then captured and automatically processed to create the 3D model of the full face, stored on the computer, and later imported into the Mirror® software, used to localize landmarks and generate measurements. One investigator (HK) digitized all the photographs.

A total of 14 soft tissue landmarks related to the nasal region were identified according to Farkas: 6 midline (unpaired) and 8 right and left (paired) landmarks (Fig. 1 and Table 1).[29]

Various morphometric nasal measurements were then automatically generated as described by Farkas et al., linear vertical (2), horizontal, (8) and sagittal (2) in addition to angulation measurements (3) (Table 2).[29]

To assess intraexaminer reliability, the same investigator digitized a randomly selected subsample of 20 photographs, one month after the first assessment. In addition, another set of 20 photographs was re-digitized by another investigator (MS) to evaluate interexaminer reliability.

Statistical Analysis

Descriptive statistics for the total sample and separately for males and females were generated. The measurement's reliability was evaluated with the two-way mixed effects intra-class correlations for absolute agreement on single measures.

The difference between males and females was assessed using an independent *t*-test. The linear association between all measurements and age and BMI was investigated using the Pearson product-moment correlation coefficient.

The Statistical Package for Social Sciences (version 24.0, IBM®) was used to process and analyze the data. The level of significance was set at 0.05.

Table 1: Definition of facial landmarks used in the study

Abbreviation	*Landmark*	*Definition*
Unpaired		
G	Glabella	Most prominent midline point between the eyebrows
N	Nasion	Point in the midline of both the nasal root and the nasofrontal suture
prn	Pronasale	Most protruded point of nasal tip
Sn	Subnasale	Deepest point of the columella-upper-lip Junction
M	Median	Deepest point of the nasofrontal angle (sellion or subnasion)
LS	Labiale superius	Outermost point on the mucocutaneous border of upper lip in midline
Paired		
mfR, mfL	Maxillofrontale	Where the maxillofrontal and nasofrontal sutures meet (terminal points of the nasal root width)
enR, enL	Endocanthion	The point located at the inner commissure of each eye fissure
alR, alL	Alare	Nasal wings at the most lateral point of the outer surface, the point where the nasal blade (ala nasi) extends farthest out
sbalR, sbalL	Subalare	Point where the nasal alar bases disappear into the skin of the upper lip (the point at the lower limit of each alar base)
(al'-al')R, (al'-al')L		Points at the midportion of the right and left ala, used to measure the thickness
acR, acL	Alar curvature	The most lateral point on the curved base line (alar groove) of each ala.
c'R, c'L	Superior point of the nostril	Highest point of each nostril or the superior terminal point of each nostril axis
sn'R, sn'L		Point at each margin of the midportion of the columella crest, used to measure the columella width

Table 2: Nasal morphology measurements: abbreviations and definitions

Description		*Definition*
Vertical (mm)		
Nose height	n-sn	Distance from nasion to subnasale point
Nasal bridge length	n-prn	Distance from nasion to pronasale point
Horizontal (mm)		
Nose width	alR-alL	Distance from right ala to left ala
Nasal root width	mfR-mfL	Distance from right to left maxillofrontale point
Ala length surface	acR-prn-acL	
Ala length (right and left)	acR-prn; acL-prn	Anteroposterior distance from pronasale point (tip) to alar crease point (ac)
Ala thickness (right and left)	(al'-al')R; (al'-al')L	Distance from al' to al' on right and left sides
Nasal root slope length (right and left)	enR-m; enL-m	Distance from sellion to endocanthion on right and left sides
Columella width	sn'R-sn'L	Distance from right to left sn'
Nostril floor width (right and left)	sbalR-sn; sbalL-sn	Distance from subalare to subnasale on right and left sides
Sagittal (mm)		
Nasal tip protrusion	sn-prn	Distance from subnasale to pronasale point
Columella length (right and left)	c'R-sn; c'L-sn	Distance from c' to sn on right and left sides
Angulations (degrees)		
Nasofrontal angle (NFA)	g-n-prn	Angle defined by glabella-to-nasion line intersecting with a line over the dorsum of the bony pyramid (nasion to tip)
Nasolabial angle (NLA)	prn-sn-ls	Angle between columellar point to subnasale and subnasale to labrale superioris lines
Nasal tip angle (NTA)	n-prn-sn	Angle between the nasal dorsum line and the columella line

