Craniofacial structure of Japanese and European-American adults with normal occlusions and well-balanced faces

Kuniaki Miyajima, DDS, MS, PhD,[a] James A. McNamara, Jr., DDS, PhD,[b] Tetsushi Kimura, DDS,[c] Satoru Murata, DDS,[d] and Tetsuo Iizuka, DDS, DMS[e]
Nagoya, Japan, and Ann Arbor, Mich.

The purpose of this study is to compare two groups of adults from different races who were selected on the basis of having normal ("ideal") occlusions and well-balanced faces. The lateral cephalometric radiographs of 54 Japanese adults (26 men and 28 women) were compared with a sample of 125 adults (44 men and 81 women) of European-American ancestry. The samples were chosen by orthodontists of the same racial background as the sample selected. Each lateral cephalogram was traced and digitized, and differences between cephalometric measurements between groups were analyzed with completely randomized *t* tests. In comparison to the European-American sample, the Japanese sample, in general, was smaller in anteroposterior facial dimensions and proportionately larger in vertical facial dimensions. The facial axis angle was more vertical in Japanese subjects, indicating a more downward direction of facial development. On average, the subjects in the Japanese sample were more protrusive dentally, with a more acute nasolabial angle and a greater tendency toward bilabial protrusion. These differences, evident even in groups with so-called "well-balanced faces", indicate that fundamental variation exists in the craniofacial structure of Japanese and European-Americans. The results of this study support the premise that a single standard of facial esthetics is not appropriate for application to diverse racial and ethnic groups. (Am J Orthod Dentofac Orthop 1996;110:431-8.)

In today's multicultural society, racial and ethnic differences are assuming an increasing level of importance. In the past, the majority of patients in a given practice usually were from one or two racial or ethnic groups (e.g., Japanese in Tokyo, European-Americans and African-Americans in Chicago). Currently, metropolitan areas of the world have a much more diverse patient population, bringing with it a need to recognize that a single standard of facial esthetics may not be appropriate when making diagnostic and treatment planning decisions for patients from diverse racial and ethnic backgrounds.

[a]Associate Professor, Department of Orthodontics, School of Dentistry, Aichi-Gakuin University, Nagoya, Japan.
[b]Professor of Dentistry, Department of Orthodontics and Pediatric Dentistry, and Research Scientist, Center of Human Growth and Development, The University of Michigan, Ann Arbor, Mich.; private practice of orthodontics, Ann Arbor, Mich.
[c]Private practice in Nagoya, Japan.
[d]Faculty member, Department of Orthodontics, School of Dentistry, Aichi-Gakuin University, Nagoya, Japan.
[e]Professor and Chairman, Department of Orthodontics, School of Dentistry, Aichi-Gakuin University, Nagoya, Japan.
Reprint requests to: Dr. Kuniaki Miyajima, Department of Orthodontics, School of Dentistry, Aichi-Gakuin University, 2-11, Suemori-dori, Chikusa-ku, Nagoya, 464, Japan.

0889-5406/96/$5.00 + 0 **8/1/67955**

Standards of facial esthetics have begun to change worldwide as technology has facilitated global communication. For example, in Japan there has been a gradual shift in preference toward a flatter facial profile than that exhibited by the typical Japanese, due in part to the influence of Europeans and Americans who now are seen more frequently on Japanese television and in Japanese entertainment, business, and education, and who live side-by-side with Japanese families. Conversely, in more racially and ethnically diverse countries such as the United States, there appears to be a rebirth of ethnic pride. It is not uncommon to have a patient seek a treatment plan that is based in part on norms derived from his or her specific racial or ethnic group as, for example, in the extraction/nonextraction decision in African-American patients.

CEPHALOMETRIC NORMS

Within the orthodontic community, attempts have been made to quantify facial esthetics through cephalometric analysis, with virtually all the early cephalometric analyses based on sample populations of people of European-American ancestry.[1-6] In addition, most major longitudinal growth studies

are based on samples of people of European background.[7-12]

The first attempt to apply cephalometric analysis to ethnic groups other than those of European ancestry was published in 1951 by Cotton, Takano, and Wong[13] who independently applied the Downs analysis to African-Americans, Japanese-Americans, and Chinese-Americans. Since that time, various investigators have analyzed African-Americans,[14-19] Africans,[20-23] Chinese,[24] Indians,[25,26] and other ethnic groups.[27,28]

Many of the early publications concerning cephalometric norms for Japanese were published in the Japanese language[29-38] and thus were not readily available to the English-speaking orthodontist. Sakamoto[30] subdivided 371 Japanese subjects with normal occlusions into five groups according to age. He noted no sexual dimorphism until age 10 years and also reported that growth increments in male subjects were greater than in female subjects. In comparison to existing European-American standards, the Japanese had longer faces in absolute size and in facial pattern. The Japanese sample also was more retrognathic, with a more vertical direction of facial growth. Yamauchi[31] noted that the Japanese profile is characterized by a more protrusive labial region as compared with white populations.

