Central Asian Journal of Medical Sciences
CAJMS
Original Article
Cent Asian J Med Sci. 2018 Sep;4(3):179-186. https://doi.org/10.24079/CAJMS.2018.09.003

Lateral Cephalometric Standards for Mongolian 6-15 Year Old Children with Normal Occlusion

Bolormaa Sainbayar[1], Ganjargal Ganburged[1], Odonchimeg Demid[1], Keiji Moriyama[2], Oyuntsetseg Bazar[3], Tsasan Tumurkhuu[4], Amarsaikhan Bazar[5]

[1]Department of Orthodontics, School of Dentistry, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia; [2]Department of Maxillofacial Orthognathics, Tokyo Medical and Dental University, Tokyo, Japan; [3]Department of Pediatric and Prevention Dentistry, School of Dentistry, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia; [4]Enerel Dental Clinic, Ulaanbaatar, Mongolia; [5]Department of Prosthodontics, School of Dentistry, Mongolian National University of Medical Sciences, Ulaanbaatar, Mongolia

Submitted: 24 May, 2018
Revised: 24 August, 2018
Accepted: 12 September, 2018

Corresponding Author
Bolormaa Sainbayar, DDS, MD
Department of Orthodontics, School of Dentistry, Mongolian National University of Medical Sciences,
Ulaanbaatar 15120, Mongolia
Tel: +976-99886360
E-mail:bolormaa.s@mnums.edu.mn

Objectives: The aim of this study was to establish the age and gender-specific lateral cephalometric standards for Mongolian children with normal occlusion. **Methods:** A total of 541 children between 6 and 15 years of age were selected based on the normal occlusion criteria. Lateral cephalograms of each subject were scanned and analyzed with the use of WinCeph version 11.0 software package. Descriptive statistics (mean and standard deviation) were calculated for all measured variables. Independent t-tests were performed to assess the intergender differences. **Results:** Cephalometric angular measurements remain largely constant, whereas most cephalometric linear measurements change with advancing age, such as anterior facial height (N-Ans, Ans-Me), hard palatal length (Ans-Pns) mandibular ramus height (Cd-Go), mandibular body length (Cd-Gn) were increasing significantly by dental age in both gender. Gender differences were not statistically significant for any of the angular measurement at ages studied, but linear measurements of male subjects had larger average values than female subjects. **Conclusion:** Our results showed that linear cephalometric dimension of the hard tissue was gender-dependent. Therefore, gender-specific differences of craniofacial distances should be taken into account during diagnosis and treatment planning. The results from this study can be used as reference values for 6-15 years old children of Mongolia.

Keywords: Cephalometric Standards, Angular Cephalometric Measurement, Linear Cephalometric Measurement, Mongolian Children, Orthodontics.

Introduction

A cephalogram is an essential tool for orthodontic diagnosis to relate patients with different malocclusions to their associated standards. The principle is that the radiographic measurements of each patient are compared with normative values. Small differences between the patient's measurements and the respective norms are interpreted as a normal variation, while larger differences indicate structural deviations. A systematic comparison of the actual and normative values of each measurement allows the practitioner to determine whether the malocclusion in question is due merely to deviations in position of the teeth and the alveolar processes or whether discrepancies exist in size and position of the jaws. The analyses will indicate necessary structural changes for achieving optimal morphologic results and will support the extraction decision as well as the decision whether or not to perform orthognathic surgery as part of the treatment.

Every population demonstrate differences regarding various details of facial morphology. These differences are easily discernible when individuals with different ethnic background are compared [1-4]. Enkhtuvshin found that Japanese facial structures differed in facial form and size distinct from Mongolians [5]. It seems possible that cephalometric norms of a Mongolian population may show traits that differentiate it from other populations. These findings show confounding variables brought about by age, gender, and race must be recognized for meaningful diagnosis. Therefore, each population need lateral cephalometric measurement norms as a reference tool for research, diagnosis, and treatment planning of craniofacial deformities.

In previous lateral cephalometric studies of the Mongolian population, adults were studied according to gender and age using lateral cephalometric angular measurement method [6-9]. However, a comprehensive Mongolian cephalometric reference database for children is still lacking. Cephalometric angular measurements remain largely constant during craniofacial growth and development, whereas most cephalometric linear measurements change with advancing age [10].

