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Craniofacial skeletal and soft tissue morphology in Icelandic adults

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SUMMARY The purpose of the study was to describe the craniofacial characteristics of Icelandic adults on lateral skull cephalograms. The material consisted of 155 (47.8%) males and 169 (52.5%) females. The mean ages were 35.5 and 34.2 years, respectively. Twenty-two skeletal reference points and 11 soft tissue points were digitized and processed by standard methods with the Dentofacial Planner® computer software program. The 45 variables calculated were both angular and linear. Two-sample *t*-tests were used to study the differences between sexes.

Mandibular prognathism was significantly greater in males ($P \leq 0.05$), but the inclination of both the upper and lower jaws was greater in females ($P \leq 0.01$). Linear measurements were usually larger for males. The lips were less protrusive in males ($P \leq 0.01$), but the thickness was greater compared with females ($P \leq 0.001$). The nose was significantly more protrusive in males ($P \leq 0.001$). When the Icelandic sample was compared with closely related ethnic groups, such as the Swedes and the Danes, it was interesting to note that the Icelanders seem to be more like the Swedes than the Danes.

Introduction

Various growth studies, longitudinal or semi-longitudinal, have demonstrated that different linear and angular cephalometric measurements vary between males and females and change with age (Björk, 1947; Ødegaard, 1970; Riolo *et al*., 1974; Ingerslev and Solow, 1975; Berg, 1983; Bishara, 1981; El-Batouti *et al*., 1994). Furthermore, differences have been described among races (Cotton *et al.*, 1951; Altemus, 1960; Miyajima *et al.*, 1996) and among Caucasians (Canut *et al*., 1987; Argyropoulos and Sassouni, 1989; El-Batouti *et al.*, 1995; Reich and Dannhauer, 1996). Differences have even been found among such closely related and homogeneous ethnic groups as the Scandinavians (Solow and Sarnäs, 1982).

Cephalometric analysis has proven to be a useful tool in the diagnosis, evaluation and treatment planning of patients undergoing orthodontic treatment and/or orthognathic surgery and to evaluate treatment results. Most cephalometric standards published have focused on describing changes during childhood and through adolescence, which is the age at which patients usually seek orthodontic treatment (Ødegaard, 1970; Riolo *et al*., 1974; Bishara, 1981; Berg, 1983; El-Batouti *et al*., 1994; Reich and Dannhauer, 1996). Less research has been carried out to describe changes after the age of 20 years, although an increasing number of adults are undergoing orthodontic treatment. Adults make up around 15 per cent of all orthodontic patients. However, they are still only a small proportion of all adults who could benefit from such therapy (Buttke and Proffit, 1999).

Studies have shown that growth changes in the cranofacial complex can take place from the early 20s and to the late 40s (Forsberg, 1979; Behrents, 1985; Forsberg *et al.,* 1991; Bondevik, 1995; Iseri and Solow, 1996), indicating that craniofacial growth changes can be expected throughout life.

For orthodontic and other diagnostic procedures, cephalometric standards should be available for different populations, sex and age groups. The purpose of this study was to measure the craniofacial skeletal and soft tissue morphology of Icelandic adults, to estimate the differences between the sexes, and to compare the results with data obtained from closely related ethnic groups.

Material and methods

Subjects

The material used in this investigation was collected at the Department of Orthodontics, Faculty of Odontology, University of Iceland, in 1987 and 1988. The subjects were all parents of children who participated in a study at the faculty that has been described elsewhere (Arnlaugsson and Magnusson, 1996; Johannsdottir *et al*., 1997, 1999). In total, 796 parents were invited to participate and 332 (41.7 per cent) agreed to take part. The following records were taken: study models, lateral cephalograms, postero-anterior skull radiograms and panoramic films. In this study, only the cephalograms were analysed. Films of poor quality and those where the posterior teeth were not occluded were rejected. Edentulous individuals and those with a significant reduction in the number of teeth were excluded. Individuals of foreign origin and those who had received orthodontic treatment were also excluded. Thus, cephalograms from 324 adults, 155 (47.8 per cent)

males and 169 (52.5 per cent) females, were available for analysis. The mean age for the males was 35.5 years and for the females 34.2 years.

