

Crown size of permanent teeth in Icelanders

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Mesiodistal and buccolingual crown diameters were measured from casts of 1010 dentitions of schoolchildren from Northeast Iceland. Their teeth proved to be larger than in Europeans generally, being exceeded only by Australian Aborigines, some American Indian populations, and American Negroes. In comparison with Ohio Caucasians of Northwest European origin Icelanders showed clearly larger dimensions, less sexual dimorphism, and a different pattern of dimorphism. Crown indices were also distinctly different in Icelanders and Ohio Caucasians

□ *Odontometrics; sexual dimorphism; molar size sequence*

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Studies of skeletal human populations indicate a general trend towards reduction of tooth size, which probably reached its nadir in Mediaeval European populations (11). The reduction appears to be associated with advancing cultural evolution, but the causal relationship between the two is far from clear (6, 7, 20, 34).

The small size of the teeth of Europeans or Caucasians seems to have become an accepted generalization. It is, for instance, a basic assumption in a recent statistically advanced analysis of dental micro-evolution (29). However, the variation in tooth size among contemporary European populations is not particularly well known. Moreover, a reversal of the reduction trend has been reported in Swedes (10) and in Lapps (22). There is thus reason to suspect that the teeth of European populations may not be as uniformly small as believed and that changes in tooth dimensions may occur within a relatively short time. It is therefore desirable to study contemporary European populations of known racial background to obtain a broader basis for comparative and analytic odontometric research.

Iceland was settled about 1100 years ago, mostly from Scandinavia and the Viking colonies in Ireland, Scotland, and the British Isles. Among the settlers were also Celts, but their exact number is not known (5).

The population has remained relatively free from admixture since the time of settlement. Our opportunity for odontologic research work arose in connection with a more extensive biological and epidemiological project 'The Icelander in the Changing World'.

Materials and methods

The material consists of stone casts of the dentitions of 1010 children from three locations in Northeast Iceland (2).

The maximum mesiodistal (MD) diameter was measured parallel to the occlusal and vestibular surfaces, using a sliding caliper with a vernier scale, a graded gauge, and sharpened beaks. The buccolingual (BL) diameter recorded was the greatest distance between the vestibular and lingual surfaces at right angles to the MD measurement.

Both sides were recorded by the same investigator with a reading accuracy of 0.05 mm. No malformed or incompletely erupted teeth were measured. Teeth were also rejected if crowding, carious lesions, restorations, deposits, or faulty casts prevented measurements between intact surfaces. Since no significant bilateral asymmetry was found, the statistics are based on right-side data. Left-side figures were used only when the tooth on the right side was

Table 1. Mesiodistal diameter (in mm) of the permanent teeth of modern Icelanders

Tooth	Sex	No.	\bar{x}	s	CV	t
I ¹	♂	411	8.99	0.54	6.01	6.60‡
	♀	439	8.75	0.52	5.94	
	♂ + ♀	850	8.87	0.54	6.09	
I ²	♂	320	6.95	0.54	7.77	2.94†
	♀	342	6.83	0.51	7.47	
	♂ + ♀	662	6.89	0.53	7.69	
C	♂	162	8.14	0.42	5.16	8.27‡
	♀	220	7.79	0.40	5.14	
	♂ + ♀	382	7.94	0.44	5.54	
P ¹	♂	231	7.22	0.41	5.68	4.02‡
	♀	268	7.07	0.42	5.94	
	♂ + ♀	499	7.14	0.42	5.88	
P ²	♂	197	6.89	0.43	6.24	1.21
	♀	227	6.84	0.42	6.14	
	♂ + ♀	424	6.86	0.42	6.12	
M ¹	♂	309	10.98	0.57	5.19	6.12‡
	♀	312	10.70	0.57	5.33	
	♂ + ♀	621	10.84	0.59	5.44	
M ²	♂	100	10.08	0.58	5.75	4.01‡
	♀	121	9.78	0.53	5.42	
	♂ + ♀	221	9.92	0.57	5.75	
I ₁	♂	465	5.59	0.35	6.26	4.91‡
	♀	482	5.48	0.34	6.20	
	♂ + ♀	947	5.53	0.35	6.33	
I ₂	♂	431	6.20	0.36	5.81	7.28‡
	♀	442	6.02	0.37	6.15	
	♂ + ♀	873	6.11	0.38	6.22	
C	♂	217	7.13	0.41	5.75	9.90‡
	♀	307	6.80	0.35	5.15	
	♂ + ♀	524	6.94	0.41	5.91	
P ₁	♂	255	7.30	0.41	5.62	5.12‡
	♀	309	7.12	0.42	5.90	
	♂ + ♀	564	7.20	0.42	5.83	
P ₂	♂	200	7.45	0.46	6.17	4.18‡
	♀	239	7.27	0.44	6.05	
	♂ + ♀	439	7.35	0.46	6.26	
M ₁	♂	280	11.45	0.58	5.07	6.66‡
	♀	287	11.12	0.60	5.40	
	♂ + ♀	567	11.28	0.61	5.41	
M ₂	♂	115	10.85	0.60	5.53	4.71‡
	♀	158	10.49	0.64	6.10	
	♂ + ♀	273	10.64	0.65	6.11	