Several studies have evaluated Japanese adults with normal occlusions and acceptable facial profiles.[34-36] For example, Yamauchi et al.[34] had male and female samples of 37 such subjects. They noted size differences between male and female subjects, the latter being smaller, especially in lower facial height. The degree of lower lip protrusion was greater in male subjects than in female subjects. Ito and Suematsu[36] evaluated 38 Japanese women with normal occlusions and acceptable profiles. They reported that the subjects in this sample showed the greatest variation in lower facial dimensions in comparison to upper facial dimensions, with the greatest differences observed in the chin region.

Masaki[38] contrasted the craniofacial structure of 51 Japanese and 48 European-American children 7 to 15 years of age who had normal occlusions. No selection was made on the basis of facial esthetics. He noted that posterior cranial base length was longer in Japanese boys and girls, whereas anterior cranial base length was longer in white boys and girls. The Japanese sample had more retruded maxillae, steeper mandibular plane angles and y-axes, and larger lower anterior facial heights than did their European-American counterparts.

One of the first investigations published in English to consider Japanese cephalometric norms was by Uesato et al.[39] who analyzed a sample of 50 posttreatment lateral head films from orthodontic patients treated at a Japanese university and in a private practice in Hawaii. The sample of 25 male and 25 female patients of Japanese ancestry ranged in age from 11 to 18 years (mean, 14 years). Selection was on the basis of the status of the dentition (acceptable occlusions and incisor relationships) and the existence of a balanced facial profile, determined on the basis of the Ricketts[40] "E" (esthetic) line and the Steiner[3] "S" (soft-tissue) line. Lower lips that were positioned between these two lines were considered esthetically balanced. Uesato et al.[39] reported less variation from the published norms of Steiner[3] than did the investigation of Miura et al.[33] who did not select their Japanese sample on the basis of facial esthetics.

Other studies of Japanese craniofacial structure published in English include those of Engel and Spolter[41] and Nezu et al.[42] who sought to develop clinical and visual norms for Japanese patients that were similar in nature to those established previously for white patients by Rocky Mountain Data Systems, a commercial cephalometric laboratory. Engel and Spolter[41] concluded that Japanese patients have more protrusive dentitions and more vertical growth patterns than do their white counterparts. Nezu et al.[42] stated that the more retrusive profile evident in Japanese patients is due to a retruded chin position.

PURPOSE

A review of the literature reveals some apparent differences in craniofacial structure between persons of Japanese and European-American ancestry. The cephalometric studies of Japanese cited previously, however, often did not take facial esthetics into consideration when the samples were defined. One study that did select subjects on the basis of facial balance[39] analyzed the records of persons who already had undergone orthodontic treatment, and the cephalometric norms used to determine facial balance were derived from non-Japanese populations. No direct comparison of Japanese and European-American samples of untreated subjects with normal occlusions and well-balanced faces has been published to date.

It is the purpose of this study to present data on a sample of Japanese subjects selected by Japanese orthodontists who are compared with an untreated

sample of European-American subjects selected by American orthodontists on the basis of normal occlusions and well-balanced faces. By undertaking this comparison, an understanding of the underlying structural differences between these two racial groups may be obtained.

A global question addressed by this study is whether there indeed is a universal standard of facial esthetics. If there is a common standard of facial balance regardless of race or ethnic group, then the differences between groups selected on the basis of so-called "ideal facial esthetics" should be minimal. On the other hand, clear differences existing between these groups lend evidence to the existence of diverse esthetic standards, based in part on racially and ethnically based preferences.

MATERIALS AND METHODS

Samples

Two groups of untreated adults were compared in this study, one of Japanese origin and one of European-American origin.