Cephalometric analysis

The cephalograms were taken with a Lumex cephalostat (Tagarno). The focus–median plane distance was 180 cm and the focus–film distance 190 cm, producing a 5.6 per cent enlargement of the midline structures. The cephalograms were taken with the subjects in an upright position with their teeth occluded and lips relaxed. The films were then traced on acetate paper by one of the authors (BJ) in a negatoscope in a half-dark room. Reference points were identified and later digitized on a digitizing table (Numonics®, Vertigraph Inc., Dallas, Texas, USA) and processed by Dentofacial Planner® (Dentofacial Software Inc., Toronto, Ontario, Canada) software. The magnification of the radiographs was corrected by the computer software program.

The following skeletal and soft tissue cephalometric landmarks (Björk, 1947; Downs, 1948; Solow, 1966; Moyers, 1973; Chaconas, 1980; Kreiborg, 1981; Bhatia and Leighton, 1993) were identified on each radiogram (Figure 1).

Statistical method

Descriptive statistics, including the mean, standard deviation and the maximum and minimum values, were computed for each variable. Two-sample *t*-tests were used to compare the means of different groups and 95 per cent confidence intervals were calculated.

Reliability

Twenty-eight randomly selected cephalograms were retraced and redigitized after an interval of at least 2 weeks. In order to estimate the measurement error, Dahlberg's (1940) formula was used

$$Se = \sqrt{\Sigma d^2/2n}$$

where d is the difference between repeated measurements and n is the number of paired measurements. Systematic error was estimated using a one-sample *t*-test, as suggested by Houston (1983).

Results

In general, the error of the measurements was small; variables involving teeth such as ILs/NSL, ILs/NL, ILi/ML and ILs/ILi and soft tissue variables including the soft tissue landmark GL showed the largest variance. When evaluating the systematic error, one variable, NSL/FH, reached the 10 per cent level of significance.

The results for the skeletal and soft tissue variables are presented in Tables 1 and 2, respectively.

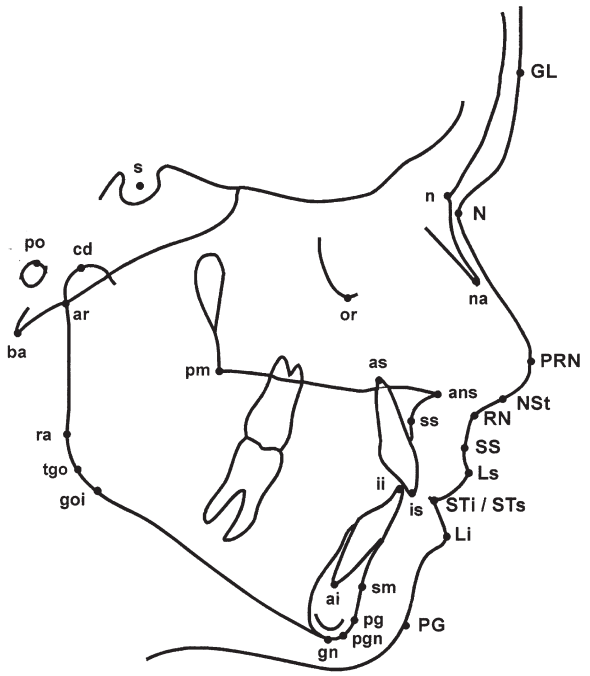

Figure 1 Cephalometric landmarks.

