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Relationship between the Estimated Dental Age and Chronological Age Using the Demirjian Method in an Iranian Population

Aisan Nouri [1] , Mostafa Sheikhi [2] ⬤ ✉ , Seyed Kian Haji Seyed Javadi [3]

[1] Dental Biomaterials Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
[2] Department of Orthodontics, School of Dentistry, Zanjan University of Medical Sciences, Zanjan, Iran
[3] Community Oral Health Department, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

✉ **Corresponding author:**
Mostafa Sheikhi, Department of Orthodontics, School of Dentistry, Zanjan University of Medical Sciences, Zanjan, Iran

mostafasheikhi9045@gmail.com

Abstract

Background and Aim: The most valid method for radiographic estimation of dental age is the Demirjian method. However, the use of Demirjian indices has shown variations among different races worldwide. Therefore, the aim of this study was to investigate the relationship between the chronological age and dental age of 6-15-year-old children in Zanjan, Iran by using the Demirjian method.

Materials and Methods: In this descriptive correlational study, 250 panoramic radiographs of children aged 6 to 15 years in Zanjan, Iran were used. The dental age was calculated from the radiographic images based on the calcification stage of all left mandibular teeth according to the Demirjian method. The chronological age and demographic data were collected based on patient records. The relationship between the chronological age and dental age was analyzed by the Spearman correlation coefficient and Wilcoxon test.

Results: There was a strong positive correlation between the chronological age and dental age of all participants (r=0.93). Comparing the mean chronological age and dental age of the participants showed a significant difference between the two values (P<0.001).

Conclusion: Based on the results of the present study, it may be concluded that despite significant statistical differences, the Demirjian method has sufficient clinical accuracy for dental age estimation in 6–15-year-olds in Zanjan, Iran.

Key Words: Age Determination by Teeth; Child; Iran; Radiography, Panoramic; Tooth Calcification

Introduction

Dental age is a type of developmental age considered by pediatric dentists, orthodontists, and dental practitioners in treatment of various anomalies [1, 2]. Different methods are used to determine dental age. The Demirjian method is the most valid method and, due to its simplicity, it is also highly accepted [3, 4]. This method is based on estimating dental maturity or dental age according to the data extracted from panoramic radiographs of a large population of Canadian-French girls and boys. According to Demirjian, it seems that the developmental pattern of teeth in different populations is not highly different, the maturity index in different populations is similar, and a

difference is only seen when these maturity indices are translated to dental age which depends on the target population [5]. However, application of the Demirjian method and maturity indices for different populations has always been a matter of question [6, 7]. This method has been studied in different populations, and the application of the Demirjian indices has shown differences between different races worldwide [8].

Chandramohan et al. [9] showed a significant difference between dental age and chronological age of girls and boys aged 11-16 years in Bangalore, India, and reported that the Demirjian method can be used in this population with a suitable correction factor. Mohtavipour et al. [10] reported that the Demirjian dental age standards may not be appropriate for children aged 6-14 years in Guilan, Iran and age-specific dental assessment standards should be established for this population. In a retrospective cross-sectional study, Sheikhi et al. [7] reported that the Demirjian method was accurate in estimating the actual age of 4-5 year-old children in Rasht, Iran.

Although several studies have been conducted in different cities of Iran in order to evaluate the effectiveness of the Demirjian method, to date, no study has been conducted in Zanjan, Iran and it seems necessary to evaluate the accuracy of this method for dental age estimation in children residing in Zanjan. This study aimed at investigating the relationship between chronological age and dental age of 6- to 15-year-old children in Zanjan, Iran by the Demirjian method.