Nagoya Sample. Subjects included in this group were selected from Japanese men and women, 20 to 25 years of age. Initially, a clinical examination was made to determine the status of the occlusion, and those subjects who were judged to have a normal (ideal) occlusion were selected. These subjects did not show rotation of teeth or crowding of the dental arches. In addition, these subjects had not undergone orthodontic treatment and also had no prosthetic replacement of teeth. The normal occlusion sample identified was a highly select group, representing far less than 1% of the available population of untreated persons.

The second step in subject identification was obtaining a lateral cephalogram. On the basis of the cephalogram, four Japanese orthodontists selected a subsample of subjects who were judged unanimously to have well-balanced faces. About half of the normal occlusion group were selected, resulting in a total of 26 men and 28 women.

Ann Arbor Sample. The Ann Arbor sample was composed of 44 men (average age 36 ± 10 years) and 81 women (39 ± 9 years) of European-American ancestry who were judged to have balanced facial esthetics and normal occlusions. After a normal occlusion sample was identified on the basis of a clinical examination, a subsample was selected for facial balance. On the basis of an untraced lateral head film, three American orthodontists unanimously agreed that each subject had a well-balanced face. The subjects in this sample also had no history of orthodontic treatment or extensive restorative dentistry. A more detailed description of the hard tissue measures is provided by McNamara and Ellis[43] and of the soft tissue measures by McNamara et al.[44]

Cephalometric Analysis

The lateral head film of each subject was traced by one investigator and checked for accuracy by another. The selected landmarks were digitized where the landmarks were converted to an X-Y coordinate system. Measures of craniofacial form were calculated by computer and tabulated by gender into skeletal, dental, and soft tissue relationships. The angular and linear measurements chosen were derived, in part, from the analysis developed by McNamara.[45-47] The error of the method has been reported elsewhere.[47]

Statistical Analysis

Standard descriptive statistics (means and standard deviations) were calculated for both samples. Comparisons between the samples were conducted by means of completely randomized *t* tests.

RESULTS

Sexual Dimorphism

Table I presents the means and standard deviations of the measurements for the male and female Japanese samples. Of the 24 craniofacial measurements, 5 showed significant sexual dimorphism, 3 measures of which (Co-Point A, Co-Gn, ANS-Me) apparently reflected the expected average size differential between the men and women. One other notable difference was in the mandible, with the female Japanese subjects having a steeper mandibular plane angle (26.1°) than the male Japanese subjects (22.3°). No differences were observed in the dental or soft tissue measures, with the nasolabial angle slightly greater than 90° for both the men and women (Table I).

Sexual dimorphism in the Ann Arbor European-American sample also was noted (Table II). In general, the men were larger than the women, although there were no statistical differences in the positions of Point A and pogonion, relative to the nasion perpendicular, or in the mandibular plane angle or the facial axis angle. No difference was observed in the nasolabial angle (102° ± 8° for both genders), but the cant of the upper lip (relative to the nasion perpendicular) was more acute in the women (14° ± 8°) than in the men (8° ± 8°).

Nagoya-Ann Arbor Comparisons

Nagoya adults generally have smaller craniofacial dimensions than do Ann Arbor adults. Nagoya men (Table III) and women (Table IV) have smaller midfaces, as indicated by effective midfacial length (Co-Point A). However, although Nagoya men have shorter mandibles than do Ann Arbor men, no sta-

Table I. Adult Japanese occlusal, skeletal and facial variables. Comparison of group means between Nagoya female (n = 28) and male (n = 26) samples