Table 3: Descriptive statistics of nasal morphology in assessed male and female Lebanese sample compared to established norms ($n = 176$)

	Study sample–Lebanese males				*Study sample–Lebanese females*				*Farkas*	
Measurement	*Min*	*Max*	*Mean*	*SD*	*Min*	*Max*	*Mean*	*SD*	*Males Mean (SD)*	*Females Mean (SD)*
Vertical (mm)										
Nose height (n-sn)	51.03	65.35	58.72	3.06	48.30	64.13	56.14	3.26	54.8 (3.3)	50.6 (3.1)
Nasal bridge length (n-prn)	44.32	61.06	52.37	3.63	41.11	57.00	49.14	3.18	50.0 (3.6)	44.7 (3.4)
Horizontal (mm)										
Nose width (al_R-al_L)	31.02	41.73	37.08	2.13	26.39	38.83	32.54	2.42	34.9 (2.1)	31.4 (2.0)
Nasal root width (mf_R-mf_L)	19.74	30.13	24.67	2.20	18.53	28.84	23.05	2.38	19.6 (1.9)	18.4 (1.9)
Ala length surface (ac_R-prn- ac_L)	64.80	87.03	77.19	4.56	60.02	78.76	69.86	3.63	NA	NA
Columella width (sn'_R-sn'_L)	6.30	11.36	8.59	1.16	5.73	10.91	7.73	0.92	6.9 (0.7)	6.8 (0.7)
Ala length Right (ac_R-prn)	24.14	31.72	28.64	1.89	21.46	31.02	26.08	1.86	35.0 (1.6)	31.5 (1.8)
Left (ac_L-prn)	23.71	32.67	28.32	1.98	21.80	29.45	25.39	1.68	35.0 (1.7)	31.4 (1.8)
Ala thickness Right $(al'\text{-}al')_R$	1.90	6.96	4.33	1.34	1.73	6.47	3.87	1.08	5.9 (0.7)	5.3 (0.7)
Left $(al'\text{-}al')_L$	2.60	6.06	4.35	0.88	1.83	6.02	3.87	0.95	5.8 (0.7)	5.3 (0.7)
Nasal root slope length Right (en_R-m)	21.64	29.91	26.08	2.03	18.21	27.01	23.07	1.77	NA	NA
Left (en_L-m)	19.40	29.90	24.04	2.26	17.26	25.45	21.54	1.71	NA	NA
Nostril floor width Right ($sbal_R$-sn)	8.13	16.15	11.65	1.85	7.34	14.72	10.29	1.30	12.9 (1.7)	10.9 (1.4)
Left ($sbal_L$-sn)	8.48	16.56	13.64	2.05	8.12	15.38	11.52	1.55	12.8 (1.7)	10.9 (1.5)
Sagittal (mm)										
Nasal tip protrusion (sn-prn)	16.51	24.96	20.03	2.13	14.47	23.25	19.02	1.86	19.5 (1.9)	19.7 (1.6)
Columella length Right (c'_R-sn)	8.52	16.02	12.37	1.76	8.25	14.97	11.51	1.47	11.6 (1.7)	11.5 (1.7)
Left (c'_L-sn)	9.13	15.64	12.59	1.70	8.80	15.23	11.69	1.38	11.5 (1.7)	11.4 (1.7)
Angulations (degrees)										
Nasofrontal angle (NFA; g-n-prn)	141.28	164.91	149.24	4.88	140.01	160.15	150.46	4.53	130.3 (7.4)	134.3 (7.0)
Nasolabial angle (NLA; prn-sn-ls)	110.10	145.74	129.73	8.06	115.81	162.27	132.71	8.37	99.8 (11.8)	104.2 (9.8)
Nasal tip angle (NTA; n-prn-sn)	80.69	113.01	99.13	8.00	85.80	113.78	101.63	5.91	71.7 (7.4)	67.4 (7.4)

Results

Reliability of repeated measurements was high with intraclass correlation coefficients ranging between 0.978 and 0.989 for intraexaminer reliability and between 0.962 and 0.984 for interexaminer reliability.