Recent studies shows that malocclusion prevalence among Mongolian children was 64.7%, 1983, 87%, 2004, 79.5%, 85.9%, 2011 indicating malocclusion prevalence is increasing yearly [11-13]. Thus a comprehensive Mongolian lateral cephalometric measurement database for children is important tool for diagnosis of malocclusion and treatment planning of orthodontics. Therefore, the purpose of the present study was to establish gender and age-specific lateral cephalometric normative data for Mongolian children from 6-15 years of age with normal.

Materials and Methods

Subjects

A total of 1387 children between 6-15 year old, from the 33th and 67th General Educational School in Ulaanbaatar, Mongolia were recruited for this study. We collected medical records, which included information about previous dental casts, oral examination charts, extra and intraoral photographs, cephalogram X-rays, orthopantomogram X-rays, dental casts, and 3D images.

Primary inclusion criteria was normal occlusal relationship and no orthodontic treatment before and throughout the observation period. The occlusal relationship was defined as normal when the following criteria were fulfilled: class I canine relationship and mesial step or a flush terminal plane deciduous molar relationship in the deciduous and mixed dentition, all teeth present according to age, good facial symmetry, no significant medical history, no history of trauma, no midline deviation, positive overjet less than 3.5 mm, and positive overbite less than 2/3 overlap of the maxillary to the mandibular incisors. Using all collected data, we selected 541 children (228 male, 313 female) with normal occlusion. According to Hellman's dental age classification all subjects were divided into 6 groups IIA (Eruption of 2nd deciduous molar), IIC (Eruption of 1st permanent molar), IIIA (Eruption of permanent incisor), IIIB (Eruption of permanent canine and premolar), IIIC (Beginning of second permanent molar eruption), IVA (Eruption of second molar completed) [14].

Lateral Cephalograms

Digital lateral cephalograms were made with the teeth in centric occlusion at a focus/object distance of 150 cm and an object/receptor distance of 20 cm using a Veraviewpocs (Morita, Japan). The subjects were placed in a head holder and asked to look straight forward before adjusting the nasal positioner with built-in millimeter scale.

Measurements on Lateral Cephalograms

Anatomic landmarks and reference lines were identified directly on the digital computer images (Figure 1). 19 linear and 19 angular measurements were calculated electronically using the Winceph version 11.0 software package (Rise corporation, Japan), scaling the measured values to the actual subject dimensions.

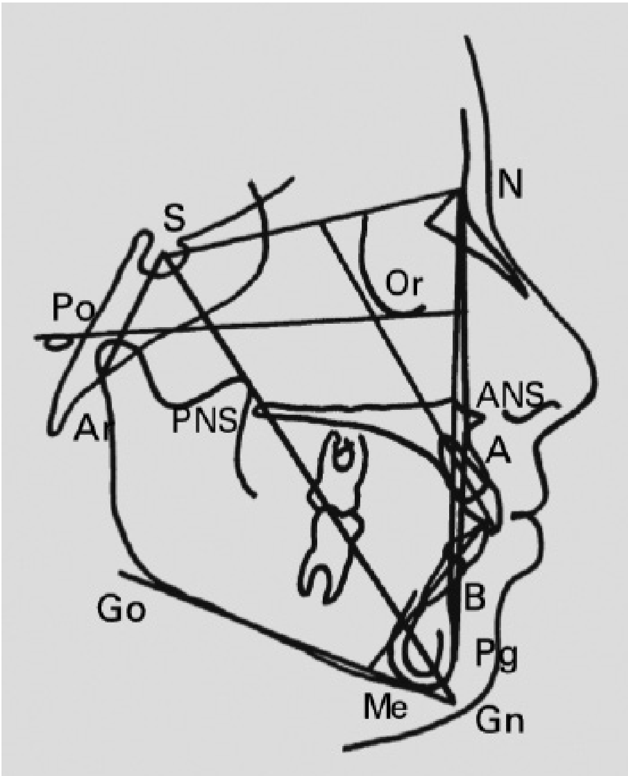

Figure 1. Cephalometric tracing of average subject in the sample, indicating identification of landmarks and reference lines. S = Center of pituitary fossa of sphenoid bone; N = intersection of internasal suture with nasal frontal suture in midsagittal plane; ANS = tip of anterior nasal spine; A = deepest point of curve of maxilla between anterior nasal spine and dental alveolus; B= most posterior point in concavity along anterior border of symphysis; Pg = most anterior point on midsagittalsymphysis; Gn = midpoint between most anterior and inferior point on bony chin; Me = most inferior point of symphysis; Go = most convex point along inferior border of ramus; Ar = posterior border of neck of condyle; Po = highest point of ear canal, most superior point of external auditory meatus; Or = most inferior point of external border of orbital cavity; PNS = tip of posterior nasal spine.