Variable	*Female*		*Male*		*Significance*
	Mean	*SD*	*Mean*	*SD*	
Maxilla					
SNA angle	82.1	3.1	82.2	3.0	ns
Nasion perp. to Point A (mm)	2.3	2.7	2.5	3.4	ns
Angle of convexity	3.2	2.3	2.4	2.7	ns
Condylion to Point A (mm)	86.3	3.4	91.4	4.6	**
Mandible					
SNB angle	78.8	3.1	79.4	3.4	ns
Pogonion to nasion perp (mm)	−1.7	6.8	0.3	5.0	ns
Condylion to gnathion (mm)	118.8	4.7	125.5	5.1	**
Intermaxillary relationships					
ANB angle	3.3	1.8	2.8	2.0	ns
Wits appraisal (mm)	−1.7	2.3	−0.5	2.5	ns
Facial angle	89.3	3.2	90.2	2.3	ns
Occ. to SN angle	18.2	4.1	15.6	4.8	*
Mandibular plane angle	26.1	5.4	22.3	3.9	**
Facial axis angle (−90°)	−3.5	4.0	−4.2	3.2	ns
ANS-menton (mm)	72.7	4.4	75.1	4.1	*
Dentition					
Overjet (mm)	2.9	0.7	2.8	0.7	ns
Overbite (mm)	2.1	0.8	2.4	1.3	ns
Max. incisor to Point A vert (mm)	6.0	2.8	5.7	2.6	ns
Max. incisor to SN angle	104.4	6.1	103.9	5.5	ns
Mand. incisor A-Po (mm)	4.9	1.5	4.0	2.5	ns
Incisor mand. plane angle	93.2	5.3	95.4	7.2	ns
Soft tissue					
UL to E-line (mm)	−2.5	1.9	−2.9	2.2	ns
LL to E-line (mm)	0.9	1.9	−0.3	2.6	ns
Cant of upper lip (degrees)	17.9	5.4	17.1	9.0	ns
Nasolabial angle	92.2	8.7	90.7	10.4	ns

Perp., perpendicular; *Occ*, occlusal; *max*, maxillary; *Vert*, vertical; *mand*, mandible; *UL*, upper lip; *LL*, lower lip.
*$p < 0.05$; **$p < 0.01$; *ns*, not significant.

tistical differences were seen between the female samples with regard to the three cephalometric assessments of mandibular size and position. Lower anterior facial height (ANS-Me) was not statistically different between the two samples, but this measure was 6 mm longer in the Nagoya women than in the Ann Arbor women. The facial axis angle was more acute in Japanese of both genders.

No differences were seen in interdental measurements (overbite, overjet) or in the relationship of the upper incisor to the maxilla in either sex. The lower incisor was more procumbent in the Nagoya men and women than in their Ann Arbor counterparts.

Bilabial protrusion was evident in Nagoya men and women compared with the Ann Arbor samples (Tables III and IV). The nasolabial angle was more acute in the Japanese samples, and the upper lip was canted more anteriorly relative to the nasion perpendicular.

DISCUSSION

This investigation is the first to compare samples of untreated Japanese and European-American persons characterized as having normal occlusions and well-balanced faces. No previous study of racial differences has compared so-called "ideal" samples, although several studies have evaluated patients from one ethnic group with normal or ideal occlusions (e.g., European-American: Hellman,[48] Downs,[2] Riedel,[49] Casko and Shepard,[50] and Ben-Bassat et al.[51] Japanese: Sakamoto,[30] Miura et al.,[33] Shishikura,[35] Masaki,[38] Engel and Spolter,[41] and Nezu et al.[42]).

As mentioned earlier, all subjects in the Japanese sample of well-balanced faces analyzed by Uesato and colleagues[39] had undergone orthodontic treatment before analysis, and the criteria used for selection (lip contour and facial balance) had been established previously on European-American subjects. By focusing on the facial profile in addition to an acceptable occlusion, the values reported by Uesato et al.[39] were closer to the cephalometric norms recommended by Steiner[3] than were the values reported by Miura et al.[33] who studied a sample of Japanese persons with normal occlusions without consideration of the facial profile. The Miura sample showed an increased ANB

Table II. Adult European-American occlusal, skeletal, and facial variables. Comparison of group means between Ann Arbor female (n = 81) and male (n = 44) samples

Variable	Female		Male		Significance
	Mean	SD	Mean	SD	
Maxilla					
SNA angle	82.6	2.8	83.8	3.2	*
Nasion perp. to Point A (mm)	0.5	2.3	1.0	2.7	ns
Condylion to Point A (mm)	91.0	4.3	99.8	6.0	**
Mandible					
SNB angle	80.0	2.8	81.6	2.7	**
Pogonion to nasion perp (mm)	−1.8	4.5	−0.3	3.8	ns
Condylion to gnathion (mm)	120.2	5.3	132.3	6.8	**
Intermaxillary relationships					
ANB angle	2.5	1.4	2.2	1.8	ns
Wits appraisal (mm)	−0.9	2.2	−0.7	2.8	ns
Facial angle	89.1	2.8	89.8	1.7	ns
Occ. plane to SN angle	14.9	3.4	12.6	3.5	**
Mandibular plane angle	22.7	4.3	21.3	3.9	ns
Facial axis angle (−90°)	0.2	3.2	0.5	3.5	ns
ANS-menton (mm)	66.7	4.1	74.6	5.0	**
Dentition					
Overjet (mm)	3.6	0.9	3.3	1.0	ns
Overbite (mm)	2.7	1.0	2.8	1.3	ns
Max. incisor to Point A vert (mm)	5.4	1.7	5.3	2.0	ns
Max. incisor to SN angle	107.1	5.6	105.7	6.6	ns
Mand. incisor A-Po (mm)	1.8	1.7	1.3	2.3	ns
Incisor mand. plane angle	94.9	6.3	92.3	7.4	ns
Soft tissue					
Nasolabial angle	102.2	7.7	102.4	8.2	ns
Cant of upper lip (degrees)	13.7	8.2	8.4	7.8	**
UL to E-line (mm)	−5.7	1.9	−6.4	2.4	ns
LL to E-line (mm)	−3.2	2.0	−4.3	2.4	**