The majority of the measurements were found to have significant variability, as shown by the range and the standard deviations (Table 2).

Lebanese Nasal Morphology Norms

Gender-specific measurements were generated for both males and females (Table 3). All linear and angular measurements displayed some variability among the assessed Lebanese sample as displayed by minimum values, maximum values, and standard deviations (Table 4). Among the linear measurements, the greatest variability was found for the ala length surface with a range of 22.23 mm in males and 18.74 mm in females, and the least variability was displayed for the left ala thickness in both genders.

Correlations with Age

Mean age was 23.59 ± 3.56 and 22.72 ± 3.4 in the male and female subsamples, respectively (Table 5). The nasal which measured six were statistically significantly and positively correlated with age in the female sample ($r = 0.199$–0.355, $p \leq 0.046$; Table 6) and one measurement (nasal tip angle) was statistically significantly and negatively correlated with age ($r = -0.225$, $p \leq 0.023$; Table 6). In the male subsample, nine of the nasal measurements were statistically significantly and positively correlated with age, and were of generally stronger magnitude than in the female sample ($r = 0.289$–0.559, $p \leq 0.049$; Table 6). Similar to the female sample, nasal tip angle was statistically significantly and negatively correlated with age ($r = -0.548$, $p \leq 0.001$; Table 6).

Correlations with BMI

The mean BMI was 25.26 ± 3.29 and 21.82 ± 3.09 for males and females, respectively (Table 5). The majority of the nasal measurements were not statistically significantly correlated with BMI. In the female subsample, only 4 measurements (nose height, columella width, nasal tip protrusion, and left columella length) were weakly correlated with BMI but statistically significant ($r = 0.200$–0.286, $p \leq 0.05$; Table 6). In the male subsample, only the left ala length was statistically significantly correlated with BMI ($r = 0.314$, $p = 0.04$; Table 6).

Discussion

The analysis of nasal morphology is integral to the fields of reconstructive and esthetic surgery, orthodontics, maxillofacial surgery, and forensics.[23,24,30,31] The availability of gender-specific and ethnicity-specific data is crucial to the formulation of accurate conclusions of deviations from norms. In a landmark study,

Table 4: Gender differences in nasal morphology (*n* = 176)

	Males (M) (n = 75)	*Females (F) (n = 101)*	*Difference (M-F)*	*Student's t-test*	
	Mean (SD)	*Mean (SD)*	*Mean (SE)*	*t*	*p-value*
Vertical (mm)					
Nose height (n-sn)	58.72 (3.06)	56.14 (3.26)	2.58 (0.56)	4.577	$<0.001^{**}$
Nasal bridge length (n-prn)	52.37 (3.63)	49.14 (3.18)	3.23 (0.59)	5.496	$<0.001^{**}$
Horizontal (mm)					
Nose width (al_R-al_L)	37.08 (2.13)	32.54 (2.42)	4.54 (0.41)	11.038	$<0.001^{**}$
Nasal root width (mf_R-mf_L)	24.67 (2.2)	23.05 (2.38)	1.62 (0.41)	3.950	$<0.001^{**}$
Ala length surface (ac_R-prn- ac_L)	77.19 (4.56)	69.86 (3.63)	7.33 (0.7)	10.516	$<0.001^{**}$
Columella width (sn'_R-sn'_L)	8.59 (1.16)	7.73 (0.92)	0.86 (0.18)	4.869	$<0.001^{**}$
Ala length Right (ac_R-prn)	28.64 (1.89)	26.08 (1.86)	2.55 (0.33)	7.725	$<0.001^{**}$
Left (ac_L-prn)	28.32 (1.98)	25.39 (1.68)	2.93 (0.31)	9.326	$<0.001^{**}$
Ala thickness Right $(al'-al')_R$	4.33 (1.34)	3.87 (1.08)	0.46 (0.22)	2.065	0.042^{*}
Left $(al'-al')_L$	4.35 (0.88)	3.87 (0.95)	0.48 (0.16)	2.912	0.004^{**}
Nasal root slope length Right (en_R-m)	26.08 (2.03)	23.07 (1.77)	3.01 (0.33)	9.180	$<0.001^{**}$
Left (en_L-m)	24.04 (2.26)	21.54 (1.71)	2.5 (0.37)	6.718	$<0.001^{**}$
Nostril floor width Right ($sbal_R$-sn)	11.65 (1.85)	10.29 (1.3)	1.36 (0.3)	4.543	$<0.001^{**}$
Left ($sbal_L$-sn)	13.64 (2.05)	11.52 (1.55)	2.12 (0.34)	6.300	$<0.001^{**}$
Sagittal (mm)					
Nasal tip protrusion (sn-prn)	20.03 (2.13)	19.02 (1.86)	1.01 (0.34)	2.928	0.004^{**}
Columella length Right (c'_R-sn)	12.37 (1.76)	11.51 (1.47)	0.86 (0.28)	3.107	0.002^{**}
Left (c'_L-sn)	12.59 (1.7)	11.69 (1.38)	0.9 (0.26)	3.421	0.001^{**}
Angulations (mm)					
Nasofrontal angle (NFA; g-n-prn)	149.24 (4.88)	150.46 (4.53)	−1.21 (0.82)	−1.481	0.141
Nasolabial angle (NLA; prn-sn-ls)	129.73 (8.06)	132.71 (8.37)	−2.97 (1.46)	−2.035	0.044^{*}
Nasal tip angle (NTA; n-prn-sn)	99.13 (8)	101.63 (5.91)	−2.5 (1.31)	−1.917	0.059

