Transverse Dental and Dental Arch Depth Dimensions in the Mixed Dentition in a Skeletal Sample from the 14th to the 19th Century and Norwegian Children and Norwegian Sami Children of Today

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Abstract: Secular changes in transverse dental arch dimensions and dental arch depth were studied. Four cohorts with mixed dentitions were selected. The skull group comprised 48 skulls dating from the 14th to the 19th century and belonging to The Schreiner Collection at the Department of Anatomy, University of Oslo. The 1980s Sami group was comprised of 39 boys and 34 girls born in 1987 and living in the northern part of Norway. The 1960s Oslo group was comprised of 31 boys and 30 girls born in 1963 and living in the southern part of Norway. The 1980s Oslo group was comprised of 32 boys and 26 girls born in 1983 and living in the same area in southern Norway as the previous Oslo group. Sex was unknown in the skeletal sample, and the groups were analyzed with the sexes pooled; separate descriptive values are presented for the modern groups. The mandibular intercanine distance was smaller in the skulls compared with the modern groups. The transverse intermaxillary difference between the molars was larger in the skull group than in the 1980s Oslo group. The difference between the maxillary and mandibular intercanine distances was larger in the skulls compared with the modern groups, although the small number of measurements in the skull group impeded further analysis. The arch depth was smaller in the skull group compared with the modern groups; the 1960s Oslo group deviated because of a higher prevalence of caries in the second deciduous molars. The overjet was smaller among the skulls. The arch form measured as the angle between the left and right molar tooth rows was more acute in the skulls than in the modern groups. It was concluded that smaller arch depths are found in skeletal samples at early ages and that attrition does not explain the more upright incisors found in skeletal samples. A secular trend was found in the intermaxillary relation, which indicated that children in the 1980s Oslo group were at greater risk of developing a posterior cross-bite than children born in the 14th to 19th centuries. (*Angle Orthod* 2002;72:439–448.)

Key Words: Child; Dental arch/growth and development; Maxillofacial development; Health transition; Malocclusion/etiology; Dentition/anatomy and histology; Cross-bite

INTRODUCTION

Transverse dental arch dimensions are important in the development of the dentition. Deviations from the normal occlusion include the lateral cross-bite and the scissors-bite. A relatively narrow maxilla can develop into a lateral cross-bite, but this process is gradual. Measurements of the transverse distance are a better method for scientific purposes if more subtle differences are being investigated.

Some authors have suggested that there is an increased prevalence of malocclusion not only for shorter periods of time,[1–4] but also for longer periods of time.[5–8] Altered intermaxillary transverse relations are one of the findings in studies that compare skeletal samples with contemporary samples. One aspect often discussed in this context is the change in dietary habits that have occurred during the last centuries.[7,9,10] The texture of food has become finer because of food processing, and is considered less demanding on the masticatory muscles and teeth. This lower chewing activity would lead to alterations in facial development[11] and

narrower maxillary arches, as has been shown in animal experiments.[12–14] That the texture of food is less demanding has also been discussed in the context of short-term changes. Arch width and arch depth are dependent on each other. A change in a transverse dimension will affect arch depth if the arch perimeter remains unchanged.[15,16] One study on skeletal remains found shorter arch depths in a medieval sample compared with a modern group,[17] and a shorter maxilla was found in a cephalometric investigation of medieval skulls.[18]

When comparisons are made with skeletal samples, the dimensional changes that occur post-mortem must be considered. Cranial dimensions have been found to shrink post-mortem. Shrinkage has been estimated to be in the range of 0.3% to 1.7%. Larger changes occur in the posterior parts of the mandible where there is no bony support in the transverse direction.[19–22]

The purpose of the present investigation was to examine differences in transverse arch dimensions and arch depth in the mixed dentition in four groups living under different conditions at different time periods. The study comprised a skeletal group, a group of Sami children born in the 1980s and brought up in a comparatively traditional way, a group of Norwegian children born in the 1960s, and a group of Norwegian children from the same area born in the 1980s.

