Iran J Ortho. 2020 September; 15(2):e116247. doi: 10.5812/ijo.116247.

Published online 2021 June 13. **Research Article**

Evaluation of Cephalometric Standards for Zanjanian Population According to Downs' Analysis

Katayoon Khaleghi [1], Azin Nourian [2], Pooya Ghorbankhan [3] and Arash Farzan [4, *]

[1] Zanjan University of Medical Sciences, Zanjan, Iran
[2] Department of Orthodontics and Dentofacial Orthopedics, School of dentistry, Zanjan University of Medical Sciences, Zanjan, Iran
[3] Private Practice, Arak, Iran
[4] Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, Zanjan University of Medical Sciences, Zanjan, Iran

[*] *Corresponding author*: Department of Orthodontics and Dentofacial Orthopedics, School of Dentistry, Zanjan University of Medical Sciences, Zanjan, Iran. Email: dr.arash.farzan@gmail.com

Received 2021 May 16; **Revised** 2021 June 02; **Accepted** 2021 June 04.

Abstract

Background: Following the morphological features of different races and ethnic groups, knowledge of standard dentofacial patterns of each ethnic group is essential. Therefore, this study aimed to explain cephalometric standards for the Zanjanian population according to Downs' analysis and compare them to Caucasian individuals.

Methods: Seventy lateral cephalometries of Zanjanian adults (17 - 29 years old) who had been referred to a private orthodontic office in Zanjan, Iran with class I molar and canine relationship and normal overjet and overbite as well as minimum crowding/spacing/rotations were scanned and traced with the Novatech scanner and Dolphin software version 10. Next, statistical analyses were performed in order to compare the Zanjanian population to Caucasians.

Results: We found a significant difference between males and females in terms of interincisal angle, incisor-occlusal angle, incisor-mandibular plane angle, upper incisor proclination, facial angle, and angle of convexity.

Discussion: The analysis of six statistically significant parameters indicates that the upper and lower incisors in women of Zanjan were proclined and protruded compared with those of Caucasian subjects. Due to the statistical analysis on facial angle and angle of convexity, women also show more maxillary prognathism and skeletal class II pattern. Generally, a comparison of Zanjanian population cephalometrics based on Downs' analysis showed an increase in maxillary prognathism, maxillary and mandibular incisal protrusion and posterior rotation of the mandible.

Conclusions: In conclusion, the Zanjanian population tends to have more dental and skeletal class II patterns than the Caucasians. In addition, gender comparison indicates lower and upper-incisors protrusion in women of Zanjan.

Keywords: Orthodontic, Dolphin Software, Downs' Analysis, Cephalometry

1. Background

Since the invention of cephalometry, numerous researchers have described several points, lines, and angles on the cephalogram to analyze, diagnose, and recommend treatment options. Orthodontists use cephalogram tracing for determining the direction and degree of orthodontic manipulation (1). Knowledge of typical dimensions and angles is essential in orthodontic diagnosis and treatment planning (2). The facial and skeletal characteristics of a nation play a critical role in orthodontic treatment planning (3). Therefore, for a more reliable diagnosis, several authors assessed the cephalometric standards through noticeable racial differences (3, 4). Downs was presumably the first to describe the variation in human facial relationships in 1948; providing analysis based on evaluations performed on five skeletal and five dental parameters (1, 5). Studies were conducted by Haji Ghadimi et al. (6), Farahani et al. in Tehran (7), Farhadian et al. in Hamedan (8) and Nouri et al. in Ghazvin (9). Other studies on the Iranian population among various ethnicities have also proved the differences in cephalometric standards between the Iranians and other communities. According to studies, Iranians cannot apply the standard criteria presented in various cephalometric analyses related to other nations (10, 11). As there are different races in different geographical regions of Iran with different skeletal and dental patterns, the study of normal cephalometry of each part separately is essential. In addition, there are differences between males and females and different ages in a racial group that should be considered (12-14). Due to the importance of this issue, McNamara's Analysis standards can be applied for

some Iranian types (15). For the Zanjanian population, no standard cephalometric study has been conducted yet.