Table 5: Descriptive statistics for age and BMI in the assessed sample of Lebanese patients (*n* = 176)

		Age	*BMI*
Overall sample	Min	18.10	16.51
	Max	37.68	33.22
	Mean	23.39	22.88
	SD	4.03	3.52
Males	Min	18.10	17.53
	Max	37.68	33.22
	Mean	23.59	25.26
	SD	3.56	3.29
Females	Min	18.29	16.51
	Max	35.65	31.24
	Mean	22.72	21.82
	SD	3.4	3.09

Farkas et al. compared craniofacial anthropometric data from more than 20 countries across five regions of the world (Europe, the Middle East, Asia, Africa, and North America).[23] With respect to the nasal region, their findings indicate that nasal measurements from different regions varied significantly from North American standard norms and that even among some of the Caucasian ethnicities, nose height differed significantly from the North American norms. The three middle Eastern countries assessed in the study were Egypt, Iran, and Turkey, and the data again suggests that for these populations nasal height was significantly greater than reported for North Americans. While the study provided limited data on nasal morphology owing to its more comprehensive assessment of craniofacial anthropometry, the results echo the recurring literature that highlights the importance of using ethnicity-specific normative values for the assessment of facial morphology in general and especially of nasal morphology.[16,23,24,32–34]

Owing to the lack of such population-specific normative data for facial and nasal morphology, it is common practice to assess patients against internationally recognized North American and/or European published norms. One of the most comprehensively reported and most commonly used of these databases is that of Farkas.[35] The data reported in the present study represent the first attempt at creating a normative nasal morphology database of the Lebanese population. Comparison to the established standards of Farkas[35] immediately highlights the differences exhibited by the Lebanese nose. Although linear measurements of the base of the nose (nasal floor width, nasal tip protrusion, and columella length) were similar to Farkas' norms, almost all vertical and width measurements were consistently larger in Lebanese males and females compared to their European counterparts (≥2.18 mm

Table 6: Significant correlations between nasal measurements and each of age and BMI ($n = 176$)