*$p < 0.05$; **$p < 0.01$; *ns*, not significant.

Table III. Adult male comparisons of group means between Ann Arbor (n = 44) and Nagoya (n = 26) samples

Variable	Ann Arbor		Nagoya		Significance
	Mean	SD	Mean	SD	
Maxilla					
Nasion perp. to Point A (mm)	1.1	2.7	2.5	3.4	ns
Condylion to Point A (mm)	99.8	6.0	91.4	4.6	**
SNA angle	83.8	3.2	82.2	3.0	*
Mandible					
Pogonion to nasion perp (mm)	−0.3	3.8	0.3	5.0	ns
Condylion to gnathion (mm)	132.3	6.8	125.5	5.1	**
SNB angle	81.6	2.7	79.4	3.4	**
Intermaxillary relationships					
ANB angle	2.2	1.8	2.8	2.0	ns
Wits appraisal (mm)	−0.7	2.8	−0.5	2.5	ns
Facial axis angle (−90°)	0.5	3.5	−4.2	3.2	**
Mandibular plane angle	21.3	3.9	22.3	3.9	ns
ANS-menton (mm)	74.6	5.0	75.1	4.1	ns
Dentition					
Overjet (mm)	3.3	1.0	2.8	0.7	ns
Overbite (mm)	2.8	1.3	2.4	1.3	ns
Max. incisor to Point A vert (mm)	5.3	2.0	5.7	2.6	ns
Max. incisor to SN angle	105.7	6.6	103.9	5.5	ns
Mand. incisor A-Po (mm)	2.3	2.1	4.0	2.5	**
Incisor mand. plane angle	92.3	7.4	95.4	7.2	ns
Soft tissue					
Nasolabial angle	102.4	8.2	90.7	10.4	**
Cant of upper lip (degrees)	8.4	7.8	17.1	9.0	**
Max. incisor to E-line (mm)	−6.4	2.4	−2.9	2.2	**
Mand. incisor to E-line (mm)	−4.3	2.4	0.3	2.6	**

*$p < 0.05$; **$p < 0.01$; *ns*, not significant.

Table IV. Adult female comparisons of group means between Ann Arbor (*n = 81) and Nagoya (n = 28) samples*

Variable	*Ann Arbor*		*Nagoya*		*Significance*
	Mean	*SD*	*Mean*	*SD*	
Maxilla					
Nasion perp. to Point A (mm)	0.4	2.3	2.3	2.7	**
Condylion to Point A (mm)	91.0	4.3	86.3	3.4	**
SNA angle	82.4	3.0	82.1	3.1	ns
Mandible					
Pogonion to nasion perp (mm)	−1.8	4.5	−1.7	6.8	ns
Condylion to gnathion (mm)	120.2	5.3	118.8	4.7	ns
SNB angle	80.0	2.8	78.8	3.1	ns
Intermaxillary relationships					
ANB angle	2.5	1.4	3.3	1.8	ns
Wits appraisal (mm)	−0.9	2.2	−1.7	2.3	ns
Mandibular plane angle	22.7	4.3	26.1	5.4	**
Facial axis angle (−90°)	0.2	3.2	−3.5	4.0	**
ANS-menton (mm)	66.7	4.1	72.7	4.4	**
Dentition					
Overjet (mm)	3.6	0.9	2.9	0.7	ns
Overbite (mm)	2.7	1.0	2.1	0.8	ns
Max. incisor to Point A vert (mm)	5.4	1.7	6.0	2.8	ns
Max. incisor to SN angle	107.1	5.6	104.4	6.1	ns
Mand. incisor A-Po (mm)	2.7	1.7	4.9	1.5	**
Incisor mand. plane angle	94.9	6.3	93.2	5.3	ns
Soft tissue					
Nasolabial angle	102.2	7.7	92.2	8.7	**
Cant of upper lip (degrees)	13.7	8.2	17.9	5.4	*
Max. incisor to E-line (mm)	−5.7	1.9	−2.5	1.9	**
Mand. incisor to E-line (mm)	−3.2	2.0	0.9	1.9	**