Materials and Methods

This descriptive correlational study was conducted on 250 radiographs. The sample size was calculated according to the following formula $N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{u_p^2} + 3$ and considering α=0.05 and β=0.10. The children were selected by convenience sampling. All panoramic radiographs were of good quality and belonged to children aged 6 to 15 years referred to an oral and maxillofacial radiology center in Zanjan, Iran. After selecting the study population, using the information available in the radiology center archives, the researcher collected patient information including chronological age by year, month and day from the clinicians who had ordered the radiographs after obtaining written informed consent from the patients. Radiographic images of patients with incomplete records, previous history of orthodontic treatment, dental injuries or abnormalities, systemic diseases, and those taking steroids were excluded and replaced [11, 12]. All selected panoramic radiographs were coded such that the research team were blinded to the sex and age of patients to avoid bias in the results. To collect information, 30 images were examined independently by a radiologist, a pediatric dentist, an orthodontist, and a trained senior dental student using a negatoscope (LED, AjTeb, Tehran, Iran). To ensure optimal inter-rater reliability, the consensus of all researchers was applied in cases of disagreement. After 2 weeks, 30 images were randomly selected and re-examined by the same observers to assess intra-rater reliability. After ensuring optimal inter-rater and intra-rater reliability, information of the rest of the radiographic images was extracted by the trained dental student. Dental age was determined using 7 left mandibular teeth except for the third molar tooth according to the method proposed by Demirjian et al [5]. In this method, 7 teeth were examined in the left quadrant and each tooth was assigned a letter from A to H depending on its calcification stage. Each letter was then assigned a specific number. Eventually, the numbers were summed, and the total value ranging from 0 and 100 indicated the maturity index. This number was converted to dental age using the Demirjian percentage chart or table [5, 13,14]. The chronological age of the participants was determined by subtracting

their date of birth from the date of radiography. The data were analyzed by SPSS version 19 after allocating appropriate codes. Distribution of chronological age and dental age data was evaluated by the Kolmogorov–Smirnov test. The correlation between these two ages was assessed using the Spearman test. The Wilcoxon signed-rank test was used to determine the difference between the mean chronological age and dental age. The Cohen's kappa coefficient for agreement between the observers (inter-rater reliability) and data reliability for different teeth (intra-examiner reliability) ranged from 0.83 to 0.94, and the significance level of the results was considered to be 0.05. This study was approved by the Ethics Committee of Zanjan University of Medical Sciences (IR.ZUMS.REC.1398.031).

Results

In this study, out of 250 radiographs, 128 (51.2%) belonged to females and 122 (48.8%) belonged to males. The mean difference between the chronological age and dental age of the participants was 0.15 years (55 days) (Table 1).

Table 1: Mean chronological age and estimated dental age

Age	Mean (years)	Std. Deviation (years)	P value
Chronological Age	8.75	1.38	0.009*
Dental Age	8.90	1.34	0.000*

*Significant

There was a strong positive correlation (r=0.93) between dental age and chronological age indicating that as the chronological age increased, the dental age also increased (Figure 1). There was also a strong positive correlation in both females and males (Figure 2). The r value (correlation coefficient) was 0.94 for females and 0.91 for males.

The chronological age of 133 individuals was lower and that of 73 was higher than the estimated dental age and 44 patients had

chronological age equivalent to their dental age. Therefore, the Demirjian method over-estimated the age of the majority of the study participants. There was a significant difference between the mean chronological age and dental age of the participants (P<0.001).
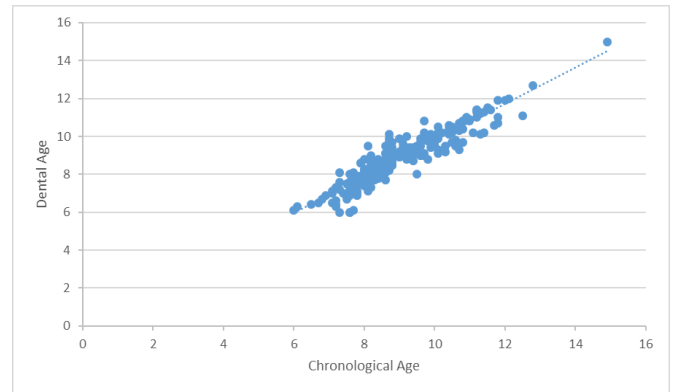