2. Objectives

The present study aimed to determine the cephalometric standards of young Zanjanian adults with class I occlusion based on Downs' analysis in 2016.

3. Methods

In this descriptive analytical retrospective cross-sectional study in 2016, cephalograms of seventy Zanjanian adults (35 males and 35 females) with an age range of 17 - 29 were assessed based on Downs' analysis. Members were chosen based on the convenience sampling method with the following inclusion and exclusion criteria.

Inclusion criteria: (1) zanjanian population; (2) presence of all permanent teeth except for third molars; (3) class I molar and canine relationship; (4) normal overjet and overbite (3 mm); (5) minimum crowding/spacing/rotations; (6) age range between 17 - 29.

Exclusion criteria: (1) previous orthodontic or surgical treatment.

3.1. Data Collection

Seventy patients who had been referred to a private orthodontic office in Zanjan, Iran, were selected based on the inclusion and exclusion criteria. Lateral cephalometries was requested for all participants. Patients were briefed about the study and signed informed consent forms before participating in the study. Cephalometric radiographs were taken with all subjects in natural head position and their teeth in centric occlusion. The Novatech scanner was used for scanning the cephalometries, then the digitalized forms were transferred to the Dolphin software version 10. After selecting the desired parameters, tracing and measuring the values were performed by the software.

3.2. Statistical Analysis

Descriptive statistics, including the mean, standard deviation (SD) and P-value, were measured. Statistical differences between the Zanjanian norms and the Caucasian norms based on Downs' analysis were calculated using a one-sample *t*-test. To compare the measurements between men and women, independent samples *t*-test was used. And a level of $P < 0.05$ was considered significant.

4. Results

In this study, ten Downs' cephalometric variables were evaluated in 35 men and 35 women with an age range of 17 - 29 amonst the Zanjanian population. Mean $\pm$ standard deviation and P-value were calculated, which are presented in Table 1. Furthermore, we compared these values with the measurements obtained in a similar study on Caucasians, as shown in Table 2.

Statistical analysis showed a significant difference between men and women in six parameters, including four dental parameters (interincisal angle, incisor-occlusal angle, incisor-mandibular plane angle and upper incisor proclination) and two skeletal ones (facial angle and angle of convexity) , which showed a tendency to class II pattern among women.

Of the ten measured parameters, five were higher in men, and five were higher in women (Table 1).

Regarding Downs' average value, comparing Zanjanian and Caucasian populations showed an increase in six parameters in zanjanian adults (facial angle, angle of convexity, mandibular plane angle, cant of occlusal plane, incisor-mandibular plane angle, upper incisor proclination). A-B plane angle was almost the same, and three of the parameters were below the average range (Y-axis, incisor-occlusal angle, incisor-mandibular plane angle) (Table 2).

5. Discussion

Cephalometric analysis has been routinely utilized in order to discover the relationships of the dentofacial complex (16). For more trustworthy diagnoses, several standards have been developed about various racial and ethnic groups. All these studies indicate that the standard measurements for one group should not be considered normal for others. Different populations must be managed according to their particular characters (17). We decided to examine the Zanjanian population features based on Downs' analysis specifically to reach this purpose.

Downs' analysis includes ten measurements (five skeletal and five dental parameters) which have been determined from comparison and correlations of cephalometric records of 20 Caucasian patients (5, 18). Each variable is discussed separately below:

The facial angle is an indication of the anteroposterior positioning of the mandible to the upper face (19, 20). In this study, the increase of facial angle in men indicates the tendency towards skeletal class III with a prominent chin in Zanjanian men.