Error of the method

The reproducibility of the measurements was assessed by statistically analyzing the differences between double measurements taken at least 2 week apart on 123 randomly selected cephalograms. The error was calculated from the equation:

$$error = \sqrt{\frac{\sum d^2}{2n}}$$

where D is the difference between duplicated measurements and N is the number of double measurements [15] . The errors ranged from 0.25 (N-Ans) to 1.26 (Ans-Pns) for the linear measurements and from 0.51 (SNA) to 1.14 (Facial angle) for the angular measurements. Pearson's R between corresponding first and second measurements were all greater than 0.59 ($p<0.05$).

Data analysis

Descriptive statistics were performed (SPSS, version 22.0,USA), and Student's t tests were employed to test for gender differences. Bonferroni corrections were carried out to reduce the possibility of significances due to chance, considering p-values less than the corresponding Bonferroni correction values as significant [16]. Sample means, standard deviations and ranges of each respective linear and angular measurement were interpreted as lateral cephalometric norms for Mongolian children. Separate norms were calculated for boys and girls regarding parameters demonstrating gender.

Ethical statement

Ethical approval for this study was acquired from the Research Ethics Committee of the Mongolian National University of Medical Sciences on June 19, 2015. Before data collection, the parents of all children signed a written, informed consent.

Results

Demographic characteristics of participants are shown in Figure 2. A total of 541 patients, 228 males (43%) and 313 females (57%), were enrolled in this study. Subjects characteristics according to Helman's dental age classification are shown in Figure 3.

Means and standard deviations for all cephalometric angular and linear measurements are shown by dental age in Table 1 and Table 2, respectively. Gender differences in cephalometric angular and linear measurements in Table 3 and Table 4. The cephalometric landmarks and reference lines used in this study are illustrated in Figure 1, respectively.

Lateral cephalometric linear measurements, cranial base (Ba- S, N-S), anterior facial height (N-Ans, Ans-Me, N-Me), hard palatal length (Ans-Pns) mandibular ramus height (Cd-Go), mandibular body length (Cd-Gn) were increased significantly with dental age in both genders, indicating that lateral cephalometric

Table 1. Skeletal and Dentoalveolar Cephalometric angular measurement standards according to Hellman dental age groups