Figure 1. Relationship between the chronological age and estimated dental age by the Demirjian method in the study participants
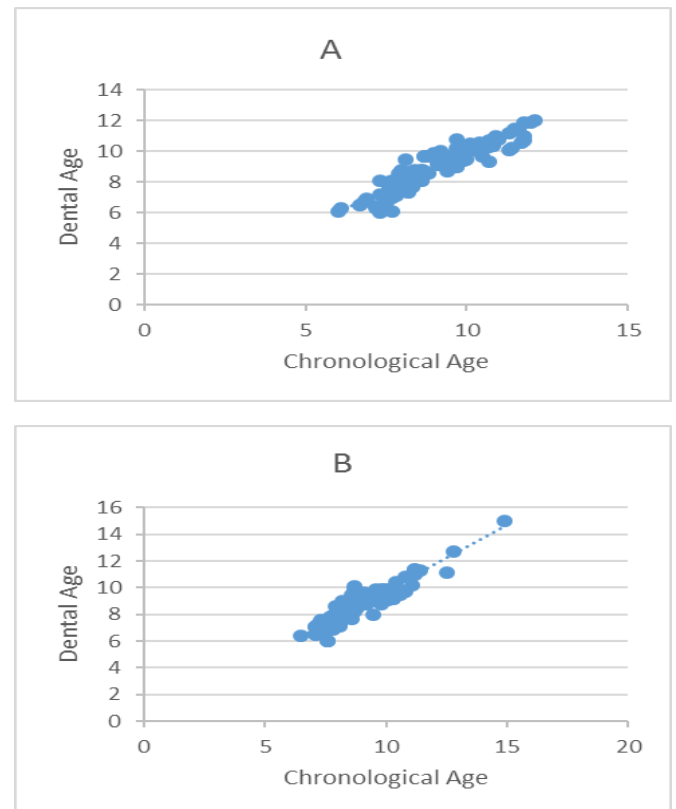

Figure 2. Relationship between the chronological age and estimated dental age by the Demirjian method in females (A) and males (B)

Examination of the difference between the chronological age and dental age of males and females also showed that out of 128 females, the chronological age of 68 (53%) was lower and 38 (30%) was higher than their dental age and 22 (17%) had similar chronological age and dental age. Among males (n=122), the chronological age of 65 (53%) was lower and 35 (29%) was higher than their dental age and 22 (18%) had similar chronological age and dental age. Comparing the mean of these two groups in both males and females showed that there was a significant difference between the mean values (P<0.001 in females and P=0.006 in males).

Discussion

In this study, the Demirjian method overestimated dental age by 0.15 years (55 days). Namadchian et al. [13] also showed that dental age was overestimated by the Demirjian's method. In a study by Sheikhi et al. [7], dental age of 5-16 year-old children in Rasht, Iran was over-estimated by 0.01 years (4 days). The small difference between the study of Sheikhi et al, and the present study could be due to differences in the statistical tests used and differences in the race of the study populations. However, the results of the study by Sheikhi et al. [12] who examined the accuracy of the Demirjian method in estimating the dental age of 5-17 year-old children in Kerman, showed that the estimated dental age of these children was 0.11 years (40 days) lower than their actual age. The differences in the results may be due to differences in the study populations, lifestyles, diet, and perhaps the statistical tests used in studies. Moreover, the study by Sheikhi et al, [12] in Kerman covered a wider age range than the present study and the study conducted in Rasht [7].

The results of the present study showed that there was a strong positive correlation between the chronological age and estimated dental age with the Demirjian's method in total, and also separately in males and females. This finding was similar to the results of a study by Naseh et al. [15]. They reported a strong significant correlation between chronological age and dental age so that the correlation coefficient (r) in girls and boys was 0.91 and 0.90, respectively. In the present study, this coefficient was 0.94 for females and 0.91 for males. According to the results of the present study, the correlation coefficient of chronological age and estimated dental age in the entire population was 0.93. This coefficient was calculated to be 0.95 in the study by Sheikhi et al. in Kerman [12] which was in agreement with the results of the present study. Gupta et al. [16] in Uttar Pradesh, India reported a correlation coefficient of 0.824 for 762 samples. The correlation coefficients for boys and girls were 0.852 and 0.780, respectively. Sheikhi et al. [7] in their study conducted in Rasht, Iran reported a correlation coefficient of 0.73. The correlation coefficients for boys and girls were 0.75 and 0.68, respectively. The difference between the abovementioned studies and the present study could be due to differences in sample size and use of the Pearson correlation test by them; whereas, we used the Spearman test for correlation analysis.