Apex inferius (ai), the root apex of the most prominent lower incisor; anterior nasal spine (ans), the apex of the anterior nasal spine; articulare (ar), the point of intersection of the dorsal contour of the Condylar head and the contour of the external cranial base; apex superius (as), the root apex of the most prominent upper incisor; basion (ba), the most inferior posterior point in the sagittal plane on the anterior rim of the foramen magnum; condylion (cd), a point on the contour of the condyle obtained by bisecting the angle formed by tangents to the upper and posterior borders of the condyle, the tangents being parallel to ML and perpendicular to ML, respectively; gnathion (American menton; gn), the most inferior point of the mandibular symphysis; gonion inferius (goi), the posterior tangent point of the mandibular inferior border near gonion; incision inferius (ii), the midpoint on the incisor edge of the most labially positioned mandibular central; incision superius (is), the midpoint on the incisor edge of the most labially positioned maxillary central; nasion (n), the anterior limit of the nasofrontal suture; nasale (na), the tip of the nasal bone; orbitale (or), the deepest point on the infraorbital margin; pogonion (pg), the most prominent point of the mandibular symphysis; prognathion (American gnathion; pgn), the point on the mandibular symphysis farthest from the condylion; pterygomaxillare (pm), the intersection between the nasal floor and the posterior contour of the maxilla; porion (po), the midpoint on the upper contour of the external auditory canal; ramus point (ra), the lower tangent point of the posterior border of the ramus; sella (s), centre of the sella turcica; supramentale (Downs B-point; sm), the deepest point on the contour of the mandibular alveolar process, between infradentale and the pogonion; subspinale (Downs A-point; ss), the deepest point on the contour of the maxillary alveolar process between the anterior nasal spine and prosthion; tangent gonion (tgo), the tangent intersection at gonion, the intersection between the mandibular line and the ramus line; glabella (GL), the most prominent or anterior point in the midsagittal plane of the forehead at the level of the superior orbital ridges; soft tissue nasion (N), the deepest point in the soft tissue concavity overlying the frontonasal suture; nasal septum tangent point (columella or Steiner's S-point; NSt), the most anterior point on the columella of the nose, representing the anterior delimiter of the nasolabial angle; labrale inferius (Li), the most anterior point on the margin of the lower membranous lip; labrale superius (Ls), the most anterior point on the margin of the upper membranous lip; soft tissue pogonion (PG), the most anterior point on the soft tissue chin in the midsagittal plane; pronasale (PRN), the most anterior point on the nose tip; retronasale (RN), the junction of the columella of the nose with the philtrum of the upper lip; sulcus superioris (SS), the deepest point in the concavity of the upper lip; stomion inferius (STi), the most superior point on the vermilion of the lower lip; stomion superius (STs), the most inferior point on the vermilion of the upper lip.

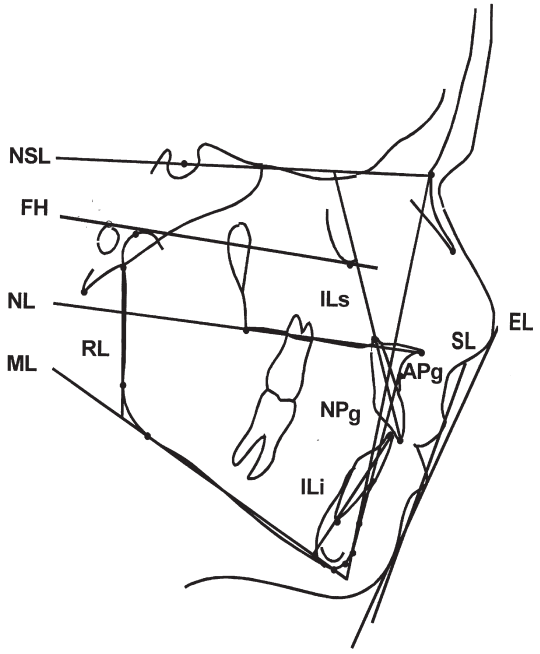

Figure 2 The following reference lines were used: NSL, nasion–sella line (n–s); FH, Frankfort horizontal (po–or); NL, nasal line (pm–ans); ML, mandibular line (goi–gn); RL, ramus line (ra–ar); NPg, nasion–pogonion line (n–pg); APg, subspinale– pogonion line (ss–pg); ILs, long axis of the upper incisors (as–is); ILi, long axis of the lower incisors (ii–ai); Steiner's line, SL (NSt–PG); Rickett's E-line, EL (PRN–PG).