MATERIALS AND METHODS

The skull group

The skull material was from The Schreiner Collection at the Department of Anatomy, University of Oslo. The collection consists of skulls from different parts of Norway. The majority of the material is from the 14th to the 16th century, but the collection also contains more recent material. The skulls in the group chosen for this study are considered to originate from the 14th to the 19th century.[23] They are stored at 21°C, 40% relative humidity. All the skulls in the collection with a mixed dentition were selected for the study. Inclusion criteria were:

a. The permanent incisors and the permanent first molars were in full eruption or had been lost post-mortem. Cases where the permanent lateral incisors had not erupted completely were also included.
b. The deciduous second molars, deciduous first molars, and deciduous canines were in place or had been lost post-mortem. The deciduous canines did not have to be present if they were thought to have been lost because of space problems.
c. The permanent second molars were covered by bone or were judged to be unerupted.

These inclusion criteria were designed to ensure that the skulls in the skull group were from children who were eight to 11 years of age and had a mixed dentition. Forty-eight skulls were selected according to these criteria. According to the registration cards, six of the selected crania were of Sami descent. The condition of the crania differed, therefore, the number of measurements taken varied. Ten skulls lacked mandibles.

The 1980s Sami group

Seventy-three nine-year-old children of Sami origin born in 1987 and living in the northern part of Norway were selected for the study. This group was comprised of 39 boys with a mean age of 8.9 years (SD 3.7 months) and 34 girls with a mean age of 8.9 years (SD 3.4 months). The children were from nomadic families in the villages of Karasjok and Kautokeino. These families moved with their reindeer to the mountain plateaux in the summertime. These children were brought up in a more traditional way: they were introduced to hard foods at an early age and often ate dried meat and hard bread.[24] Children with a history of orthodontic treatment or prolonged sucking habit extending past four years of age were excluded.

The 1960s and the 1980s Oslo groups

A total of one hundred nineteen nine-year-old children were selected for these two groups. One group included 31 boys with a mean age of 9.3 years (SD 4.0 months) and 30 girls with a mean age of 9.2 years (SD 3.6 months) from the University of Oslo growth archive and born in 1963. A second group included 32 boys with a mean age of 9.4 years (SD 3.1 months) and 26 girls with a mean age of 9.3 years (SD 3.5 months) from the same area and born in 1983. Children with a recent history of immigration (the last two generations) were excluded. Children with a history of orthodontic treatment or prolonged sucking habit extending past four years of age were excluded.

Measurements

Measurements in the skull group were made directly on the skulls. Measurements in the other groups were made on dental casts. All measurements were made by one of the authors (RL) using a sliding caliper.

The distance between the right and left maxillary first molars was recorded. The minimal intermolar distance at the gingival margin, the intermolar distance between the tips of the mesiobuccal cusps, and the intermolar distance between the central fossae were recorded. The intermolar distance in the mandible was measured as the distance between the tips of the first molar mesiobuccal cusps and the shortest intermolar distance as the distance between the lingual surfaces at the gingival margin. If the cusp tips were abraded, the assumed center of the abraded area was used.

Maxillary and mandibular intercanine distances were measured between the cusp tips of the deciduous canines and, in cases of abrasion, the assumed center of the abraded area was used (Figure 1). Some children lacked deciduous
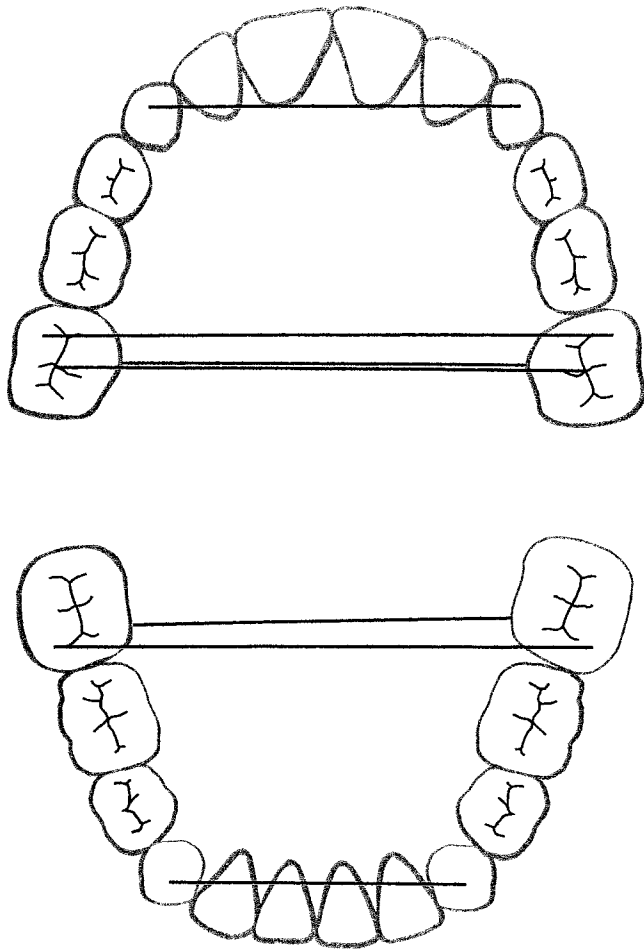
FIGURE 1. Points used for the transverse measurements.