The results of the present study showed that despite the slight difference between the mean chronological age and dental age (55 days), this difference was statistically significant. In the study by Prakoeswa et al. [17] with a sample size of 162 people in Surabaya, Indonesia, the mean difference between the two age groups was not statistically significant in males aged 6-17 years (18 days).The mean difference between the two age groups was not statistically significant in children aged 5-17 years in Shiraz (40 days) [14] and children aged 5-16 years in Rasht (4 days) [7]. In the study by

Sheikhi et al. [12] samples were selected randomly. In the present study, however, convenience sampling was applied, and the results could not be generalized to the entire population.

Some authors consider the difference between dental age and estimated age of up to 12 months to be the normal standard [18]. Thus, despite the significant differences between the data, it can be argued that 55 days in this study is not significant in the clinical scale and the Demirjian method can be accurate to estimate the age of 6–15-year-old children in Zanjan. Despite the low correlation between the chronological age and the dental age of the study population, Sheikhi et al. [7] reported that the Demirjian method had sufficient accuracy for age estimation of 5-16 year-old children in Rasht. Other studies, such as the study by Naseh et al. [15] in Qazvin, Iran, Rai in India [18], NykaÈnen et al. [19] in Norway, Farah et al. [20] in Western Australia and Leurs et al. [21] in Netherlands reported the optimal accuracy of the Demirjian method in estimating the age of children. However, some other studies such as those by Moness Ali et al, [22] in Egypt, Tunc and Koyuturk , [23] in northern Turkey, Nyarady et al. [24] in southwestern Hungary, Lee et al. [25] in South Korea, Chen et al, [26] in China and Mckenna et al. [27] in Australia found that application of the Demirjian method in some populations was unacceptable due to the large differences. This difference in the results could be due to factors such as differences in ethnicity, race, culture, sample size, environmental factors, socioeconomic status, nutrition, dietary habits, statistical methods, and subjectivity of different populations [28]. Based on the results, it can be argued that the efficacy and accuracy of each method for estimating dental age are different and for each population, the most efficient method should be investigated and applied.

Conclusion

Based on the results of the present study, it may be concluded that the Demirjian method has sufficient and acceptable accuracy for dental age estimation in 6-15-year-old children in Zanjan, Iran.

Acknowledgements

References

1. Kumagai A, Jeong S, Kim D, Kong HJ, Oh S, Lee SS. Validation of data mining models by comparing with conventional methods for dental age estimation in Korean juveniles and young adults. Sci Rep. 2023 Jan 13;13(1):726.

2. Moca AE, Ciavoi G, Todor BI, Negruţiu BM, Cuc EA, Dima R, Moca RT, Vaida LL. Validity of the Demirjian Method for Dental Age Estimation in Romanian Children. Children (Basel). 2022 Apr 16;9(4):567.

3. Melo M, Ata Ali F, Ata-Ali J, Martínez-González JM, Cobo T. Demirjian and Cameriere methods for age estimation in a Spanish sample of 1386 living subjects. Sci Rep 2022; 12(1): 2838.

4. Talaipour A R, Seyedmajidi S, Sajjadi S H, Fani S. Evaluation of the accuracy of Demirjian method in estimating chronological age. J Res Dent Sci 2022;19(2):159-64.

5. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Annals of human biology. 1976;3(5):411-21.

6. Acuña-Méndez N, Valentina Espinoza-Silva P, Rodríguez-Niklitschek C, Fonseca GM. About the Recent Chilean Immigration Phenomenon: A Scoping Review on Radiographic Methods for Dental Age Estimation in Children. Int J Morphol. 2022;40(3):650-6.

7. Sheikhi M, Dakhilalian M, Jamshidi M, Nouri S, Babaei M. Estimation of Chronologic Age in 5-16 Year-Old Children and Adolescents by Demirjian Method in Rasht. JSSU 2013; 21 (1):85-93.

8. ImaniMoghaddam M, Bagherpour A, Tohidi E, Einolghozati M. Age assessment of developmental stages of permanent

mandibular teeth using the Demirjian method. J Mashhad Dent Sch. 2011;35(1):9-16.

9. Chandramohan P, Puranik MP, Uma S. Demirjian method of age estimation using correction factor among Indian children: A retrospective survey. J Indian Assoc Public Health Dent. 2018;16(1):72-4.