From the cephalometric landmarks and reference lines, the following linear and angular measurements were carried out: basal sagittal measurements—angular: s–n–ss, s–n–sm, s–n–pg, ss–n–sm, n–ss–pg (supplementary angle); linear: ss ⊥ n–pg; basal vertical measurements—angular: NSL/FH, NSL/NL, NL/ML, NSL/ML, RL/ML; linear: n–gn (anterior face height), s–goi (posterior face height); ratio: n–ans/ans–gn (anterior face ratio); mandibular length—linear: cd–tgo, cd–pgn, ar–pgn; dental measurements—angular: ILs/NSL, ILs/NL, ILi/ML, ILs/ILi; linear: is ⊥ ss–pg, is ⊥ n–ss, ii ⊥ ss–pg, ii ⊥ n–sm; cranial base—angular: n–s–ba, n–s–ar; linear: s–n, s–ba, s–ar, n–ba; nasal bone—angular: s–n–na; linear: n–na; soft tissue measurements—angular: GL–RN–PG (supplementary angle), GL–PRN–PG, N–PRN–PG, N–SS–PG, NSt–RN–Ls (nasolabial angle); linear: Ls ⊥ EL, Ls ⊥ SL, Li ⊥ EL, Li ⊥ SL, PRN at N–pg (prominence of soft tissue nose in relation to the N–pg line), PRN at N–PG (prominence of soft tissue nose in relation to the N–PG line), ss–SS.

Skeletal variables

Maxillary prognathism was not different between the sexes, but mandibular prognathism was significantly greater in males judging from the sagittal position of both point B and pogonion ($P \leq 0.001$). The basal sagittal jaw relationship (ANB angle) was slightly different between the sexes where females on average showed higher values ($P \leq 0.05$). There was no difference in the inclination of the upper jaw. On the other hand, the inclination of the mandible both in relation to the cranial base ($P \leq 0.001$) and the nasal plane ($P \leq 0.01$) was significantly greater in females. The total anterior and posterior face heights were significantly larger in males ($P \leq 0.001$), but the anterior face height ratio was not different. The mandibular base length and ramus length were significantly larger in males ($P \leq 0.001$). The inclination of the upper incisors was greater in males, both in relation to the cranial base ($P \leq 0.01$) and to the nasal plane ($P \leq 0.05$). Other dental variables were not different between the sexes. The cranial base flexure was not different between the sexes, but anterior, posterior and total cranial base dimensions were significantly larger in males ($P \leq 0.001$). The prominence and length of the nasal bone was significantly greater in males ($P \leq 0.001$).

Soft tissue variables

Facial convexity, with or without inclusion of the nose, was not different between the sexes, independent of whether the soft tissue landmarks GL or N were used. Nasolabial angle also did not differ. Protrusion of the lips in relation to both Rickett's aesthetic and Steiner's lines was significantly less in males ($P \leq 0.01$). Protrusion of the nose in relation to both n–pg and N–PG was significantly greater in males ($P \leq 0.001$), as was the thickness of the upper lip ($P \leq 0.001$).

Discussion

According to Palsson and Edwards (1972), Iceland was settled in the late eighth century. Most of the settlers were of Scandinavian origin, but information indicates that among the founders were also individuals from the British Isles (Palsson and Edwards, 1972). Data from modern genetic analysis have suggested that 20–25 per cent of the Icelandic founding males had Gaelic ancestry and that the majority of female settlers may have originated from the British Isles (Helgason *et al.*, 2000a, b). Due to the isolation of the country throughout the centuries and the rather low number of inhabitants, the Icelandic population became notably genetically homogeneous. In 1900, the total number of inhabitants in Iceland was 78 000, and 5800 (7.5 per cent) lived in Reykjavik. In 1988, when the material in this study was gathered, the total number of inhabitants in Iceland was 252 000, and 96 000 (38.1 per cent) lived in the capital. Throughout the 20th century, people from the countryside have been migrating to the Reykjavik district. The sample in this study was gathered from Reykjavik and is considered to represent the whole population of Iceland (Statistical Institute of Iceland, 1988).

The findings showed that males had consistently larger values for linear dimensional variables, including anterior and posterior face heights, mandibular length, cranial base dimensions and nasal bone length. A different configuration was noted between the sexes both for the sagittal plane and the vertical dimensions, but the differences were not as apparent as the linear variables. The findings are in agreement with other similar investigations (Ingerslev and Solow, 1975; Formby *et al.*, 1994).