			Females		Males	
			Age	*BMI*	*Age*	*BMI*
Age		Pearson correlation		**0.309**[**]		**0.341**[*]
		Sig. (2-tailed)		0.002		0.025
Nasal measurements						
Nose height	n-sn	Pearson correlation	–0.030	**0.221**[*]	–0.021	0.167
		Sig. (2-tailed)	0.769	**0.030**	0.886	0.284
Nose width	al-al	Pearson correlation	**0.227**	**0.291**	**0.354**	**0.393**
		Sig. (2-tailed)	0.023	0.004	0.015	0.009
Right ala length	ac_R-prn	Pearson correlation	0.156	0.141	**0.456**[**]	0.114
		Sig. (2-tailed)	0.119	0.171	0.001	0.465
Left ala length	ac_L-prn	Pearson correlation	**0.199**[*]	0.156	**0.397**[**]	**0.314**[*]
		Sig. (2-tailed)	0.046	0.129	0.006	0.040
Ala surface length	ac_R-prn- ac_L	Pearson correlation	**0.244**[*]	0.187	**0.331**[*]	0.297
		Sig. (2-tailed)	0.014	0.068	0.023	0.053
Right ala thickness	$(al'-al')_R$	Pearson correlation	–0.097	0.079	0.223	–0.050
		Sig. (2-tailed)	0.334	0.446	0.132	0.751
Left ala thickness	$(al'-al')_L$	Pearson correlation	–0.146	0.109	–0.007	–0.179
		Sig. (2-tailed)	0.144	0.290	0.961	0.252
Right nasal root slope	en_R-m	Pearson correlation	0.138	–0.078	**0.300**[*]	0.115
		Sig. (2-tailed)	0.170	0.451	0.041	0.463
Left nasal root slope	en_L-m	Pearson correlation	0.173	–0.054	**0.289**[*]	0.168
		Sig. (2-tailed)	0.084	0.603	0.049	0.281
Columella width	sn′-sn′	Pearson correlation	0.033	**0.286**[**]	0.005	–0.055
		Sig. (2-tailed)	0.741	0.005	0.972	0.727
Right nostril floor width	$sbal_R$-sn	Pearson correlation	0.177	0.125	–0.222	0.036
		Sig. (2-tailed)	0.077	0.227	0.134	0.817
Left nostril floor width	$sbal_L$-sn	Pearson correlation	**0.230**[*]	0.162	0.226	0.163
		Sig. (2-tailed)	0.020	0.115	0.127	0.295
Nasal tip protrusion	sn-prn	Pearson correlation	**0.209**[*]	**0.200**	**0.559**[**]	0.095
		Sig. (2-tailed)	0.036	0.050	<0.001	0.543
Right columella length	c'_R-sn	Pearson correlation	**0.355**[**]	0.174	**0.516**[**]	0.293
		Sig. (2-tailed)	<0.001	0.089	<0.001	0.057
Left columella length	c'_L-sn	Pearson correlation	**0.332**[**]	**0.222**[*]	**0.493**[**]	0.272
		Sig. (2-tailed)	0.001	0.030	<0.001	0.078
Nasofrontal angle	g-n-prn	Pearson correlation	0.126	–0.022	**0.318**[*]	0.029
		Sig. (2-tailed)	0.210	0.832	0.029	0.854
Nasolabial angle	prn-sn-ls	Pearson correlation	–0.125	–0.032	–0.196	–0.291
		Sig. (2-tailed)	0.212	0.754	0.186	0.058
Nasal tip angle	n-prn-sn	Pearson correlation	**–0.225**[*]	0.108	**–0.548**[**]	–0.274
		Sig. (2-tailed)	0.023	0.294	<0.001	0.076

difference in the means). Although the difference in the width of the columella was small in actual measurement (0.9 mm in females and 1.7 mm in males), the difference in means was equal to 1.5 times the standard deviation for females and 2 times the standard deviation in males, thereby suggesting a clinically significant difference. All angular nasal measurements assessed were also larger for Lebanese males and females than in the Farkas database (≥16 degrees difference in means). Contrastingly, the only measurements that were smaller for the Lebanese sample, in both sexes, were ala length (difference of 5.4–6.7 mm in means) and thickness (difference of 1.4–1.6 mm in means).