FIGURE 2. Points and lines used for the measurements of arch depth and angle between the left and right molar tooth rows.

canines, therefore, the intercanine distance could not be registered. The permanent canine was never used.

Arch depth was defined as the perpendicular distance from the first permanent molars to the incisors. A line connecting the mesial surfaces of the permanent first molars was the posterior measurement point, and the tangent to the buccal surfaces of the incisors was the anterior measurement point. The perpendicular distance between these lines was defined as arch depth (p in Figure 2).

The angle between the left and right molar teeth was measured with a protractor parallel to the occlusal plane. The best fitting lines passing through the buccal cusps of the first permanent molar, the second deciduous molar, and the first deciduous molar were used. This intermolar angle was measured in both the maxilla and the mandible (Figure 2).

The difference between maxillary and mandibular arch widths was used to evaluate relative widths within the groups. The central fossae and the mesiobuccal cusps in the maxillary first permanent molars were used to determine whether mesiopalatal rotation of the molars might have a greater effect on the transverse distance measured at the mesiobuccal cusps. The number of registrations in the
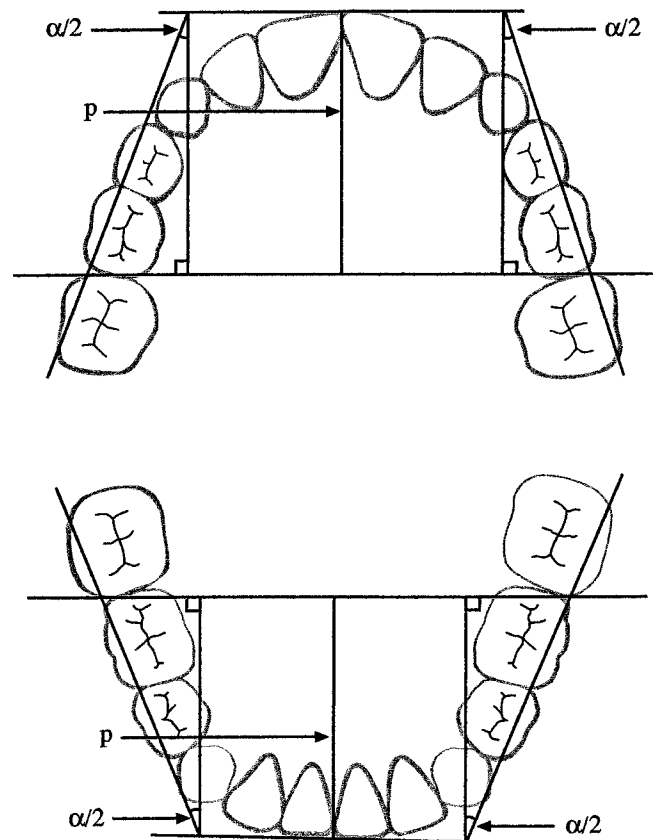
groups differs since measurements were made only when the measurement points could be accurately identified.

Comparisons between groups were made with the sexes pooled since sex in the skeletal sample was unknown. Separate values for the boys and the girls are shown in the modern cohorts. An analysis of variance (ANOVA) and the Games and Howell post hoc test were used to analyze the groups. This post hoc test was chosen since the sizes of the groups varied. The level of significance was set at $P < .05$.