*$p < 0.05$; **$p < 0.01$; *ns,* not significant.

angle (4.5° versus 2.8° for the Uesato sample) and a greater tendency toward bialveolar protrusion. However, the standards for selection used by the Uesato group were ethnically biased, as the cephalometric criteria were derived from persons of European rather than Japanese ancestry, thus affecting the detection of racial differences.

Skeletal Relationships

In this study, distinct racial differences were found between Japanese and American men, especially in the vertical dimension (Table III). The facial axis angle of Ricketts[6] was more acute in the Nagoya sample (−4.2°) than in the Ann Arbor sample (0.5°). There was no difference in lower anterior facial height between groups; however, the smaller anteroposterior dimensions of the Japanese sample led to a relatively increased vertical facial dimension in this group in comparison to the Ann Arbor sample.

As with the male samples, the greatest skeletal differences between female samples were seen in vertical facial dimensions (Table IV). Lower anterior facial height was 72.7 mm in Japanese women and 66.7 mm in Ann Arbor women. As with the men, Nagoya women had a more vertically oriented facial axis angle (−3.5°) than did the Ann Arbor sample of women. In contrast to the men, the mandibular plane angle was statistically greater in Nagoya women (26.1°) than in Ann Arbor women (22.7°). Nagoya women had smaller midfacial lengths (as measured from condylion to Point A) than did Ann Arbor women, and Point A in Japanese women was more protrusive relative to the nasion perpendicular. The SNA angle, however, was not statistically different between groups. Mandibular dimensions also were similar between the two samples.

The results of this skeletal measure comparison of Japanese and European-Americans with normal occlusions and well-balanced faces generally were similar to the observations of other investigators who studied samples not selected on the basis of facial esthetics. For example, Sakamoto,[30] Masaki,[38] and Engel and Spolter[41] reported that Japanese subjects also appeared to have a more vertical mandibular growth pattern, as measured by lower anterior facial height and facial axis angle.

Dentitional Relationships

The most obvious difference in the dentition between samples was the position of the lower

incisor relative to skeletal structures (Table III). Mandibular dentoalveolar protrusion is more pronounced in Nagoya men, as indicated by the relationship of the lower incisor to the mandibular plane and to the A-Po line. No differences were observed in maxillary incisor position between racial groups.

As with the male samples, greater racial differences were observed in the position of the lower incisor than in the upper incisor between female samples (Table IV). The mandibular incisor was more protrusive relative to the A-Po line in Nagoya women than in Ann Arbor women, yet there was no difference in the relationship of the lower incisor to the mandibular plane between racial groups.

Similar findings were reported by Yamauchi[31] and Engel and Spolter,[41] among others, who concluded that Japanese persons appear to have more protrusive dentitions than their European-American counterparts, as indicated by the angle of convexity, the interincisal angle and maxillary incisor protrusion.

Soft Tissue Relationships

Perhaps the greatest racial differences were observed in the soft tissue profile. Even though all subjects were selected on the basis of having balanced facial profiles, the nasolabial angle was more acute and the cant of the upper lip was more protrusive in Nagoya men then in Ann Arbor men (Table III). Both the upper and lower lips were 3 to 4 mm more protrusive relative to the esthetic line of Ricketts[6,36] in Nagoya men than in Ann Arbor men.

The nasolabial angle was more acute in the Nagoya women (92.2°) than in the Ann Arbor women (102.2°; Table IV). Racial differences in the cant of the upper lip were less obvious in women than in men, due primarily to a greater anterior cant of the upper lip in subjects of European ancestry. A more forward lip position relative to Ricketts' "E" line was observed in Nagoya women.