The larger angle of convexity in women in our study showed a prominent maxillary denture base in relation to the mandible. Dr. Holdaway has stated in his article in 1983

Table 1. Mean, Standard Deviation and P-Value of Ten Downs Analysis Parameters According to Gender [a]

Cephalometric Parameters	N	Mean ± SD	P-Value
Facial angle			0.001 [b]
Female	35	87.28 ± 1.90	
Male	35	89.34 ± 2.57	
Angle of convexity			0.000 [b]
Female	35	6.18 ± 3.11	
Male	35	2.46 ± 3.52	
A-B Plane angle			0.165
Female	35	-5.01 ± 2.29	
Male	35	-4.25 ± 2.23	
Y-axis			0.963
Female	35	58.20 ± 2.90	
Male	35	58.58 ± 3.22	
mandibular plane angle			0.298
Female	35	23.27 ± 4.35	
Male	35	22.14 ± 4.64	
Cant of occlusal plane			0.148
Female	35	10.87 ± 3.46	
Male	35	9.37 ± 3.29	
Interincisal angle			0.001 [b]
Female	35	127.99 ± 5.44	
Male	35	133.85 ± 6.83	
Incisor-occlusal angle			0.012 [b]
Female	35	66.75 ± 3.80	
Male	35	69.57 ± 5.23	
Incisor-mandibular plane angle			0.003 [b]
Female	35	97.02 ± 5.17	
Male	35	93.06 ± 6.24	
Upper incisor proclination			0.004 [b]
Female	35	7.24 ± 2.30	
Male	35	5.48 ± 2.62	

[a] Facial angle (angle between nasion - pogonion and Frankfurt horizontal line); Angle of convexity (angle between nasion - a point and a point - pogonion line); A-B plane angle (point a-point b to nasion-pogonion angle); Y axis (sella gnathion to Frankfurt Horizontal Plane); Mandibular plane angle (angle between Frankfort horizontal line and the line intersecting Gonion-Menton); Cant of occlusal plane (angle of cant of occlusal plane in relation to FH plane); Inter-incisal angle (angle between long axes of upper and lower incisors); Incisor occlusal plane angle (angle between line through long axis of lower incisor and occlusal plane); Incisor mandibular plane angle (angle between line through long axis of lower incisor and mandibular plane); Upper incisor proclination (U1 to A-Pog Line).
[b] Statistically significant.

that convexity is not a soft-tissue measurement. Nevertheless, since convexity is straightly related to harmonious lip positions, it could affect the dental relationships needed to produce harmony in the human face (19).

The third parameter, i.e. A-B plane angle with -4.25 in men and -5.01 in women, indicated a class II pattern with a more prominent maxilla among Zanjanian women. However, it was not statistically significant.

According to Downs' analysis, the Y-axis increased in class II facial pattern and also indicated the vertical growth pattern of the mandible (20. Also, the difference was not statistically significant but showed a minor increase in men.

The last two skeletal parameters, i.e. mandibular plane

Table 2. Mean, Standard Deviation of Downs Analysis Parameters of Zanjanian and Caucasian

Cephalometric Parameters/Nation	Mean ± SD
Facial angle	
Zanjanian	88.31 ± 2.47
Down	87.8 ± 2.57
Angle of convexity	
Zanjanian	4.32 ± 3.79
Down	0 ± 3.52
A-B Plane angle	
Zanjanian	-4.63 ± 2.28
Down	-4.6 ± 2.23
Y_Axis	
Zanjanian	58.37 ± 3.04
Down	59.4 ± 3.8
Mandibular plane angle	
Zanjanian	22.71 ± 4.50
Down	21.9 ± 3
Cant of occlusal plane	
Zanjanian	10.12 ± 3.44
Down	9.3 ± 3.8
Interincisal angle	
Zanjanian	130.92 ± 6.80
Down	135.4 ± 3.5
Incisor-occlusal angle	
Zanjanian	68.16 ± 4.75
Down	69.57 ± 5.23
Incisor-mandibular plane angle	
Zanjanian	95.04 ± 6.03
Down	91.4 ± 3.8
Upper incisor proclination	
Zanjanian	6.36 ± 2.60
Down	2.7 ± 3

