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McNamara norms for Turkish adolescents with balanced faces and normal occlusion

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Background: There are no norms for the McNamara analysis for Turkish adolescents.
Objective: To obtain cephalometric standards for the McNamara analysis for Turkish adolescents with balanced faces and Class I occlusions, and to compare the standards with published data.
Methods: The cephalometric radiographs of 116 children (83 female, 33 male) between 11 and 16 years of age with Turkish grandparents and Class I occlusion, well-aligned upper and lower dental arches, no anterior and/or posterior crossbites and normal dentofacial structures were used. The eight linear and two angular measurements in the McNamara analysis were measured on images of the scanned radiographs. Measurements of the male and female subjects were compared with each other and with published norms for North American adolescents and adults.
Results: The Co-Gn, Co-A, ANS-Me and Ui-A were larger in the male subjects. Comparisons between the present study and McNamara's original study revealed that Anatolian Turkish adolescents, particularly girls, have smaller midfacial and mandibular lengths and longer and more retrusive faces than North American adolescents and adults.
Conclusions: The small, but statistically significant, gender differences in mandibular and midfacial lengths and lower anterior face height may not be clinically significant. A single set of Turkish norms for the McNamara analysis may be appropriate.
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Introduction

Cephalometric analysis is an important part of orthodontic diagnosis and treatment planning. It provides information on the relationships of the facial bones and teeth not easily obtained by physical examination. The usual method is to compare a variable in an individual with the same variable in an age-matched, representative sample. The information gained can be used in communication with other professionals and with patients. Some specialised analyses have been designed to compare different ethnic/racial or family groups, but the McNamara analysis, which is the subject of this communication, is a clinical analysis composed of eight linear and two angular measurements.[1] This analysis describes the relative positions of the maxillae and mandible, the length of the mandible, the height of the face and the positions of the incisors. It has several limitations, such as reliance on linear measurements, which are influenced by magnification and may differ from cephalostat to cephalostat, the use of unfamiliar measurements to describe the positions of the incisors and no soft tissue measurements. In spite of these disadvantages we have found that the measurements in the analysis give a useful appraisal of dentofacial relationships, particularly for the age group likely to require orthopaedic treatment.

As no norms for Turkish adolescents exist for the McNamara analysis and eight out of 10 of the measurements in this analysis are affected by magnification, we decided to obtain norms for Turkish adolescents with well-balanced faces and Class I occlusions, and to determine if there are gender differences in the measurements.

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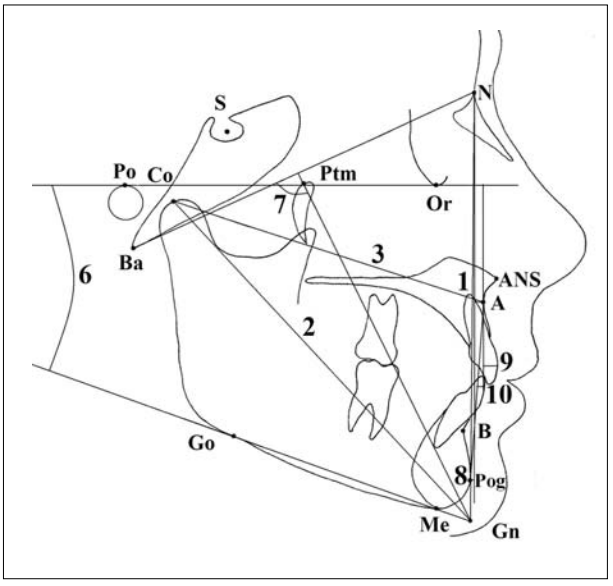


Figure 1. The landmarks and measurements used in McNamara cephalometric analysis.[1]
1. A-N perpendicular (mm)
2. Effective mandibular length (Co-Gn, mm)
3. Effective midfacial length (Co-A, mm)
4. Maxillo-mandibular difference (Mx-Md difference, mm)
5. Lower anterior facial height (ANS-Me, mm)
6. Mandibular plane angle (FH/MP, degrees)
7. Facial axis angle (90° minus NBa-PtmGn, degrees)
8. Pog-N perpendicular (mm)
9. Ui-A (mm)
10. Li-APog (mm)