Similar findings have been reported by Miura et al.[33] who noted a greater tendency toward bialveolar protrusion in Japanese subjects. Nezu et al.[42] reported that the Japanese subjects have more protrusive profiles because of a retruded chin position. They cautioned against excessive anterior expansion in Japanese patients during orthodontic treatment because of incisor and bilabial protrusion tendencies. They also stated that an improvement of the soft tissue profile during growth could not be expected in the Japanese patient.

CONCLUSION

The results of this study of two racially diverse groups of persons with so-called "well-balanced faces" indicate that fundamental variations exist in the craniofacial structure of Japanese and European-Americans. The findings of this study support the premise that a single standard of facial esthetics is not appropriate for application to diverse racial and ethnic groups, at least for the present. The long-term effects of increasing global communication and interaction on perceptions of facial esthetics still remains a matter of conjecture.

REFERENCES

1. Wylie WL. The assessment of anteroposterior dysplasia. Angle Orthod 1947;1: 97-109.
2. Downs WB. Variation in facial relationships: their significance, treatment and prognosis. Am J Orthod 1948;34:812-40.
3. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953;39:729-55.
4. Tweed CH. Evolutionary trends in orthodontics, past present and future. Am J Orthod 1953;39:81-108.
5. Tweed CH. The Frankfort mandibular incisal angle in orthodontic diagnosis. Angle Orthod 1954;20:121-69.
6. Ricketts RA. The influence of orthodontic treatment on facial growth and development. Angle Orthod 1960;30:103-33.
7. Riolo ML, Moyers RF, McNamara JA Jr, Hunter WS. An atlas of craniofacial growth: cephalometric standards from the University School Growth Study, the University of Michigan. Monograph 2, Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan, 1974.
8. Broadbent BH Sr, Broadbent BH Jr, Golden WH. Bolton standards of dentofacial development growth. St Louis: CV Mosby, 1975.
9. Prahl-Anderson BP, Kowalski CJ, Heydendael PHJM. A mixed-longitudinal interdisciplinary study of growth and development. New York: Academic Press, 1979.
10. Behrents RG. Growth in the aging craniofacial skeleton. Monograph 17, Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan, 1985.
11. Bishara SE, Jakobsen JR. Longitudinal changes in three normal facial types. Am J Orthod 1985;88:466-502.
12. Buschange PH, Tanguay R, Turkewicz J, Demirjian A, LaPalme L. A polynomial approach to craniofacial growth: description and comparison of adolescent males with normal occlusion and those with untreated Class III malocclusion. Am J Orthod Dentofac Orthop 1986;90:437-42.
13. Cotton WN, Takano WS, Wong WMW. The Downs analysis applied to three other ethnic groups. Angle Orthod 1951;21:213-20.
14. Drummond RA. A determination of cephalometric norms for the Negro race. Am J Orthod 1968;54:670-82.
15. Fonseca RJ, Klein WD. A cephalometric evaluation of American negro women. Am J Orthod 1978;73:152-60.
16. Richardson ER. Racial differences in dimensional traits of the human face. Angle Orthod 1980;50:301-11.
17. Richardson ER. Atlas of craniofacial growth in Americans of African descent. Monograph 26, Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan, 1991.
18. Conner AM, Moshiri R. Orthognathic surgery norms for American black patients. Am J Orthod 1985;87:119-34.
19. Flynn TR, Ambrogio RJ, Zeichner SJ. Cephalometric norms for orthognathic surgery in black American adults. J Oral Maxillofac Surg 1989;47:30-9.
20. Jacobson A. The craniofacial skeleton of the South African negro. Am J Orthod 1978;73:681-91.
21. Bacon W, Girardin P, Turlot JC. A comparison of cephalometric norms for the African Bantu and a caucasoid population. Eur J Orthod 1983;5:233-40.
22. Bacon W, Mathis R. Normal craniofacial architecture of the Cameroonian and of the Senegalese. Trop Dent J 1983;6:75-83.
23. Kapila S. Selected cephalometric norms in Kikuyu children. Angle Orthod 1989;59:139-44.
24. Lew KK, Ho KK, Keng SB, Ho KH. Soft-tissue cephalometric norms in Chinese adults with esthetic facial profiles. J Oral Maxillofac Surg 1992;50:1184-9.
25. Nanda R, Nanda RS. Cephalometric study of the dentofacial complex of north Indians. Angle Orthod 1969;39:22-8.
26. Valiathan A. Racial comparisons of dentofacial cephalometric norms using Downs' analysis. J Indian Dent Assoc 1975;47:461-4.
27. Khattabi S, Palot C. Evaluation de normes cephalometriques du jeune adulte marocain. Orthod Fr 1980;51:391-6.