Measurements were repeated on 15 models and 11 skulls one month or more after the first measurement. Systematic errors were tested for using paired t-tests. Measurement error was calculated using the formula $Se = \sqrt{S_d^2/2}$. The level of significance was set at $P < .05$.

The errors in the transverse measurements were 0.1 to 0.4 mm. The 0.4-mm errors were made in the skulls in the maxillary first permanent intermolar distance measured at the central fossae and in the mandibular first permanent intermolar distance measured at the mesiobuccal cusps. The measurement error in the perpendicular distance from the first permanent molars to the incisors (arch depth) was 0.2–0.3 mm, as was the error in the overjet measurement. The overjet measurement in the skulls also had an inherent error because of the placement of the jaws in relation to each other. Error tended generally to be larger for the skulls than

for the models (0.0–0.1 mm). Errors in the angular measurements between the molar tooth rows were 0.7°–1.5°. The angular measurements between the molar tooth rows in the mandibles of the skulls had a systematic error (0.7°), the second registration being smaller than the first. No systematic errors were detected in the other measurements.

RESULTS

The intermolar and the intercanine distances are shown in Table 1. The intermolar and the maxillary intercanine distances did not differ among the groups. The mandibular intercanine distance was smaller in the skulls compared with the 1980s Sami group ($P <. 01$) or the 1960s Oslo group ($P < .05$).

Arch depth and intermolar angle are shown in Table 2. Maxillary arch depth was smaller in the skulls compared with the 1980s Sami group ($P < .05$), the 1980s Oslo group ($P < .001$), or the 1960s Oslo group ($P < .01$). The same maxillary distance was also smaller in the 1960s Oslo group compared with the 1980s Oslo group ($P < .05$). The mandibular arch depth was smaller in the skulls compared with the 1980s Sami group ($P < .01$) or the 1980s Oslo group. The intermolar angles in the maxilla and in the mandible were smaller in the skulls compared with the other groups ($P < .001$).

Table 3 presents the intermaxillary differences in the transverse dimensions and arch depth. The difference between the maxillary and the mandibular intermolar widths measured at the mesiobuccal cusps was larger in the skulls compared with the 1980s Oslo group ($P <.05$). The difference between the maxillary intermolar width measured at the central fossae and the mandibular intermolar width measured at the mesiobuccal cusps was larger in the skulls compared with the 1980s Sami group ($P < .05$) or the 1980s Oslo group ($P < .001$). The difference between the maxillary and the mandibular intermolar widths measured at the lingual surfaces was larger in the skulls compared with the 1980s Oslo group ($P < .01$). The difference between the maxillary and the mandibular intercanine distances was significantly different among the groups ($P < .05$), but there were too few skull measurements to detect any other differences with certainty. The intermaxillary difference in arch depth was smaller in the skulls compared with the 1980s Oslo group ($P < .01$). The overjet was smaller in the skulls compared with the other groups ($P < .001$).

DISCUSSION

Transverse dental arch dimensions and arch depth were studied in the mixed dentition in different ethnic groups living at different periods of time. Four groups were examined: a skeletal sample; two groups from the Oslo area, one born in the 1960s and one in the 1980s; and a group of Sami descent born in the 1980s. Sex-pooled values were

used since sex was unknown in the skeletal sample. The main findings were smaller arch depths and a different angle between the left and right molar teeth in the skeletal sample compared with the modern groups. The transverse intermaxillary relations differed between the 1980s Oslo group and the skeletal sample.

The form of the dental arch in the skulls differed compared with the arch forms in the modern groups. The differences in maxillary intercanine distance (deciduous canines) between the groups were nonsignificant, although the mean in the skull group was among the larger means when one percent shrinkage was assumed. In the mandible, however, the distance between the deciduous canines was shorter in the skulls compared with the modern samples, though not significantly so compared with the 1980s Oslo group. This becomes more evident when the intermaxillary differences in intercanine distances are compared. In the ANOVA, this difference varied among the groups ($P < .05$), but the number of measurements in the skull group (nine) was too small for a difference to be detected in further analysis. In some skulls, however, the intercanine distance could be measured in either the maxilla or the mandible. Taking these additional values into consideration did not change the overall impression that the transverse intermaxillary relation at the deciduous canines in the skulls differed from that in the modern groups. This is an important finding. The intermaxillary intercanine relation was one of the most influential factors in the development of a posterior cross-bite in a study on three-year-old children.[25] In another study of children from birth to three years of age, the teeth in the children that had an interfering contact in centric relation were the deciduous canines. This means that the intercanine relation is important in the development of a posterior cross-bite. These findings are related to sucking habits.[26] Posterior cross-bite is also a part of a Class III malocclusion. The intercanine relation can have the same influence in a mild Class III malocclusion, but it has no influence on the centric relation in a severe Class III malocclusion.