Angular measurement	Dental age (Hellman)											
	II A		II C		III A		III B		III C		IV A	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal relationship												
Ba- S	22.6	3.0	23.4	2.9	23.5	2.7	24.6	2.7	25.7	3.0	26.2	3.1
N-S	65.4	2.5	66.4	2.8	67.9	2.9	69.1	3.0	71.0	2.7	72.2	3.1
N-Ans	47.0	2.8	48.3	3.3	50.4	3.2	52.7	2.9	55.0	3.1	56.5	3.2
Ans-Me	61.5	2.8	61.6	4.0	63.3	4.3	65.2	4.0	67.3	3.8	69.7	4.1
Na-Me	106.9	4.7	108.6	5.3	112.5	6.5	116.9	5.9	121.3	5.6	125.3	6.0
ANS-PNS	45.9	2.7	45.8	2.2	46.5	2.4	48.2	2.9	49.9	2.9	51.8	2.8
S-Ptm	18.4	2.4	18.6	2.7	19.6	2.6	19.7	2.3	20.5	2.4	20.8	2.9
A-Ptm	44.6	2.4	44.5	2.2	45.0	2.3	46.5	2.7	48.0	3.0	49.0	2.8
Ptm-Ms	9.3	2.3	10.2	2.4	11.9	2.3	14.2	3.0	16.9	3.0	18.9	3.6
A-Ms	35.3	2.0	34.3	2.2	33.1	2.2	34.2	2.3	31.2	2.3	30.1	2.4
Gn-Cd	99.3	4.4	100.6	5.2	104.7	6.0	110.9	6.0	115.5	5.4	119.9	5.7
Pog-Go	65.0	3.5	66.5	3.6	68.3	5.0	72.4	4.6	75.9	4.2	78.7	4.1
Cd-Go	47.4	2.7	47.8	4.0	50.2	3.9	53.6	4.4	55.7	4.7	59.5	4.7
Wits appraisal	-3.4	2.3	-4.3	1.9	-3.3	2.4	-3.1	2.5	-2.6	2.3	-2.4	2.6
Dentoalveolar relationship												
Is-Is	27.4	1.6	27.3	2.2	28.0	2.6	29.3	2.3	30.3	2.1	31.2	2.5
Li-Li	35.6	2.0	35.8	2.6	37.7	2.6	39.4	2.5	41.0	2.4	42.4	2.5
Mo-Mi	27.7	1.9	27.9	2.1	28.7	2.0	29.6	2.3	30.7	2.2	32.2	2.2
Mo-Ms	14.9	1.9	15.1	1.8	16.7	1.9	18.7	2.1	20.5	2.0	22.6	2.1
Is-Mo	36.5	2.3	36.1	2.1	36.9	2.8	37.7	2.4	37.0	2.7	36.4	2.3
Li-Mo	33.9	2.0	33.8	1.8	33.6	2.4	33.6	2.3	32.9	2.6	32.0	2.4
OB	1.6	1.0	1.4	1.0	1.9	1.2	2.6	1.4	3.0	2.0	3.1	1.2
OJ	1.5	1.3	1.5	1.2	2.1	1.2	2.7	1.4	3.0	1.3	3.1	1.3

linear measurements increaseas Mongolian children increase in age.

The increased ranges of the anteroposterior and vertical parameters were considered clinically significant. Most lateral cephalometric angular measurements remained largely constant during craniofacial growth (Table 1, 2), whereas AB angle, mandibular angle, occlusal angle, ANB angle became smaller with age in both genders.

The inclination of the maxillary incisor in relation to the anterior cranial base, Frankfort horizontal plane and Nasion-Sella (U1-FH, U1-SN) slightly increased with advancing age in both gender. The inclination and position of the lower incisors relative to mandibular plane angle increased in both genders (Table 1, 2).

Gender differences were not statistically significant for any of the angular measurement at with it being significantly larger in males. Following Bonferroni correction, gender differences were detected in the linear dimensions N-S, N-Ans, Ans-Me, N-Me, A-Ptm, Gn-Cd, Li-Li, Mo-Mi, Is-Mo, Li-Mo, with boys having larger average values than females ($p<0.05$). No significant differences were documented in interdental changes, sagittal overjet, overbite and molar relationship.

Compared with Japanese children, Mongolian were found to have decreased anterior face height (N-Ans, Ans-Me, N-Me). In addition, the upper and lower incisors were significantly more proclined and more protruded in Mongolian than in Japanese children (Table 5).

Table 2. Skeletal and Dentoalveolar Cephalometric linear measurement standards according to Hellman dental age groups