28. Shalhoub SY, Sarhan OA, Shaikh HS. Adult cephalometric norms for Saudi Arabians with a comparison of values for Saudi and North American Caucasians. Br J Orthod 1987;14:273-9.
29. Iizuka T, Ishikawa F. Normal standards for various cephalometric analysis in Japanese adults. J Jpn Orthod 1957;16:4-12.
30. Sakamoto T. A study on the development changes of dentofacial complex of Japanese with special reference to Sella Turcica. J Jpn Orthod 1959;18:1-17.
31. Yamauchi K. Studies on "beautiful face" of Japanese female adult: part 1, roentgenocephalometric analysis. [In Japanese.] J Jpn Orthod 1959;18:18-20.
32. Yamauchi K, Sakuda M. Relationship between dental arch and craniofacial components: Japanese male adults with normal occlusions. [In Japanese.] J Jpn Orthod Soc 1959;18:21-4.
33. Miura F, Inoue N, Suzuki K. The standards of Steiner analysis for Japanese. [In Japanese.] Bull Tokyo Med Dent Univ 1963;10:387-95.
34. Yamauchi K, Ito K, Suematsu H, Ozeki S. Sex difference of Japanese adult profile with normal occlusion on cephalometric roentgenograms. [In Japanese.] J Jpn Orthod 1967;26:155-60.
35. Shishikura K. The study on measurements of hard and soft tissue by cephalograms—particularly on normal and Class I occlusion among Japanese adults. [In Japanese.] J Jpn Orthod 1969;28:263-73.
36. Ito K, Suematsu H. Cephalometric study on the profile of Japanese young adult females with normal occlusion. [In Japanese.] J Jpn Orthod 1967;26:35-41.
37. Yogosawa F. The relationship between dentoskeletal framework and soft tissue profile. [In Japanese.] J Jpn Orthod 1969;28:33-59.
38. Masaki F. The longitudinal study of morphological differences in the cranial base and facial structure between Japanese and American whites. [In Japanese.] J Jpn Orthod 1980;39:436-56.
39. Uesato G, Kinoshita Z, Kawamoto T, Koyama I, Nakanishi Y. Steiner cephalometric norms for Japanese and Japanese-Americans. Am J Orthod 1978;73:321-7.
40. Ricketts RM. Planning treatment on the basis of facial pattern and an estimate of its growth. Angle Orthod 1957;27:14-37.
41. Engel G, Spolter BM. Cephalometric and visual norms for a Japanese population. Am J Orthod 1981;80:48-60.
42. Nezu H, Nagata K, Yoshida Y, Kosaka H, Kikiuchi M. Cephalometric comparison of clinical norms between the Japanese and Caucasians. [In Japanese.] J Jpn Orthod 1982;41:450-65.
43. McNamara JA Jr, Ellis E. Cephalometric analysis of untreated adults with ideal facial and occlusal relationships. Int J Adult Orthod Oral Surg 1988;3:221-31.
44. McNamara JA Jr, Brust EW, Riolo ML. Soft tissue evaluation of individuals with an ideal occlusion and a well-balanced face. In: McNamara JA Jr, ed. Esthetics and the treatment of facial form. Monograph 28, Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, The University of Michigan, 1993.
45. McNamara JA Jr. A method of cephalometric evaluation. Am J Orthod 1984;86: 449-69.
46. McNamara JA Jr, Bookstein FL, Shaughnessy TG. Skeletal and dental adaptations following functional regulator therapy. Am J Orthod 1985;88:91-110.
47. McNamara JA Jr, Brudon WJ. Orthodontic and orthopedic treatment in the mixed dentition. Ann Arbor; Needham Press, 1993.
48. Hellman M. Some facial features and their orthodontic implications. Am J Orthod 1939;25:927-51.
49. Riedel RA. Esthetics and its relation to orthodontic therapy. Angle Orthod 1950;20:168-78.
50. Casko JS, Shepard WB. Dental and skeletal variation within the range of normal. Angle Orthod 1984;54:5-17.
51. Ben-Bassat Y, Dinte A. Brin I, Koyoumdjisky-Kaye E. Cephalometric pattern of Jewish East European adolescents with clinically acceptable occlusion. Am J Orthod Dentofac Orthop 1992;102:443-8.