A difference in the transverse intermaxillary relation at the molars was found mainly between the 1980s Oslo group and the skulls. In a previous study, a reduction in the transverse intermaxillary relation was found between children born in the 1980s and children born in the 1960s. This reduction was discovered when the sexes were analyzed separately in a larger sample that included Swedish children.[27] Sex-pooled values were used in the present study, which reduced the power of the analysis. On the other hand, this means that the difference between the skulls and the children born in the 1980s is probably a true finding. The contemporary children were of the same age and the skeletal group was selected according to dental development. This inevitably led to a greater variation in age in the skeletal group. Dental arch size is dependent on the stage of eruption in the anterior part of the arch where tooth size is a determining factor.[28,29] In the posterior part, there is an

TABLE 1. Intermolar and Intercanine Distances[a]

(mm)	Skull Group (Sk)	1980s Sami Group (Sa)		1960s Oslo Group (O63)		1980s Oslo Group (O83)	
		Girls	Boys	Girls	Boys	Girls	Boys
Maxillary intermolar distance at the mesiobuccal cusps of the first molars	n	34	39	30	31	26	32
	mean	49.42	51.49	49.41	50.51	49.24	50.32
	SD	2.0	2.06	2.72	2.37	2.47	3.07
	n 47	73		61		58	
	mean 50.20	50.53		49.97		49.83	
	SD 2.07	2.27		2.59		2.84	
	P						
Maxillary intermolar distance at the central fossae of the first molars	n	34	39	30	31	26	32
	mean	45.00	46.76	45.19	46.21	44.70	45.66
	SD	2.17	2.04	2.53	2.16	2.23	2.78
	n 47	73		61		58	
	mean 46.11	45.94		45.71		45.23	
	SD 2.05	2.27		2.38		2.57	
	P						
Maxillary intermolar distance at the lingual surfaces of the first molars	n	34	39	30	31	26	31
	mean	32.64	33.63	32.47	32.90	31.96	32.32
	SD	2.06	2.03	2.47	2.12	1.98	2.58
	n 47	73		61		57	
	mean 33.12	33.17		32.69		32.16	
	SD 1.94	2.09		2.29		2.31	
	P						
Mandibular intermolar distance at the mesiobuccal cusps of the first molars	n	34	38	30	30	26	32
	mean	43.31	44.77	43.43	43.84	42.97	44.51
	SD	2.24	2.39	2.37	2.59	2.58	2.72
	n 38	72		60		58	
	mean 43.57	44.08		43.64		43.82	
	SD 2.19	2.42		2.47		2.75	
	P						
Mandibular intermolar distance at the lingual surfaces of the first molars	n	32	36	29	31	26	32
	mean	31.43	32.25	31.88	31.89	31.00	32.22
	SD	1.96	2.01	2.10	2.05	2.09	2.39
	n 37	68		60		58	
	mean 31.49	31.87		31.88		31.67	
	SD 1.89	2.01		2.06		2.32	
	P						
Maxillary intercanine distance	n	30	38	23	28	26	30
	mean	31.91	33.03	31.34	31.99	31.67	32.11
	SD	1.75	1.87	1.47	2.10	1.67	1.94
	n 14	68		51		56	
	mean 32.16	32.53		31.70		31.91	
	SD 1.55	1.89		1.85		1.82	
	P						
Mandibular intercanine distance	n	23	36	18	20	25	30
	mean	26.27	27.20	26.36	26.83	25.85	26.59
	SD	1.77	1.53	1.54	1.82	1.57	1.91
	n 15	59		38		55	
	mean 25.23	26.84		26.61		26.26	
	SD 1.38	1.67		1.69		1.79	
	P **/Sa */O63						

[a] SD indicates standard deviation; n, number of patients; intermolar distance, distance between the left and right molars in either the mandible or the maxilla; intercanine distance, distance between the left and right deciduous canines in either the mandible or the maxilla.