Table 1 Craniofacial morphology of Icelandic adults, skeletal and dental variables.

	Males					Females						
Measurement	*n*	Mean	SD	Minimum	Maximum	*n*	Mean	SD	Minimum	Maximum	Mean difference	95% CI
Basal sagittal												
s–n–ss (°)	155	81.9	4.0	70.3	93.1	169	81.0	3.6	69.3	90.8	0.8	(–0.0/1.7)
s–n–sm (°)	155	80.1	3.7	70.0	90.7	169	78.6	3.8	67.8	90.8	1.5	(0.7/2.3)***
s–n–pg (°)	155	81.8	4.0	71.2	91.5	169	80.1	3.8	69.3	92.0	1.6	(0.8/2.5)***
ss–n–sm (°)	155	1.8	2.7	–6.4	8.5	169	2.5	2.5	–5.5	9.0	–0.7	(–1.2/–0.1)*
ss ⊥ n–pg (mm)	155	0.2	3.2	–9.5	8.5	169	0.9	3.2	–6.4	8.8	–0.7	(–1.4/–0.1)*
n–ss–pg (°)	155	–0.3	6.4	–18.0	19.7	169	–2.0	6.0	–17.5	13.9	1.6	(0.3/3.0)*
Basal vertical												
NSL/FH (°)	155	9.3	2.8	–5.3	17.2	169	9.7	2.7	3.5	20.2	–0.4	(–1.0/0.2)
NSL/NL (°)	155	6.9	3.5	–4.3	15.1	169	7.5	3.6	–3.8	16.8	–0.5	(–1.3/0.3)
NL/ML (°)	155	22.9	6.0	8.9	41.7	169	24.7	5.5	9.6	39.7	–1.8	(–3.0/–0.5)**
NSL/ML (°)	155	29.9	6.0	14.4	48.1	169	32.2	5.9	15.4	48.6	–2.3	(–3.6/–1.0)***
n–ans/ans–gn (%)	155	75.5	7.8	52.9	103.9	169	76.9	7.7	59.3	99.8	–1.4	(–3.1/0.3)
n–gn (anterior face height; mm)	155	122.4	7.0	104.1	139.4	169	112.6	5.4	90.4	129.1	9.8	(8.4/11.1)***
s–goi (posterior face height; mm)	155	84.5	5.4	71.1	99.6	169	74.4	4.9	60.2	87.6	10.0	(8.9/11.2)***
RL/ML (°)	155	123.3	6.4	103.4	138.6	169	123.4	6.4	108.8	139.4	–0.1	(–1.5/1.3)
Mandibular length												
cd–tgo (mm)	155	63.1	4.1	52.6	77.5	169	55.5	3.7	45.9	65.2	7.6	(6.8/8.5)***
cd–pgn (mm)	155	120.8	5.8	107.9	146.0	169	110.1	4.3	100.0	123.0	10.6	(9.5/11.7)***
ar–pgn (mm)	155	114.8	5.8	101.1	134.6	169	104.1	4.5	93.4	118.2	10.7	(9.6/11.9)***
Dental												
Ils/NSL (°)	153	103.6	7.5	79.9	120.6	168	101.1	8.5	70.3	132.1	2.5	(0.7/4.2)**
ILs/NL (°)	153	110.6	7.2	87.9	128.4	168	108.6	7.9	87.0	141.2	2.1	(0.4/3.7)*
Is ⊥ ss–pg (mm)	153	5.1	2.8	–4.1	13.5	168	5.6	2.6	–0.4	13.4	–0.4	(–1.0/0.2)
Is ⊥ n–ss (mm)	153	5.0	3.4	–3.3	17.8	168	4.8	2.8	–4.4	11.8	0.3	(–0.4/1.0)
Ili/ML (°)	155	92.6	6.7	75.8	112.1	169	92.8	7.9	69.6	113.2	–0.2	(–1.8/1.4)
Ii ⊥ ss–pg (mm)	155	1.9	2.9	–6.3	9.5	169	1.9	2.4	–4.5	8.9	0.1	(–0.5/0.6)
Ii ⊥ n–sm (mm)	155	4.3	2.6	–3.1	12.8	169	4.4	2.5	–2.1	10.9	–0.1	(–0.6/0.5)
ILs/Ili (°)	153	133.9	10.7	107.7	168.1	168	134.0	10.7	106.7	165.4	–0.1	(–2.5/2.2)
Cranial base												
n–s–ba (°)	155	130.3	5.3	117.1	156.5	169	130.2	5.1	116.3	148.7	0.1	(–1.0/1.2)
n–s–ar (°)	155	123.9	5.0	112.5	137.2	169	123.5	5.3	108.2	139.4	0.4	(–0.7/1.6)
s–n (mm)	155	70.9	3.2	62.2	80.0	169	66.6	2.7	61.2	72.5	4.3	(3.7/4.9)***
s–ba (mm)	155	46.1	3.5	27.9	54.4	169	42.4	2.7	34.0	48.7	3.7	(3.0/4.4)***
s–ar (mm)	155	36.3	3.1	26.1	45.3	169	32.6	2.8	25.4	40.2	3.7	(3.1/4.3)***
n–ba (mm)	155	106.5	4.5	95.7	119.8	169	99.3	3.8	90.0	107.9	7.3	(6.4/8.2)***
Nasal bone												
n–na (mm)	155	23.6	3.4	14.9	36.0	169	21.8	3.1	12.7	31.1	1.8	(1.1/2.5)***
s–n–na (°)	155	118.0	6.1	95.6	133.2	169	113.5	5.7	95.3	130.9	4.5	(3.2/5.8)***