Materials and methods

This study was approved by the Ethics Committee Board of the School of Dentistry, Atatürk University. The material consisted of the lateral cephalometric films of 116 (83 female, 33 male) 11 to 16 year-old Turkish adolescents with Turkish grandparents, selected from the longitudinal archive in the Department of Orthodontics, Faculty of Dentistry, Atatürk University. The mean ages of the girls and boys were 13.42 ± 1.13 years and 13.65 ± 1.47 years, respectively. The subjects had a Class I molar relationship, well-aligned upper and lower dental arches with no/little crowding, no anterior and/or posterior crossbites and normal dental development. The radiographs of subjects with a history of previous orthodontic treatment, facial and/or dental trauma, systemic disease, subjective neuromuscular symptoms, symptoms of TMD, developmental and/or acquired craniofacial or neuromuscular deformities were excluded.

All radiographs were taken with the Frankfort plane parallel to the floor, the teeth in centric occlusion and the lips at rest. The image enlargement was 8.7 per cent and the data were not corrected for this enlarge-

Table I. McNamara cephalometric norms for 11-16 year-old Turkish children.

Variable		Mean	SD	Minimum	Maximum	*p*
1. A-N perpendicular (mm)	Female	-0.44	2.52	-6.20	5.50	0.226
	Male	0.18	2.36	-3.50	5.30	
2. Effective mandibular length (Co-Gn) (mm)	Female	113.65	5.64	95.40	133.00	**0.002**
	Male	117.36	6.24	106.90	133.40	
3. Effective Midfacial length (Co-A) (mm)	Female	88.65	4.13	79.20	99.00	**0.002**
	Male	91.39	4.73	82.20	103.90	
4. Maxillo-mandibular difference	Female	24.86	3.39	13.30	32.70	0.127
(Mx-Md diff) (mm)	Male	25.97	3.87	18.70	32.80	
5. Lower anterior facial height	Female	66.66	4.16	56.60	76.10	**0.003**
(ANS-Me) (mm)	Male	69.43	4.84	59.10	79.60	
6. Mandibular plane angle (FH/MP) (degrees)	Female	25.01	3.65	16.40	33.30	0.983
	Male	25.02	3.22	17.90	32.70	
7. Facial axis angle (90°minus	Female	-1.93	3.89	-11.60	9.90	0.594
NBa-PtmGn) (degrees)	Male	-2.34	3.38	-9.80	4.60	
8. Pog-N perpendicular (mm)	Female	-4.79	4.55	-15.50	4.90	0.342
	Male	-3.92	4.29	-13.10	3.70	
9. Ui-A (mm)	Female	3.15	2.15	-3.70	6.70	**0.022**
	Male	4.19	2.22	0.50	10.90	
10. Li-APog (mm)	Female	1.67	2.28	-3.70	6.90	0.073
	Male	2.48	1.92	-0.50	7.00	

Significant values in bold

Table II. Comparisons of the means with published norms.

Parameters		Present study	Bolton (14 years)[1]	Burlington (14 years)[1]	Ann Arbor (Adults)[1]
1. A-N perpendicular (mm)	Female	-0.44 **a**			0.4 **a**
	Male	0.18			1.1
2. Effective mandibular length (Co-Gn) (mm)	Female	113.65 **c**	118.9 **c**	114.9	
	Male	117.36	120.6	119.2	
3. Effective midfacial length (Co-A) (mm)	Female	88.65 **a,c**	92.1 **c**	89.2 **a**	
	Male	91.39 **b1,b2**	95.2 **b1**	93.9 **b2**	
4. Maxillo-mandibular difference (Mx-Md diff) (mm)	Female	24.86	26.7	25.7	
	Male	25.97	25.3	25.3	
5. Lower anterior facial height (ANS-Me) (mm)	Female	66.66	65.6	66.2	
	Male	69.43	66.8	68.8	
6. Mandibular plane angle (FH-MP) (degrees)	Female	25.01 **c**			22.7 **c**
	Male	25.02 **c**			21.3 **c**
7. Facial axis angle (90˚ minus NBa-PtmGn) (degrees)	Female	-1.93 **c**			0.2 **c**
	Male	-2.34 **c**			0.5 **c**
8. Pog-N perpendicular (mm)	Female	-4.79 **c**			-1.8 **c**
	Male	-3.92 **c**			-0.3 **c**
9. Ui-A (mm)	Female	3.15	4.2		
	Male	4.19	3.8		
10. Li-APog (mm)	Female	1.67	1.4		
	Male	2.48	1.4		