Angular measurement	Dental age (Hellman)											
	II A		II C		III A		III B		III C		IV A	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal relationship												
Facial angle	82.5	2.4	82.6	2.3	83.1	2.6	83.8	2.6	84.4	2.5	85.5	2.9
Convexity	169.3	4.4	168.4	3.7	172.7	3.6	174.1	4.2	173.0	4.1	4.1	4.1
AB plane	-6.1	2.1	-5.1	2.0	-5.1	2.2	-4.6	2.5	-4.8	2.5	-4.5	2.2
Mandibular plane	30.4	3.2	30.6	2.9	30.7	3.9	29.8	4.7	29.6	4.2	27.8	4.6
Y axis	63.0	2.6	63.1	2.1	63.0	2.9	63.2	2.9	62.8	3.7	62.5	3.0
Occlusal plane	18.7	2.5	18.6	2.8	16.9	3.3	15.2	3.6	14.0	3.1	12.2	3.6
FH to SN	6.8	2.2	6.7	2.1	7.0	2.0	6.4	2.0	6.6	2.2	7.0	2.4
SNP	75.9	3.2	75.9	3.2	76.0	3.1	77.5	3.0	77.8	2.7	78.5	3.6
Sn-Gn	74.7	3.0	74.6	3.1	74.8	3.0	76.3	3.0	76.6	2.7	77.4	3.5
SNA	81.2	3.6	79.9	3.3	79.6	3.0	80.2	3.2	80.5	2.9	80.5	3.9
SNB	76.1	3.3	75.9	3.0	75.9	2.9	77.1	2.9	77.4	2.7	77.8	3.8
SNA-SNB Diff	5.1	2.0	4.0	1.5	3.7	1.8	3.1	1.8	3.1	1.8	2.7	1.7
Gonial	128.3	5.6	128.5	5.4	128.5	5.6	126.7	6.5	126.2	5.8	124.3	5.5
GZN	88.8	5.0	88.9	4.8	89.4	5.5	89.5	4.6	90.0	4.7	90.5	4.7
Ramus inclination	82.2	4.7	82.2	4.2	82.4	5.1	83.1	4.3	83.5	4.4	83.5	4.1
Dentoalveoalar relationship												
Interincisal	137.8	6.7	135.9	7.6	128.0	7.3	125.4	6.8	124.0	6.3	124.0	5.6
L1 to Man	91.5	4.8	91.4	5.3	94.0	4.8	95.0	5.3	95.9	4.9	96.5	4.3
U1 to FH	100.3	4.6	102.0	5.2	107.3	5.9	109.8	4.9	110.4	4.4	111.7	4.5
U1 to SN plane	93.7	4.9	95.4	5.5	100.2	5.9	103.4	5.0	103.9	4.2	104.7	5.0
U1 to N	6.3	2.6	6.5	2.2	7.9	2.3	8.8	2.8	9.2	2.6	9.0	3.0

linear measurements, cranial base (Ba-S, N-S), anterior facial height (N-Ans, Ans-Me, N-Me), hard palatal length (Ans-Pns) mandibular ramus height (Cd-Go), mandibular body length (Cd-Gn) were increasing significantly with dental age in both genders, indicating that cephalometric linear measurements increase with increasing age. Most cephalometric angular measurements remain largely constant during craniofacial growth, whereas AB angle, mandibular angle, occlusal angle, ANB angle became smaller with age in both genders. The inclination of the maxillary incisor in relation to the anterior cranial base, Frankfort horizontal plane and Nasion-Sella (U1-FH, U1-SN) slightly increased with age in both genders. The inclination and position of the lower incisors relative to mandibular plane angle changed to great extend in both genders. Normal occlusal relationships, especially in the anterior region, seem to be important in establishing and maintaining proportion between different craniofacial structures such as cranial base, midface, mandible, and dentition. Thus, establishing normal occlusal relationships (especially in the incisal area) at an early developmental stage is of upmost importance [17, 18] .

Gender differences were not statistically significant for any of the angular measurement in any of the age groups, whereas significant gender difference appeared in Gonial angle, revealing significantly greater dimensions in the male. In the linear dimensions N-S, N-Ans, Ans-Me, N-Me, A-Ptm, Gn-Cd, Li-Li, Mo-Mi, Is-Mo, Li-Mo, maleshad larger average values than females.

Cephalometric linear dimension values of male subjects were all slightly larger than that of female subjects. This indicates that it is essential to have cephalometric linear measurements reference values according to age and gender.

Compared with Japanese children, Mongolian were found to have a decreased anterior face height (N-Ans, Ans-Me, N-Me).