*$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.
SD, standard deviation; CI, confidence interval.

When the Icelandic sample was compared with similar Danish (Ingerslev and Solow, 1975) and Swedish (Sarnäs and Solow, 1980) groups (Table 3), maxillary and mandibular prognathism were similar, and in all groups females showed on average a larger basal sagittal jaw relationship (ANB or ANPg). The inclination of the lower jaw was on average slightly greater in the Icelandic sample in comparison with the Danish group, but very similar to the Swedish sample. This difference was also reflected in the jaw angle, which was similar in the Icelandic and the Swedish groups but smaller in the Danes. The inclination of the nasal floor was slightly greater in Danish males but Swedish males were very similar to the Icelanders. Little difference was found for females. The interjaw angle (NL/ML) was similar in the Icelandic and the Swedish groups but less inclined in the Danish group. The total length of the mandible was a little greater in Icelandic males but smaller in Icelandic females compared with the Danish group, making the Icelandic sample more like the Swedes. The inclination of the upper incisors was similar in all these three groups. The inclination of the lower incisors was notably smaller in the Icelandic group compared both with the Swedes and the Danes, the Danish group showing the most proclined lower incisors. The flexure of the cranial base and the anterior and posterior cranial base lengths were similar in all three groups (Table 3).

There was no difference in the convexity of the soft tissue facial profile between the sexes, but Formby *et al.*

Table 2 Craniofacial morphology of Icelandic adults soft tissue variables.

	Males					Females						
Measurement	*n*	Mean	SD	Minimum	Maximum	*n*	Mean	SD	Minimum	Maximum	Mean difference	95% CI
GL–RN–PG (°)	155	168.6	6.1	153.6	184.7	169	168.6	7.0	150.9	193.8	0.0	(–1.4/1.4)
GL–PRN–PG (°)	154	140.7	5.7	126.8	164.9	169	141.6	5.3	130.9	156.2	–0.9	(–2.1/0.3)
N–PRN–PG (°)	154	128.5	5.1	116.4	149.9	169	128.2	4.7	117.4	141.5	0.3	(–0.8/1.4)
N–SS–PG (°)	155	167.3	7.0	151.5	188.8	169	167.4	6.7	150.6	183.8	–0.1	(–1.5/1.4)
NSt–RN–Ls (°)	155	107.2	12.2	74.4	152.6	169	108.8	10.3	73.3	140.6	–1.5	(–4.0/0.9)
Ls ⊥ EL (mm)	154	–5.0	2.7	–13.3	1.6	169	–4.1	2.4	–9.1	1.8	–0.9	(–1.5/–0.3)**
Ls ⊥ SL (mm)	155	–2.1	2.5	–10.8	4.0	169	–1.3	2.2	–7.2	4.2	–0.7	(–1.3/–0.2)**
Li ⊥ EL (mm)	155	–3.3	3.2	–11.1	6.6	169	–2.4	2.6	–8.5	4.8	–1.0	(–1.6/–0.3)**
Li ⊥ SL (mm)	155	–1.3	3.1	–8.9	8.0	169	–0.6	2.4	–6.9	6.4	–0.7	(–1.3/–0.1)**
PRN at n–pg (mm)	154	34.6	3.1	20.2	44.1	169	30.7	2.8	22.2	37.2	3.9	(3.2/4.5)***
PRN at N–PG (mm)	154	24.1	3.0	11.5	32.1	169	21.7	2.5	14.8	28.1	2.4	(1.8/3.0)***
ss–SS (mm)	155	19.8	2.8	13.7	30.8	169	16.3	2.1	11.5	21.9	3.4	(2.9/4.0)***