* $P < .05$; ** $P < .01$.

TABLE 2. Arch Depth and Arch Form (Intermolar Angle)[a]

(mm)		Skull Group (Sk)	1980s Sami Group (Sa)		1960s Oslo Group (O63)		1980s Oslo Group (O83)	
			Girls	Boys	Girls	Boys	Girls	Boys
Maxillary arch depth (mm)	n		34	38	30	30	26	32
	mean		29.20	30.22	28.57	29.99	29.90	30.71
	SD		2.06	2.08	2.03	2.15	2.36	1.67
	n	30	72		60		58	
	mean	27.79	29.74		29.28		30.35	
	SD	1.74	2.12		2.19		2.04	
	P	***/Sa **/O63 ***/083			*/O83			
Mandibular arch depth (mm)	n		34	38	30	31	26	32
	mean		25.41	26.10	25.19	25.36	25.62	26.14
	SD		1.29	1.90	1.77	1.66	1.30	1.22
	n	32	72		61		58	
	mean	24.63	25.78		25.27		25.91	
	SD	1.66	1.67		1.70		1.27	
	P	**/Sa **/O83						
Maxillary intermolar angle (°)	n		34	29	30	31	26	32
	mean		37.1	38.7	38.3	36.6	37.8	37.7
	SD		3.3	3.1	2.7	4.6	3.8	3.2
	n	40	73		61		58	
	mean	34.1	83.0		37.4		37.8	
	SD	3.3	3.3		3.8		3.5	
	P	***/Sa ***/O63 ***/O83						
Mandibular intermolar angle (°)	n		34	39	30	31	26	32
	mean		36.9	38.6	38.8	37.0	37.8	38.3
	SD		2.7	3.5	2.4	3.3	3.8	2.8
	n	36	73		61		58	
	mean	35.3	37.8		37.9		38.1	
	SD	2.9	3.2		3.0		3.3	
	P	***/Sa ***/O63 ***/O83						

[a] SD indicates standard deviation; n, number of patients; arch depth, the perpendicular distance between the first permanent molars and the incisors (see p in Figure 2); intermolar angle, angle between the best fitting lines passing through the buccal cusps of the first permanent molars, the second diciduous molars, and the first deciduous molars.

* $P < .05$; ** $P < .01$; *** $P < .001$.

annual increase in maxillary first permanent molar width of about 0.5 mm in the ages eight to 11 years.[30] An increase in the width of the first permanent intermolar of 2.0 to 2.4 mm (female–male) in the maxilla and of 0.9 to 1.3 mm (female–male) in the mandible was found between eight and 13 years of age.[31] Knott,[30] on the other hand, found an increase of 1.5 to 1.7 mm (female–male) in the maxilla and 1.5 to 1.7 mm (female–male) in the mandible from nine to 13 years of age. That the range of ages of the children in the skeletal sample would be this large is unlikely. The standard deviation of the transverse arch measurements is, for instance, not larger in the skeletal sample than in the modern groups. The transverse intermaxillary registrations are less influenced by any differences in age.

In adults, the common finding is no change, or only small changes, in intermolar widths. In one study, no change was found between 26 and 45 years of age.[31] In another, a decrease in mandibular intermolar width of 0.6 to 0.9 mm (male–female) was found between 17 and 48 years of age and the maxilla showed insignificant changes in the same direction.[32] In a third study, a significant increase in maxillary and mandibular intermolar widths of 0.3 to 0.4 mm was found in a group between 23 and 34 years of age.[33] An exception is the study by Harris,[34] who also studied the

TABLE 3. Differences Between Maxillary and Mandibular Transverse Distances, Arch Depths, and Overjet[a]