Number of teeth measured (No.), means (\bar{x}), standard deviations (s), coefficients of variation (CV), and Student's *t* test values (t) indicating sexual dimorphism are given for males (♂), females (♀) and both sexes (♂ + ♀).

* 0.05 > P > 0.01.

† 0.01 > P > 0.001.

‡ 0.001 > P.

absent or could not be measured. No systematic differences were observed among the subpopulations. The results were therefore pooled.

To estimate the error of measurement, double determinations were made with an interval of a few weeks between the first and second measurement. The error of measurement seldom exceeded 0.6%, calculated as percentage of the mean of the two measurements. The first measurements tended to be slightly larger than the second ones. No tendency toward sidedness of the error of measurement was seen.

Results

Means, standard deviations, coefficients of variation, and *t* values indicating sexual dimorphism are given for the MD diameter in Table 1 and for the BL diameter in Table 2. Both measurements were least variable in the lower first molar and most variable in the upper lateral incisor. Only the upper second premolar mesiodistally and the upper lateral incisor buccolingually failed to show statistically significant sexual dimorphism. The dimorphism was clearly greatest in the canines, exceeding 5% in the BL measurements of upper canines, and smallest in the BL measurements of upper lateral incisors, barely over 1% (Table 3).

The molar size sequence (MSS) M1 > M2 dominated in both jaws; only a few cases of different sequences were found (Table 4).

For the sake of completeness of descriptive statistics, the means and standard deviations of the crown index, crown module, and crown area are listed in Table 5. The crown index showed very little sexual dimorphism.

Discussion

Stone reproductions of teeth tend to be slightly larger than the original teeth owing to the initial expansion of alginate and the setting expansion of gypsum products (30). Such a tendency was noticed by Hunter & Priest (21) and Lundström (24), but not by Richardson & Malhotra (32). However, the

Table 2. Buccolingual diameter (in mm) of the permanent teeth of modern Icelanders

Tooth	Sex	No.	\bar{x}	s	CV	t
I ¹	♂	234	7.35	0.49	6.67	3.16†
	♀	289	7.22	0.45	6.23	
	♂ + ♀	523	7.28	0.48	6.59	
I ²	♂	127	6.58	0.49	7.45	1.23
	♀	193	6.51	0.50	7.68	
	♂ + ♀	320	6.54	0.50	7.65	
C	♂	115	8.58	0.59	6.88	6.49‡
	♀	163	8.15	0.51	6.26	
	♂ + ♀	278	8.33	0.58	6.96	
P ¹	♂	212	9.43	0.57	6.05	4.71*
	♀	265	9.19	0.54	5.88	
	♂ + ♀	477	9.29	0.57	6.14	
P ²	♂	202	9.60	0.63	6.56	4.34‡
	♀	237	9.36	0.53	5.66	
	♂ + ♀	439	9.47	0.59	6.23	
M ¹	♂	351	11.92	0.52	4.36	9.37‡
	♀	356	11.55	0.53	4.59	
	♂ + ♀	707	11.74	0.55	4.69	
M ²	♂	89	11.77	0.77	6.54	3.85‡
	♀	107	11.36	0.72	6.34	
	♂ + ♀	196	11.55	0.77	6.67	
I ₁	♂	194	6.07	0.42	6.92	3.60‡
	♀	296	5.94	0.37	6.23	
	♂ + ♀	490	5.99	0.40	6.68	
I ₂	♂	143	6.42	0.40	6.23	1.97*
	♀	250	6.34	0.38	5.99	
	♂ + ♀	393	6.37	0.39	6.12	
C	♂	95	7.76	0.54	6.69	5.66‡
	♀	194	7.41	0.47	6.34	
	♂ + ♀	289	7.53	0.52	6.91	
P ₁	♂	177	8.00	0.50	6.25	5.85‡
	♀	240	7.71	0.50	6.49	
	♂ + ♀	417	7.83	0.52	6.64	
P ₂	♂	161	8.72	0.61	7.00	4.50‡
	♀	201	8.44	0.57	6.75	
	♂ + ♀	362	8.56	0.60	7.01	
M ₁	♂	279	10.91	0.46	4.22	6.99‡
	♀	276	10.64	0.45	4.23	
	♂ + ♀	555	10.78	0.47	4.36	
M ₂	♂	87	10.67	0.46	4.31	5.52‡
	♀	130	10.29	0.52	5.05	
	♂ + ♀	217	10.44	0.53	5.08	

Abbreviations and symbols are explained in Table 1.

total error due to the indirect method is so small that metric comparisons between skeletal materials and casts are possible. The effects of attrition and erosion are minimized in the present study because only the teeth of schoolchildren were measured.