a, $p < 0.05$; **b**, $p < 0.01$; **c**, $p < 0.001$
Image enlargement: present study 8.7 per cent; McNamara's study 8.0 per cent

ment. The films were scanned with an Epson Expression 1860 Pro scanner (Seiko Epson Corporation, Japan) and the resulting images (100 per cent) were digitised and measured using Quick Ceph 2000 (Quick Ceph Systems, San Diego, CA, USA). The landmarks and measurements in McNamara analysis are shown in Figure 1.[1]

Statistical analysis

To determine the measurement errors, 15 randomly selected radiographs were remeasured by the same examiner two weeks after the initial measurements. The reliability of the measurements was assessed with intra-class correlation coefficients.[2] Student's *t*-tests were used to compare the measurements in the boys and girls, and to compare the measurements in the Turkish boys and girls with the norms published by McNamara.[1] All statistical analyses were performed using the SPSS software package (SPSS for Windows 98, version 10.0, SPSS Inc., Chicago, IL, USA).

Results

The reliability coefficients exceeded 0.90 for all measurements, indicating that the measurements could be reliably repeated.

Comparisons of the measurements in the girls and boys are given in Table I. The effective mandibular length (Co-Gn), effective midfacial length (Co-A), lower anterior facial height (ANS-Me) and the distance from the labial surface of the most prominent upper central incisor to the perpendicular to the Frankfort line through A point (Ui-A) were significantly larger in the boys. The lower incisors in the boys were almost 1 mm further behind the A-Pog line than the lower incisors in the girls, but the difference was not statistically significant ($p = 0.073$).

The means of the female and male Turkish adolescents were compared with the 14 year-old adolescents in the Bolton and Burlington studies and the adults in the Ann Arbor study reported by McNamara (Table II).[1] The Turkish girls had significantly more

retruded maxillae (A-N perp, $p < 0.05$) than the Ann Arbor adults, and significantly shorter mandibles (Co-Gn, $p = 0.001$) than the 14 year-old American girls in the Bolton study, but not the Canadian girls in the Burlington study. The midfacial lengths (Co-A) in the Turkish girls and boys were shorter than the same lengths in the adolescents in the Bolton and Burlington studies. The Turkish adolescents also had significantly steeper mandibular plane angles (FH/MP) than the Ann Arbor adults (Females, $p < 0.001$; Males, $p < 0.001$). The facial axis angle (90º minus NBa-PtmGn), the angle between the nasion-basion line and the constructed line from the postero-superior aspect of the pterygomaxillary fissue to gnathion subtracted from 90 degrees, was significantly less in Turkish adolescents compared with the adolescents in the Ann Arbor study (Females, $p < 0.001$; Males, $p < 0.001$). The mandibles (Pog-N perp) in the Turkish adolescents were also 3 to 3.5 mm more retruded than the mandibles in the Ann Arbor adults. There were no significant differences between the positions of the upper and lower incisors (Ui-A distance, Li-APog distance) in the Turkish adolescents and the samples reported by McNamara.[1]