(mm)	Skull Group (Sk)	1980s Sami Group (Sa)		1960s Oslo Group (O63)		1980s Oslo Group (O83)	
		Girls	Boys	Girls	Boys	Girls	Boys
Difference between intermolar distances at the mesiobuccal cusps of the first molars n		34	38	30	30	26	32
mean		6.11	6.72	5.98	6.69	6.26	5.81
SD		1.42	1.31	2.40	1.44	1.49	1.57
n	37	72		60		58	
mean	6.98	6.43		6.33		6.01	
SD	1.74	1.39		1.99		1.54	
P	*/O83						
Difference between intermolar distances at the central fossae of the first molars (maxilla) and at the mesiobuccal cusps of the first molars (mandible) n		34	38	30	30	26	32
mean		1.69	1.97	1.76	2.39	1.72	1.15
SD		1.46	1.29	2.32	1.13	1.40	1.40
n	37	72		60		58	
mean	2.79	1.84		2.08		1.41	
SD	1.58	1.37		1.83		1.42	
P	*/Sa ***/O83						
Differences between intermolar distances at the lingual surfaces of the first molars n		32	36	29	31	26	31
mean		1.08	1.63	0.68	1.01	0.96	0.11
SD		1.41	2.33	2.23	1.68	1.28	1.63
n	36	68		60		57	
mean	1.77	1.37		0.85		0.50	
SD	1.78	1.95		1.96		1.53	
P	**/O83						
Difference between intercanine distances n		21	36	16	19	23	28
mean		5.72	5.77	4.98	5.40	5.81	5.52
SD		2.36	1.69	1.79	1.96	1.58	1.59
n	9	57		35		51	
mean	7.19	5.75		5.21		5.65	
SD	1.92	1.94		1.86		1.58	
P*							
Difference between arch depths n		34	37	30	30	26	32
mean		3.79	4.26	3.83	4.64	4.28	4.57
SD		1.86	1.67	1.53	1.79	1.85	1.19
n	27	71		60		58	
mean	3.26	4.03		4.01		4.44	
SD	1.44	1.77		1.77		1.51	
P	**/O83						
Overjet n		34	38	30	30	26	32
mean		3.53	3.76	3.10	4.10	3.31	3.94
SD		1.61	2.31	1.90	2.04	1.48	1.82
n	27	72		60		58	
mean	2.27	3.65		3.60		3.65	
SD	0.53	2.00		2.01		1.69	
P	***/Sa ***/O63 ***/O83						

[a] SD indicates standard deviation; n, number of patients; arch depth, the perpendicular distance between the first permanent molars and the incisors (see p in Figure 2); intermolar distance, distance between the left and right molars in either the mandible or the maxilla; intercanine distance, distance between the left and right deciduous canines in either the mandible or the maxilla.
* $P < .05$; ** $P < .01$; *** $P < .001$.

largest time span from 20 to 55 years of age. He found an increase in both maxillary and mandibular arch widths of 2.3 to 2.4 mm. These differences have no obvious explanation. One interesting finding is that all these longitudinal data report change, or sometimes no change, in the same direction and of the same magnitude in both the maxilla and the mandible. The differences found in intermaxillary relation in the present study cannot be assumed to improve in the modern groups.

The things that were not found are also interesting. The Sami group was brought up in a more traditional way and children that were nomadic in the summertime were selected for this study. This does not mean that they were not influenced by modern habits. It can be assumed that modern facilities were available to them, but that they continued to practice some of their traditional habits. Greater chewing demands and a more traditional way of living have been suggested to contribute to a lower prevalence of transverse occlusal discrepancies.[1,3,35] The measurements made on the Sami children in the present study do not differ from those made in the other modern groups. One explanation could be that the diet of the Sami children was more similar than expected to the diet of the Oslo children. Another possible explanation for secular changes in the transverse dimensions is the improved nutritional status that has occurred during the last century, which is the likely cause of the increase in body height in modern populations.[36–40] This change in body height is also apparently associated with a change in head shape.[41,42] The head was found to be narrower and longer in schoolchildren in Jena, Germany, in 1995 than in 1944, and their height also increased during this period.[42] Although the correlation between width of the head and dental arch size is low,[43–45] better nutrition, which can be assumed among the contemporary groups compared with the skeletal sample, might influence not only dental arch development but also body height and head shape.