The nasal height and width of the Lebanese sample exhibited significant differences from reported norms for Europeans, Asians, and Africans. Nasal height in the assessed Lebanese males (58.7 mm) and females (56.1 mm) was greater than in Egyptian males (56.1 mm) and was greater than in the Turkish population (54.8 mm).[24,27] Nasal bridge length was similarly larger in the Lebanese sample (52.4 and 49.1 mm in males and females respectively) than in Egyptian males (47 mm) and the Turkish population (47.1 mm).[24,27] Nasal width (al-al) on the other hand was narrower in the Lebanese males (37.1 mm) than in the Egyptian male sample (41.0 mm). Compared to other populations, nasal length in men was longer than in all the European populations assessed by Farkas et al.,[23] in addition to being longer than the height reported for numerous Asian and African countries.[16,23,36] Nasal width in the assessed Lebanese population was also larger than in the European populations, more similar to the Russian, Japanese, Azerbaijani, and Chinese populations, but larger than in the Iranian and Indian populations and smaller than in the African populations.[16,23,36]

In women, nasal length was similar to the Solvenian population, shorter than in the Portuguese population, and longer than in European, Asian, and African populations.[16,23,36] Nasal width (32.5 mm) in the female Lebanese sample was similar to the majority of the European samples but larger than in the Italian smaller than in the Slovenian populations and narrower than in the assessed Asian and African populations.[16,23,36]

The sexual dimorphism reported in this study supports the results of previous works across various ethnicities.[14,30,37–39] While individual studies report on differences with respect to which variables differed between men and women and the exact discrepancies, the universality of sexual dimorphism highlights the importance of using sex-specific norms in the assessment of nasal morphology. It is interesting to note that, in the currently assessed Lebanese sample, males had a significantly and consistently larger nose than females in all the assessed dimensions, coupled with a slightly smaller nasolabial angle (difference of approximately 3 ± 1.5 degrees).

There were statistically significant correlations between the nasal morphometric measurements in our sample and age with respect to alar length and surface area, columella length, nasal tip protrusion, and nasal tip angle. While our results support previous literature on the association between age and nasal morphology, the majority of the correlations in our sample were of low strength ($r \leq 0.397$ for 12 out of the 17 statistically significant correlations).[8,37] This is likely reflective of the small span of age assessed in this study (18.1–37.68 years, Table 5) compared to a range of 4–73 years in the study by Sforza and coworkers.[37] It is nonetheless interesting to note that, in the same age bracket, correlations were higher for males and were of moderate strength for nasal tip protrusion, columella length, and nasal tip angle have similarly reported different age-related patterns between men and women.[37]

Only a few statistically significant correlations were noted between nasal measurements and BMI, all of low magnitude ($r \leq 0.314$). This is likely reflective of the fact that the majority of the sample in both sexes lay within the normal range to borderline overweight BMI (mean BMI = 25.26 ± 3.29 for males and 21.82 ± 3.09 for females) and the lack of representation of overweight individuals with BMI >30.0 (WHO classification) or severely underweight individuals (lowest BMI was 16.5 in females and 17.5 in males compared to underweight cut-off point of 18.5).[40]

Stereophotogrammetry was chosen as the methodology of choice for the collection of data on nasal morphology owing to the increasing literature supporting its reliability and validity compared to direct anthropometric measurements, in addition to the advantages of non-invasiveness, cost-effectiveness, easy and fast data collection and minimal discomfort to subjects.[41–44] The methodology is sensitive to technical errors in image acquisition and operator errors in landmark identification, and this is reflected in studies that report variability in the accuracy of measurements based on stereophotogrammetric photographs.[45] However, the assessments of reliability in our study resulted in very high intra-examiner and inter-examiner coefficients (0.962–0.989).

Conclusion

This is the first study to report the normative sex-specific norms for nasal morphology in the Lebanese population. Sexual dimorphism is highlighted for all measurements and variations in nasal morphology are from both the established Farkas norms and norms from other populations. The data strongly suggests the need to use norms specific to the Lebanese population in the assessment of patients for esthetic and reconstructive surgery, orthodontics, and maxillofacial surgery, in addition to providing a forensic database for the Lebanese population. Additional studies on the Lebanese population are recommended in order to validate our data and expand the assessment of associations with age and BMI.

Clinical Significance

This study's clinical significance lies in its provision of precise, stereophotogrammetric measurements of nasal morphology in a young adult Middle-Eastern population, offering valuable data that enhances the accuracy of facial reconstructive surgery, contributes to the development of region-specific esthetic norms, and aids in the personalized treatment planning for both medical and cosmetic nasal interventions.

Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the Ethical Standards of the Institutional and/or National Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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