10. Mohtavipour ST, Javadzade A, Mohtavipour SS, Nemati S, Saravi AV. Dental Age Estimation of 6-14-Year-Old Guilanian Children Using Demirjian's Method. J Dent Res. 2017;9(4): P2.

11. Aragón HN, Wuscovi LF, López ME. Effects of nutrition on the estimation of dental age in Argentinian children by radiographic method. World J Adv Res Rev. 2023;17(2):578-92.

12. Sheikhi M, Dakhilalian A, Jalalian F. Accuracy of Demirjian's Method to Estimate Chronological Age in 5–17-Year-Old Iranian Population. J Adv Med Med Res. 2019 March;29(1):1-7.

13. Namadchian N, Khafri S, Sheikhzadeh S, Ghasempour M, Moudi E, Seyedmajidi S. A comparison of Demirjian and Cameriere methods in estimating age and development of a modified Cameriere method. Shiraz E Med J. 2022;23(4):1-8.

14. Kermani M, Tabatabaei Yazdi F, Abed Haghighi M. Evaluation of the accuracy of Demirjian's method for estimating chronological age from dental age in Shiraz, Iran: Using geometric morphometrics method. Clin Exp Dent Res. 2019 Mar 4;5(3):191-8.

15. Naseh R, Padisar P, Rahmani J. Correlation between dental and chronological age in 6-15 years old orthodontic patients in Qazvin. Journal of Inflammatory Diseases. 2011; 15(3):18-11

16. Gupta S, Verma AK, Patil R, Singh US, Kumar NK, Bhattacharya SB. Comparison of Demirjian and Cameriere methods and development of modified Cameriere and Demirjian formula more efficient for north Indian population. J Oral Maxillofac Pathol. 2023;27(1):138-47.

17. Prakoeswa BFWR, Kurniawan A, Chusida A, Rizky BN, Darmawan AI, Aisyah AKN, Alias A. Using the Demirjian method for estimating the dental age of children in Surabaya. Indonesia Dent J. 2023; 56(2):87-91.

18. Rai B. Dental age assessment of 7.5 to 16 year-old Indian children using Demirjian's method. Advances in Medical and Dental Sciences. 2008;2(3):53-6.

19. NykaÈnen R, Espeland L, Kvaal SI, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odontol Scand. 1998 Aug;56(4):238-44.

20. Farah C, Knott S, Booth D. Dental maturity of children in Perth, Western Australia, based on the four teeth system developed by Demirjian and Goldstein. Aust Dent J. 1995; 40(4):256-7.

21. Leurs I, Wattel E, Aartman I, Etty E, Prahl-Andersen B. Dental age in Dutch children. Eur J Orthod. 2005 Jun; 27(3): 309-14.

22. Moness Ali AM, Ahmed WH, Khattab NM. Applicability of Demirjian's method for dental age estimation in a group of Egyptian children. BDJ Open. 2019 Mar 21;5:2.

23. Tunc ES, Koyuturk AE. Dental age assessment using Demirjian's method on northern Turkish children. Forensic Sci Int. 2008 Feb;175(1):23-6.

24. Nyarady Z, Mörnstad H, Olasz L, Szabo G. Age estimation of children in south-western Hungary using the modified Demirjian method. Fogorv Sz. 2005 Oct;98(5):193-8.

25. Lee SE, Lee SH, Lee JY, Park HK, Kim YK. Age estimation of Korean children based on dental maturity. Forensic Sci Int. 2008 Jul;178(2-3):125-31.

26. Chen JW, Guo J, Zhou J, Liu RK, Chen TT, Zou Sj. Assessment of dental maturity of western Chinese children using Demirjian's method. Forensic Sci Int. 2010 Apr;197 (1-3):119. e1-. e4.

27. McKenna CJ, James H, Taylor JA, Townsend GC. Tooth development standards for South Australia. Aust Dent J. 2002 Sep;47(3):223-7.

28. Geng J, Duan S, Wang Y, Liu J. Research progress of age estimation in juveniles based on Radiography of developmental stages of teeth. Intl J Front Med. 2023;5(2): 71-7.