The smaller intercanine width found in the mandible is a sign of more crowding in the skeletal group compared with in the modern groups. In a longitudinal study on mandibular incisors from the ages of seven to 10 years, a smaller intercanine distance was found to be associated with crowding.[46] This must be related to tooth size but is nevertheless contrary to the findings of a lesser prevalence of crowding in skeletal samples.[6]

The arch depth was smaller in the skulls compared with the modern samples. The mean arch depth in the 1960s Oslo group was slightly smaller than in the two 1980s groups. This was because of a greater prevalence of caries in the deciduous molars in the 1960s Oslo group.[47] Despite a low prevalence of caries, the arch depths in the skulls were smaller than in the other groups. This difference was larger in the maxilla than in the mandible. The intermaxillary difference in arch depth was greater in the modern samples than in the skulls and significantly so when the 1980s Oslo group was compared with the skull group. This

contributed to the difference in overjet, which was smaller in the skulls than in the modern groups.

In a study comparing an adult modern sample and a 14th century skeletal sample considered to have deceased in their mid-twenties, maxillary and mandibular arch depths were found to be shorter in the skeletal sample. The difference in arch depth was larger in the maxilla than in the mandible, which agrees with the findings in the present study.[17] In a study comparing Swedish men deceased in 1810, and representing an otherwise healthy population with Swedish inductees in the 1970s, arch depth was also found to be smaller in the skeletal sample.[48] The difference in arch depth, however, was not larger in the maxilla than in the mandible.

The smaller arch depths found in skeletal samples are associated with more retroclined upper incisors, as has been found in cephalometric investigations. Luther[18] found that the maxillary incisors were 11° more retroclined in a skeletal sample compared with modern controls. Varrela[49] found a similar difference of 8°, as did Ingervall et al.[48] In another study on skeletal remains, the sample was divided into a slightly abraded and a severely abraded group. The retroclination of the maxillary incisors in the severely abraded group was 13° greater than in the slightly abraded group.[50] The inclination of the mandibular incisors is less clear-cut in comparisons of older and modern samples. Luther found more proclined mandibular incisors in the skeletal sample[18] and Varrela[49] found no difference between skeletal and modern samples, as did Ingervall et al.[48] The previously-mentioned study in which skeletal remains were divided into slightly abraded and severely abraded groups did not report the inclination of the mandibular incisors, but the interincisal angle in that study indicated that the mandibular incisors were more retroclined in the severely abraded group, although to a lesser extent than the maxillary incisors.[50] The arch depth measurements in this study indicate that the more retroclined maxillary incisors found in the skeletal samples were present in the mixed dentition. Between the times of mixed dentition and permanent dentition, arch depth decreases about 0.5 mm more in the mandible than in the maxilla[51] and continues to decrease thereafter at a similar rate in the maxilla and in the mandible.[52] That the difference in arch depth between the skeletal group and the three modern groups was larger in the maxilla than in the mandible or in the transverse dimensions is in accordance with a genetics study by Cassidy et al.[53] They found that heritability was lower for maxillary arch depth than for mandibular arch depth or arch width. They concluded that arch size had a modest genetic component.

CONCLUSION

Transverse dental arch dimensions and arch depth were studied in the mixed dentition of a skeletal sample, a Sami group born in the 1980s, and two groups of Norwegian

children from the Oslo area born in the 1960s and in the 1980s.

a. In the transverse dental arch dimension, a smaller mandibular intercanine distance was found in the skulls.
b. The intermaxillary difference in intermolar distance in the skull group was larger than in the 1980s Oslo group, indicating that the risk of developing a posterior cross-bite was greater for these Oslo children than for the other groups.
c. The intermaxillary difference in intercanine distance in the skull group was larger compared with the modern groups, indicating that the risk of developing a posterior cross-bite in the skull group was lower than in the modern groups. The number of skulls in this registration, however, was low.
d. The arch depths were smaller in the skulls compared with the modern groups. This is in accordance with the shorter arch depths that are found in adult skeletal materials when compared with adult modern samples. This indicates that the more upright maxillary incisor position found in skeletal samples is present at an early age and that dental attrition is not the only cause of this incisor position.
e. The overjet was smaller among the skulls, and although this is a less reliable registration, this finding was supported by the arch depth measurements in which the intermaxillary difference in arch depth was larger in the modern groups.
f. The dental arch form, as indicated by the angle between the left and right rows of molar teeth, was more acute in the skulls than in the modern groups.

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