angle and cant of the occlusal plane, were also not statistically significant. Nevertheless, they were both higher in women, which presented the posterior rotation of mandible and dental class II pattern in Zanjanian women (20). Among the dental parameters, the interincisal angle is the first to determine the retroclination and proclination of upper and lower incisors. It is also critical in controlling continuous alveolar eruption of incisors. An increased inter-incisal angle is often associated with an increased overbite (21). In the current study, the inter-incisal grade was significantly lower in women. In Downs' analysis, the maxillary and mandibular incisor inclination evaluation is measured by relating the upper incisors to the A-Pog line and the lower incisors to the mandibular plane (22). The rise in measurements on the incisor-mandibular plane angle and U1 to A-Pog line in women indicates a more upper and lower-incisor proclination in women than men.

In conclusion, the rational analysis of six statistically significant parameters indicates that the upper and lower incisors in women of Zanjan were proclined and protruded compared with those of Caucasian subjects, which suggests an inclination to have a class II dental pattern in Zanjanian women. Due to the statistical analysis on facial angle and angle of convexity, women also show more maxillary prognathism and skeletal class II patterns.

The results of the current study revealed several differences between Zanjanian population values and the reported norms for Dawns' analysis. In comparison with Caucasian, the Zanjanian population had proclined upper and lower incisors to their corresponding dental bases and lowered inter-incisal angle. Among the six skeletal parameters, four were higher in Zanjanian population, which revealed a skeletal class II leaning. Generally, a comparison of Zanjanian population cephalometrics based on Downs' analysis showed an increase in maxillary prognathism, maxillary and mandibular incisal protrusion and posterior rotation of the mandible.

Comparing the present study results with other studies in the Iranian population showed approximate similarity between various Iranian races toward Downs' analysis (6, 7, 9, 10, 23). According to the literature on the Iranian population, the dental system in Iranians is more protrude, and the face is more convex and tends to have a class II dental and skeletal pattern (11). Studies carried out on Egyptians (24), Yemenis (25) and Indians (26) also showed greater facial convexity in these populations in comparison with Caucasians.

In contrast with this study, Hajighadimi et al. study on Iranian children showed more incisal protrusion in men based on Tweed's and Steiner's standards (6). Basafa et al. also discussed that boys in Mashhad have a more convex face (10). The results of Farhadian et al. study on Hamedanian population determined an anterior rotation of the mandible, and therefore a more straight profile, unlike the current study (7). The results of Atashi et al. study on Tabrizian population (2007) showed that the inclination of the occlusal plane is higher in men than in women (23).

Imani et al. evaluated the soft tissue cephalometric norms of Kurdish population in Kermanshah. In this study, the upper lip thickness, soft tissue chin thickness, protrusion of the maxilla, mandible and lower lip, nasolabial angle, H angle, lower face-throat angle and mentolabial sul-

cus depth were significantly greater in Kurds than in Caucasians. Assessing the differences between Kurdish males and females was in contrast to our study, which showed greater maxillary prognathism in males (27).

Poosti et al. studied McNamara's analysis standards in the Iranian population. They concluded that applying McNamara's analysis standards in most Iranians' parameters can be valid. According to their results, the two populations are similar except for Pog-NP that implicates a more prominent chin in Iranian (15).

Rashidvash, in his study, compared the Iranian Azeris and Persians. The results showed that Iranian Azeris and Persians do not differ significantly from each other, indicating that generally, the cephalometric peculiarities are approximately the same among different ethnic groups (28).

The limitations of the present research include those associated with cross-sectional studies.

Further investigations with a larger sample size are needed to confirm the present results. We recommend future studies to assess other cephalometric analyses such as Mc Namara, Tweed, Steiner, etc., on the Zanjanian population. Also, in addition to lateral cephalometry is suggested to evaluate the 3-dimensional soft tissue norms.

5.1. Conclusion

Cephalometric norms taken from Caucasians means are helpful diagnostic aids but should not be accepted as treatment goals for all races. Zanjanian population means show a tendency towards dental and skeletal class II pattern compared to Caucasians. In addition, gender comparison indicates further lower and upper-incisors protrusion in women of Zanjan.