Table 3. Comparison of Cephalometric angular standards for male and female

Angular measurement	Gender				p-value
	Male		Female		
	Mean	SD	Mean	SD	
Skeletal relationship					
Facial angle	83.7	2.7	83.9	2.7	0.42
Convexity	156.3	4.1	147.0	4.3	0.05
AB plane	-4.9	2.3	-4.8	2.4	0.5
Mandibular plane	30.0	4.2	29.5	4.3	0.11
Y axis	63.0	3.3	62.9	2.7	0.4
Occlusal plane	15.5	3.7	15.3	4.0	0.5
FH to SN	6.5	2.1	6.8	2.1	0.8
SNP	77.2	3.3	77.2	3.1	0.9
Sn-Gn	76.0	3.3	76.0	3.0	0.9
SNA	80.4	3.3	80.2	3.2	0.4
SNB	76.9	3.2	76.8	3.0	0.8
SNA-SNB Diff	3.5	1.9	3.3	1.9	0.4
Gonial	127.7	6.0	126.1	6.0	0.02
GZN	89.5	4.6	89.4	5.5	0.2
Ramus inclination	83.1	4.3	82.4	5.1	0.5
Dentoalveolar relationship					
Interincisal	127.1	8.4	126.9	7.6	0.8
L1 to Mand	94.5	5.3	94.9	5.1	0.4
U1 to FH	108.2	6.1	108.7	5.7	0.4
U1 to SN plane	101.7	6.5	101.9	5.7	0.7
U1 to NP (mm)	8.6	2.9	8.3	2.7	0.2

Independent Samples test, significant for $p<0.05$

Discussion

In our study, Mongolian children craniofacial structures were investigated at the early mixed dentition, prepuberty and adolescence stages.

Considering the ethnic background of patients in setting treatment objectives is an important requirement for successful orthodontic treatment. This can be achieved by establishing cephalometric and facial forms for the different racial groups [4]. Among Mongolian adults, the lateral cephalometric angular measurement method has been used according to gender and age [6-9]. However, there are no lateral cephalometric linear and angular measurements standards for Mongolian children. The reference values from this study arethe first of its kind and will be useful in orthodontics for diagnosis and treatment planning among Mongolian children.

Subjects in this study were Mongolian children, aged from 6 to 15, with normal occlusion and well-balanced faces living in the city of Ulaanbaatar. The inclusion criteria for this study was very strict, Class I canine relationship and mesial step or a flush terminal plane deciduous molar relationship in the deciduous and mixed dentition, all teeth present according to age, good facial symmetry, no significant medical history, no history of trauma, no midline deviation, positive overjet less than 3,5mm, positive overbite less than 2/3 overlap of the maxillary to the mandibular incisors. Lateral cephalograms were collected from subjects. Because cephalometric analysis can involve subjective and methodological errors in identifying cephalometric landmarks, especially when a series of digital images are being analyzed, we had only one experienced investigator trace all the digital images.

The results of present study shows that cephalometric

Table 4. Comparison of Cephalometric linear standards for male and female

Linear measurement	Gender				p-value
	Male		Female		
	Mean	SD	Mean	SD	
Skeletal relationship					
Ba-S	24.6	3.0	24.7	3.1	0.82
N-S	70.0	3.4	68.8	3.4	0.00
N-Ans	53.1	4.2	52.3	4.1	0.02
Ans-Me	66.3	4.8	64.8	4.5	0.00
Na-Me	118.4	8.1	115.9	7.7	0.00
ANS-PNS	48.5	3.2	48.4	3.4	0.60
S-Ptm	20.1	2.5	19.7	2.7	0.09
A-Ptm	47.0	3.1	46.4	3.0	0.02
Ptm-Ms	14.5	4.0	14.4	4.1	0.72
A-Ms	33.9	19.9	32.0	2.6	0.10
Gn-Cd	111.4	8.9	109.8	8.1	0.03
Pog-Go	72.8	6.3	72.1	5.8	0.21
Cd-Go	53.7	5.6	53.2	5.6	0.33
Wits appraisal	-3.1	2.4	-3.0	2.5	0.89
Dentoalveolar relationship					
Is-Is	29.5	2.5	29.0	2.6	0.05
Li-Li	40.0	3.3	38.8	3.1	0.00
Mo-Mi	30.2	2.6	29.5	2.4	0.00
Mo-Ms	18.9	3.1	18.7	3.0	0.52
Is-Mo	37.3	2.8	36.7	2.4	0.01
Li-Mo	33.6	2.6	33.0	2.3	0.02
OB	2.4	1.3	2.5	1.8	0.44
OJ	2.6	1.4	2.5	1.5	0.82

Independent samples test, significant for p<0.05

Table 5. Comparison between Japanese and Mongolian children

Variable	Mongolian		Japanese		p-value
	Mean	SD	Mean	SD	
N-Ans	50.4	3.2	51.5	2.8	0.9
Ans-Me	63.3	4.3	65.5	3.8	0.8
Na-Me	112.5	6.5	114.9	4.9	0.5
U1 to FH	107.3	5.9	104.79	9.04	0.09
U1 to SN plane	100.2	5.9	96.79	8.24	0.09

Independent samples test, significant for p<0.05

In addition, the upper and lower incisors were significantly more proclined and more protruded in Mongolian than in Japanese children [19].