Table 3. Percentage sexual dimorphism (M/F - 1) × 100

Tooth	Mesiodistal		Buccolingual	
	Percentage	Rank	Percentage	Rank
I ¹	2.74	7	1.80	12
I ²	1.76	13	1.08	14
C	4.49	2	5.28	1
P ¹	2.12	11	2.61	8
P ²	0.73	14	2.56	9
M ¹	2.62	8	3.20	7
M ²	3.07	4	3.61	5
I ₁	2.01	12	2.19	11
I ₂	2.99	5	1.26	13
C	4.85	1	4.72	2
P ₁	2.53	9	3.76	3
P ₂	2.48	10	3.32	6
M ₁	2.97	6	2.54	10
M ₂	3.43	3	3.69	4
Mean	2.77		2.97	

The determination of the points of measurement is of greater concern (18), particularly with respect to the MD diameter of upper molars. The distance between the anatomical contact points is frequently used in orthodontically oriented papers, whereas in anthropologically oriented papers the maximum diameter, according to Moorrees (26), is perhaps of greater interest.

Compared with several Caucasian populations (1, 10, 15, 18, 19, 22, 23, 25, 27, 28, 33, 36) Icelanders have large teeth, both mesiodistally and buccolingually. Their teeth are, however, smaller than those of Pima Indians (19), Australian Aborigines (3, 4, 19), and American Negroes (19, 32) but exceed those of Aleuts (26). The Japanese (19) have teeth of similar or slightly smaller MD size.

Table 4. Molar size sequence (MSS) in modern Icelanders

Tooth size sequence	Percentage occurrence	No. of molar pairs
M ¹ > M ²	95.6	109
M ¹ = M ²	1.8	2
M ² > M ¹	2.6	3
M ₁ > M ₂	94.1	128
M ₁ = M ₂	1.5	2
M ₂ > M ₁	4.4	6

Table 5. Crown indices, modules, and areas (in mm) of the permanent teeth of modern Icelanders

Tooth	Sex	N	Crown index§		Crown module¶		Crown area	
			\bar{x}	s	\bar{x}	s	\bar{x}	s
I ¹	♂	217	82.53	5.78	8.14	0.42	65.78	6.88
	♀	274	82.59	4.99	7.97‡	0.42	63.03‡	6.73
	♂ + ♀	491	82.56	5.35	8.05	0.42	64.25	6.79
I ²	♂	113	96.59	7.51	6.71	0.46	45.20	6.24
	♀	172	95.54	6.24	6.66	0.47	44.51	6.25
	♂ + ♀	285	95.96	6.76	6.68	0.47	44.78	6.25
C	♂	112	105.30	5.85	8.37	0.45	70.17	7.43
	♀	155	104.43	4.87	7.97‡	0.42	63.62‡	6.63
	♂ + ♀	267	104.80	5.29	8.14	0.43	66.37	6.96
P ¹	♂	196	130.70	5.77	8.32	0.46	68.23	7.55
	♀	239	130.17	5.44	8.13‡	0.45	65.11‡	7.19
	♂ + ♀	435	130.41	5.59	8.22	0.45	66.52	7.35
P ²	♂	177	139.20	6.23	8.25	0.48	66.38	7.70
	♀	211	137.22†	5.63	8.10‡	0.46	64.21†	7.25
	♂ + ♀	388	138.12	5.90	8.17	0.47	65.20	7.45
M ¹	♂	264	108.65	4.36	11.45	0.50	131.08	11.41
	♀	267	107.87*	4.48	11.12‡	0.51	123.61‡	11.27
	♂ + ♀	531	108.26	4.42	11.28	0.51	127.32	11.33
M ²	♂	70	116.68	7.65	10.95	0.59	119.45	12.62
	♀	87	115.88	6.77	10.58‡	0.56	111.58‡	11.63
	♂ + ♀	157	116.24	7.15	10.75	0.57	115.09	12.04
I ₁	♂	190	109.14	8.31	5.83	0.31	33.93	3.60
	♀	291	108.53	6.83	5.71‡	0.32	32.66‡	3.61
	♂ + ♀	481	108.77	7.44	5.76	0.32	33.16	3.60
I ₂	♂	139	105.36	7.29	6.27	0.31	39.31	3.84
	♀	246	105.73	6.81	6.17†	0.32	38.15†	4.01
	♂ + ♀	385	105.60	6.98	6.21	0.32	38.57	3.94
C	♂	94	110.11	6.84	7.41	0.40	54.90	5.93
	♀	192	109.39	5.98	7.09‡	0.37	50.30‡	5.20
	♂ + ♀	286	109.63	6.26	7.20	0.38	51.81	5.44
P ₁	♂	172	109.73	5.98	7.65	0.41	58.54	6.30
	♀	232	108.67	6.19	7.41‡	0.42	54.90‡	6.21
	♂ + ♀	404	109.12	6.09	7.51	0.42	56.45	6.24
P ₂	♂	151	116.61	6.86	8.09	0.49	65.18	7.80
	♀	180	116.27	6.48	7.86‡	0.47	61.55‡	7.27
	♂ + ♀	331	116.43	6.65	7.97	0.48	63.21	7.51
M ₁	♂	209	95.51	4.36	11.18	0.45	125.03	10.05
	♀	214	96.34*	3.74	10.87‡	0.48	118.41‡	10.53
	♂ + ♀	423	95.93	4.05	11.02	0.47	121.68	10.28
M ₂	♂	69	98.34	4.52	10.77	0.51	116.14	10.82
	♀	107	98.24	4.12	10.39‡	0.55	108.21‡	11.41
	♂ + ♀	176	98.28	4.27	10.54	0.53	111.32	11.15