Footnotes

Authors' Contribution: Dr. Khaleghi, manuscript preparation; Dr. Nourian, case selection/preparation; Dr. Ghorbankhan, data collection and analysis; Dr.Farzan, project leading, corresponding author.

Conflict of Interests: The authors declare no potential conflicts of interest.

Ethical Approval: IR.ZUMS.REC.13950426

Funding/Support: The authors received no financial support.

Informed Consent: Patients were briefed about the study and signed informed consent forms before participating in the study.

References

1. Taub PJ. Cephalometry. *J Craniofac Surg*. 2007;**18**(4):811–7. doi: 10.1097/scs.0b013e31806848cf. [PubMed: 17667670].
2. Stupar I, Yetkiner E, Wiedemeier D, Attin T, Attin R. Influence of lateral cephalometric radiographs on orthodontic treatment planning of class II patients. *Open Dent J*. 2018;**12**:296–302. doi: 10.2174/1874210601812010296. [PubMed: 29760822]. [PubMed Central: PMC5906967].
3. Hassan AH. Cephalometric norms for saudi adults living in the western region of Saudi Arabia. *Angle Orthod*. 2006;**76**(1):109–13. doi: 10.1043/0003-3219(2006)076[0109:CNFSAL]2.0.CO;2. [PubMed: 16448278].
4. Wu J, Hagg U, Rabie AB. Chinese norms of McNamara's cephalometric analysis. *Angle Orthod*. 2007;**77**(1):12–20. doi: 10.2319/021606-62R.1. [PubMed: 17029538].
5. Downs WB. Variations in facial relationships; their significance in treatment and prognosis. *Am J Orthod*. 1948;**34**(10):812–40. doi: 10.1016/0002-9416(48)90015-3. [PubMed: 18882558].
6. Hajighadimi M, Dougherty HL, Garakani F. Cephalometric evaluation of Iranian children and its comparison with Tweed's and Steiner's standards. *Am J Orthod*. 1981;**79**(2):192–7. doi: 10.1016/0002-9416(81)90317-1. [PubMed: 6937142].
7. Faraahani M, Seyfi M, Eslami Y. [A comparison of cephalometric standards of Iranian and American Caucasian adolescents]. *Journal of Dental School Shahid Beheshti University of Medical Science*. 2004;**22**(3):495–501. Persian.
8. Farhadian N, Miresmaeili AF, Mahjoub H. [Cephalometric standards of pre-university boys with normal occlusion in Hamadan]. *Avicenna Journal of Clinical Medicine (Scientific Journal of Hamadan University of Medical Sciences and Health Services)*. 2005;**12**(1 (SN 35)):39–43. Persian.
9. Nouri M, Adeli Najafi M, Azimi S. [Digital comparison of cephalometric standards between to 11 year old iranians and American caucasions, after 2 years follow up with Dentofacial Planner software]. *Journal of Dental School Shahid Beheshti University of Medical Science*. 2008;**26**(1(75)):85–94. Persian.
10. Basafa M, Shahri F. [Cephalometric criteria of 12-year-old children in Mashhad with normal occlusion]. *Journal of Dental School Shahid Beheshti University of Medical Science*. 2007;**24**(4 (70)):415–23. Persian.
11. Azarbayejani S, Omrani A, Kalaantar-Motamedi A, Abdellahi M, Taalebi V, Teimoori F. Cephalometric norms for 6-17 year-old Iranians with normal occlusion and well-balanced faces. *Dent Res J (Isfahan)*. 2014;**11**(3):327–35. [PubMed: 25097642]. [PubMed Central: PMC4119365].
12. Golalipour MJ, Jahanshahi M, Haidari K. Morphological evaluation of head in turkman males in Gorgan-North of Iran. *Int J Morphol*. 2007;**25**(1). doi: 10.4067/s0717-95022007000100013.
13. Heidari Z, Mahmoudza HR, Noor MH. [Morphological evaluation of head and face in 18-25 years old women in southeast of Iran]. *J Med Sci*. 2006;**6**(3):400–4. Persian. doi: 10.3923/jms.2006.400.404.
14. Behbehani F, Hicks EP, Beeman C, Kluemper GT, Rayens MK. Racial variations in cephalometric analysis between Whites and Kuwaitis. *Angle Orthod*. 2006;**76**(3):406–11. doi: 10.1043/0003-3219(2006)076[0406:RVICAB]2.0.CO;2. [PubMed: 16637719].
15. Poosti M, Amini F, Darnahal A, Mokhnefi P. Normal standards of McNamara analysis in Iranian adult population. *Iran J Orthod*. 2012;**7**(1):1–5.
16. Parajuli U, Mishra P, Bhattarai P, Bajracharya M, Tuladhar S. Comparason of Downs analysis amongst Nepalese ethenic groups-Brahmins, Hindu Newars and Buddhist Newars. *J Nepal Dent Assoc*. 2013;**13**:10–4.
17. Lahlou K, Bahoum A, Makhoukhi MB, Aalloula el H. Comparison of dentoalveolar protrusion values in Moroccans and other populations. *Eur J Orthod*. 2010;**32**(4):430–4. doi: 10.1093/ejo/cjp113. [PubMed: 20018796].
18. Munandar S, Snow MD. Cephalometric analysis of Deutero-Malay Indonesians. *Aust Dent J*. 1995;**40**(6):381–8. doi: 10.1111/j.1834-7819.1995.tb04837.x. [PubMed: 8615744].

19. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. *Am J Orthod*. 1983;**84**(1):1–28. doi: 10.1016/0002-9416(83)90144-6. [PubMed: 6575614].
20. Reddy A, Manju A, Muthukumaran B, Kulkarni C, Nandakumar A. Cephalometric Downs' analysis. A mathematical framework. *16th World Computer Congress*. Beijing, China. IEEE; 2000. p. 103–6.
21. Singh S, Shivaprakash G. To evaluate the correlation between skeletal and dental parameters to the amount of crowding in class II Div. 1 malocclusions. *J Clin Diagn Res*. 2017;**11**(9):ZC22–7. doi: 10.7860/JCDR/2017/27675.10566. [PubMed: 29207827]. [PubMed Central: PMC5713849].
22. Aldrees AM. Evaluation of incisors inclination in five cephalometric analysis methods. *Pak Oral Dental J*. 2010;**30**(2):418–24.
23. Ahangar Atashi MH, Bardal R. [A template based on concept of natural head position for Tabriz's adults]. *Journal of Dental School Shahid Beheshti University of Medical Science*. 2007;**25**(2 (72)):119–26. Persian.
24. Bishara SE, Abdalla EM, Hoppens BJ. Cephalometric comparisons of dentofacial parameters between Egyptian and North American adolescents. *Am J Orthod Dentofacial Orthop*. 1990;**97**(5):413–21. doi: 10.1016/0889-5406(90)70113-Q. [PubMed: 2333855].
25. Al-Gunaid T, Yamada K, Yamaki M, Saito I. Soft-tissue cephalometric norms in Yemeni men. *Am J Orthod Dentofacial Orthop*. 2007;**132**(5):576 e7–14. doi: 10.1016/j.ajodo.2007.03.018. [PubMed: 18005826].
26. Jain P, Kalra JP. Soft tissue cephalometric norms for a North Indian population group using Legan and Burstone analysis. *Int J Oral Maxillofac Surg*. 2011;**40**(3):255–9. doi: 10.1016/j.ijom.2010.09.011. [PubMed: 20965694].
27. Imani MM, Hosseini SA, Arab S, Delavarian M. [Characterization of soft tissue cephalometric norms of Kurdish population of Iran]. *Journal of Research in Medical and Dental Science*. 2018;**6**(1):335–42. Persian.
28. Rashidvash V. Multivariate comparison of cephalometric traits in Iranian azeris and persians. *Research on Humanities and Social Sciences*. 2011;**63**(2):78–80.