Discussion

We used the lateral cephalometric radiographs of Turkish adolescents with well-balanced faces to establish clinical norms for the McNamara analysis. This analysis uses relatively few measurements to describe the dental and skeletal relationships of interest to orthodontists and maxillofacial surgeons. We found that the girls in our sample had slightly shorter midfacial (Co-A) and mandibular lengths (Co-Gn) and shorter lower anterior face heights (ANS-Me) than the boys in our sample. The differences were small, ranging from slightly over 1 mm in the case of Ui-A to almost 4 mm in the case of Co-Gn and very variable. Because different ethnic groups can have different morphological features we wanted our sample to be representative of the children we treat. Therefore, we chose adolescents with Class I occlusions and Turkish grandparents attending our clinic for treatment and in the same age group as the majority of our patients. Besides sharing a common culture and language, individuals in an ethnic group often have a similar dentofacial morphology that sets them apart from other groups.[3] However, many countries such as Turkey contain several different ethnic groups and separate norms may be required for each group.

We were primarily interested in providing norms for the McNamara analysis, which appraises dentofacial skeletal relationships. We selected individuals with close-to-ideal occlusal relationships and no visible dentoskeletal anomalies because we wanted to use the norms for orthodontic diagnosis and treatment planning for patients attending our clinic. Unlike many other orthodontic analyses the McNamara analysis relates the maxillae, mandible and incisors to vertical facial planes: the principal one is the perpendicular line to the Frankfort plane passing through nasion. Although this analysis avoids some of the problems associated with more widely used ANB angle for determining skeletal relationships, it relies on linear measurements that may vary with age and with the cephalostat used. The SNA angle increases approximately 1 degree from 6 to 18 years of age, and a 1 degree change at point A is equivalent to a 1 mm linear change in the position of point A relative to nasion.[4] Furthermore, analyses that have linear measurements are not popular because separate norms or correction factors are required for cephalostats with different image enlargements. However, we were fortunate that the image magnification of our cephalostat was 8.7 per cent, which closely matches the 8 per cent image enlargement in McNamara's study.[1]

Previous studies have reported significant differences in the dentofacial relationships of Turkish and non-Turkish children.[5–7] We found that the midfaces of the Turkish girls were slightly less protrusive than the North American adults reported by McNamara, and that the girls and boys in our sample had slightly longer faces (FH/MP, 90º minus NBa-PtmGN, Pog-N perp) than the North American adults.[1] These differences may be due to growth and/or maturational changes in the North American sample or methodological differences.[8] In contrast to our findings, Basciftci et al., who also used the McNamara analysis, reported there were no significant differences in the A-N perpendicular distance, effective mandibular and midfacial lengths between his sample of Turkish adults and North American adults.[1,8] Gazilerli[6] and Ceylan and Gazilerli[7] also reported that Turkish children had retrusive faces compared with American children.

Generally boys have larger dentofacial measurements than girls, although the differences may not be clinically significant. The concept of clinical significance in cephalometric studies has yet to become widely

adopted. We found the mean gender differences for Co-A, Co-Gn and ANS-Me were around 3–4 mm. In agreement with Ioi et al.,[9] Basciftci et al.[8] and Swlerenga et al.[10] we found that the mandibular length (Co-Gn), midfacial length (Co-A) and lower anterior face height (ANS-Me) were significantly larger in the boys. Our differences ranged from 2.74 mm for Co-A to 3.71 mm for Co-Gn. On the other hand, Wu et al.,[11] who also used the McNamara analysis, reported that only midfacial length and lower anterior facial height were larger in male Chinese subjects. Ioi et al.[9] reported that measurements of Pog-N perpendicular in Japanese and Caucasian males were -6.8 mm and -0.3 mm, respectively; and the effective mandibular lengths (Co-Gn) were 130.40 mm and 134.3 mm, respectively. The differences were statistically significant, indicating that Japanese have more retruded facial profiles than Caucasians.

Conclusions

The small, but statistically significant, gender differences in mandibular and midfacial lengths, lower anterior face height and upper incisor protrusion may not be clinically significant. A single set of Turkish norms for the McNamara analysis may be appropriate.

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