This study has provided descriptive means and range of deviations in linear and angular cephalometric measurements of the Mongolian face and their interpretations. A bias may exist in this study because of the possible inclusion of early- and late-maturing individuals in the samples. Future research should rather pursue a longitudinal approach with a larger sample size and pooled according to skeletal maturation to refine our understanding about the Mongolian face.

Conflict of Interest

The authors state no conflict of interest.

Acknowledgements

This study was partially funded by a joint research project of the Department of Prosthodontics and Orthodontics, School of Dentistry, Mongolian National University of Medical Sciences (MNUMS) and Maxillofacial Orthognathics, Tokyo Medical and Dental University (TMDU) of Japan.

We would like to express our great appreciation to our research team at the Department of Prosthodontics and Orthodontics and Pediatric and Prevention, School of Dentistry, Mongolian National University of Medical Sciences. Our special thanks to the research team at the Department of Maxillofacial Orthognatics, Tokyo Medical and Dental University for their tremendous effort and enormous support. We thank our colleagues Dr.Tsasan Tumurkhuu, Dr.Nomingerel Sukhbaatar, Dr.Gannaran Narangerel for their contribiution.

References

1. Wu J, Hägg U, Rabie ABM. Chinese norms of McNamara's cephalometric analysis. Angle orthod 2007; 77: 12-20.
2. Huang WJ, Taylor RW, Dasanayake AP. Determining cephalometric norms for Caucasians and African Americans in Birmingham. Angle orthod 1998; 68: 503-12.
3. Behbehani F. Racial variations in cephalometric analysis between Whites and Kuwaitis. Angle Orthod 2006; 76: 406-11.
4. Hassan AH. Cephalometric norms for the Saudi children living in the western region of Saudi Arabia: a research report. Head Face Med 2005; 1: 5.
5. Enkhtuvshin G. Comparison of Lateral cephalometric dimentions between Mongolian and Japanese children [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2003.
6. Sukhbaatar E. Lateral profile for Mongolian female adults [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2005.
7. Tsolmon J. Lateral cephalometric measurement norms of Mongolian female adults [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2005.
8. Azzaya U. Lateral cephalometric for Mongolian adults [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2009.
9. Suglegmaa B. Lateral cephalometric for Mongolian adults [dissertation]. Sun Yat Sen University: Guangzhuo; 2009.
10. De Castrillon FS, Baccetti L, Franchi R, Grabowski U, Klink-Heckmann JA, McNamara. Lateral cephalometric standards of Germans with normal occlusion from 6 to 17 years of age. J Orofac Orthop 2013; 74: 236-56.
11. Tsolmon K. Craniofacial morphological characteristcs of Mongolian students with normal occlusion [dissertation]. Sofia, Bulgaria: School of Dentistry, Sofia Medical University; 1983.
12. Odonchimeg D. Diagnosis and treatment methods for permanent canines with malposition [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2004.
13. Angarag A. Malocclusion prevalence of 11 years old children in Ulaanbaatar city [dissertation]. Ulaanbaatar, Mongolia: School of Dentistry, Mongolian National University of Medical Sciences; 2011.
14. Hellman M. Changes in the human face brought about by development. Am J Orthod Oral Surg 1927; 13: 475-516.
15. Dahlberg G. Statistical methods for medical and biological students Handbook. London, United Kingdom: G. Allen & Unwin Ltd; 1940. p 1-232.
16. Mark W. Study Design and Data Analysis Handbook, 2nd edition. New York, United States of America; Chapman & Hall; 2004. p 1-675.
17. Mitchell L. An Introduction to Orthodontics. Oxford, United Kingdom: Oxford University Press; 2013. p 1-336.
18. Solow B. The dentoalveolar compensatory mechanism: background and clinical implications. Br J Orthod 1980; 7: 145-61.
19. Izuka T, Ishikawa H. Normal standards for various cephalometric analysis in Japanese adults. Orthod Waves 1957; 16: 4-12.