*$P \leq 0.05$; **$P \leq 0.01$; ***$P \leq 0.001$.
SD, standard deviation; CI, confidence interval.

Table 3 Craniofacial morphology of adult Swedes, Danes and Icelanders. The Swedish sample (Sarnäs and Solow, 1980) comprised 101 males and 50 females, the Danish sample (Ingerslev and Solow, 1975) 102 males and 51 females and the Icelandic sample (current study) 155 males and 169 females.

	Swedes*		Danes†		Icelanders‡	
	Male	Female	Male	Female	Male	Female
s–n–ss	82.4	81.5	81.4	81.5	81.9	81.0
s–n–sm	–	–	–	–	80.1	78.6
s–n–pg	81.5	79.7	81.0	80.5	81.8	80.1
ss–n–pg	0.9	1.8	0.2	1.0	–	–
ss–n–sm	–	–	–	–	1.8	2.5
NSL/ML	29.4	32.1	28.0	29.6	29.9	32.2
NSL/NL	6.7	7.5	7.6	7.1	6.9	7.5
NL/ML	22.7	24.7	20.3	22.0	22.9	24.7
ML/RL	123.0	126.1	120.1	121.2	123.3	123.4
cd–pgn	128.2	117.0	125.9	118.9	120.8 (127.6)	110.1(116.3)
ILs/NL	109.0	109.3	110.9	109.9	110.6	108.6
ILi/ML	94.4	94.7	98.5	99.1	92.6	92.8
ILs/Ili	134.0	131.3	131.7	128.3	133.9	134.0
n–s–ba	129.3	129.7	130.5	130.4	130.3	130.2
n–s–ar	123.1	123.5	124.2	123.3	123.9	123.5
n–s	75.6	70.7	73.4	70.4	70.9 (74.9)	66.6 (70.3)
s–ba	49.2	45.3	48.9	46.1	46.1 (48.7)	42.4 (44.8)
s–ar	37.9	34.4	38.8	35.7	36.3 (38.3)	32.6 (34.4)

*5.8 per cent enlargement in the median plane.
†5.6 per cent enlargement.
‡Linear values in parentheses with 5.6 per cent calculated enlargement.

(1994), in a study on white adults over 30 years of age, found that females had more convex facial soft tissue profiles than males. The present investigation showed that males had thicker upper lips, less protrusive lips in relation to the E-line and a more protrusive nose than females; these results are in agreement with Formby *et al.* (1994). The nasolabial angle did not differ between the sexes in this study, but Formby *et al.* (1994) found this angle to be smaller in females.

Conclusion

The present study confirms that craniofacial morphology is different between the sexes. Icelandic males have larger linear dimensions, more protrusive and less inclined lower jaws, less protrusive but thicker lips, and a more protrusive nose. When the Icelandic sample is compared with closely related ethnic groups such as the Swedes and the Danes, it is interesting to note that the basal

cranial variables, both linear and angular, are similar in all groups, but there are differences in the inclination of the lower jaw and mandibular length, with the Icelanders more like the Swedes. The Icelanders have notably less inclined lower incisors compared with both Swedes and Danes.

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