Abbreviations and symbols are explained in Table 1.

§ Crown index = (buccolingual diam. × 100)/mesiodistal diam.

¶ Crown module = (mesiodistal diam. + buccolingual diam.)/2.

|| Crown area (robustness) = mesiodistal diam. × buccolingual diam.

The sexual dimorphism in crown size was not nearly so great as in Ohio Caucasians (15), who share racial origins with the Icelanders to a considerable extent. The rank order correlation coefficient between MD and BL size dimorphism (Spearman's rho) was 0.56, which is statistically significant ($p < 0.05$) in contrast to Ohio Caucasians. The very low dimorphism of the BL dimension of lower canines in Ohio Caucasians (13, 16) differs remarkably from the high dimorphism in Icelanders and several other populations (15). The existence of the canine 'field' of sexual dimorphism (14) receives little support from the present study.

Metric and morphologic reduction during hominid evolution has been greatest in the most distal members of each morphologic class (8, 35). The MSS $M1 > M2$ can therefore be expected to be commonest in modern man. When tested statistically, however, the MSS did not seem to distinguish between fossil and modern man (12). According to Garn et al. (12) and Devoto et al. (9), the possible taxonomic value of the MSS is restricted to the subspecies level. The MSS encountered in the Icelanders is in line with the evolutionary expectations, and in sharp contrast with the MSS in Ohio Caucasians, in whom no less than 33% of the upper molars showed the MSS $M2 > M1$.

A comparison between Icelanders, Ohio Caucasians, and five American Indian populations (9, 12, 17) revealed a statistically significant difference between Icelanders and Ohio Caucasians (maxillary MSS: chi-square = 56.28, $df = 2$, $p < 0.001$; mandibular MSS: chi-square = 6.12, $df = 2$, $p < 0.05$) and a close resemblance of Icelanders to some of the Indian populations. The conclusion appears to be that the MSS has less taxonomic value than believed even at the subspecies level. It is possible, however, that the difficulty of measuring the MD diameter of upper molars has some bearing on the unexpected difference between the two racially close populations.

The tooth shape ratios (crown indices) were similar in pattern in both sexes but they were larger for males in 11 of 14 teeth. In accordance with Lunt (25) and Thomsen (36) but contrary to the findings of Garn et al.

(16) sex differences in crown form were small, much smaller than the systematic sex differences in the MD and BL diameters, reaching statistical significance on upper P2 and M1 and lower M1 only. In 12 out of 14 teeth the coefficient of variation of crown shape was larger for males than females. The lateral incisor showed the greatest variability of crown shape in the maxilla, and the central incisor in the mandible. First molars showed greatest stability in crown form.

In conclusion, many odontometric characteristics of Icelanders proved to be distinctly different from the corresponding characteristics of Ohio Caucasians, who are also of Northwest European origin. In particular, the crown size was larger and the sexual dimorphism smaller than expected.

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