# Accuracy Of Dental Age Estimation Using Demirjian's Method In Children And Adolescents Of South Kerala - Across Sectional Study.

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**Abstract:***Age estimation of children and adolescents is essential to answer a variety of legal questions, including issues of status of majority and criminal liability. The teeth are useful predictors of age in this age-group, particularly because of their relative accuracy and also because of the lack of other reliable predictors. Aim:To estimate the Dental age using modifiied Demirjian's method and India specific formula and to correlate it with the chronological age of children and adolescents of south Kerala origin by using panoramic radiographs.Methods:By using Digital OPGs of 100 subjects aged between 8 & 18 years (50 males & 50 females), dental age was estimated by using modified Demirjian's method and India specific formula. Spearman rank correlation test was done to assess the correlation between dental age (DA) and chronological age (CA). Results &Conclusion:The mean CA was 14.31+_ 2.66 and the estimated DA by Demirjian's formula was 12.93 +_ 2.08 and by Indian formula it was 14.73 +_ 2.90 with gender variability .There were significant correlation between DA & CA in both methods; even though the original method underestimated the age by 1.38 years.*
**Key words:** *dental age, chronological age,India specific formula, Demirjian's method*

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## I. Introduction

The determination of physiological age is based on the assessment of degree ofmaturation of different tissue systems. Different categories of biological age have been established: skeletal age, morphological age, secondary sexual character age and dental age. Several methods have been proposed for assessing dental development, which is generally referred to as dental aging. Dental age assessment is important for dental treatment planning and also it has applications in forensic odontology. Teeth and bones are most commonly used for identification of an unknown individual and for age determination.[1]Dental age estimation is a practical method of assessing a child's degree of maturity. Tooth formation is used for assessing dental maturation because it is a continuous and progressive process that can be followed radiographically and most teeth can be evaluated at each examination.When compared to tooth eruption, it isless affected by endocrinopathies and environmental factors, such as malnutrition or disease.[2,3]Observing tooth formation as discrete maturity events such as crown and root stages provides the opportunity to assess maturity from childhood to early adulthood. Demirjian's et al. method [4] of age assessment utilizes seven mandibular teeth on left side, which has been widely used in all populations. Since only seven teeth were studied, it was having limited application in individuals above 16 years and there was some inaccurate results in some previous studies.[4,5,6]To overcome this, Chaillet and Demirjian[7] added the third molar for an assessment of age in French children and derived regression formulas for age assessmentand have included two additional tooth stages for easier calculation and to develop cubic equations with good reliability. Radiographic analysis including third molar development has enabled this method with applicability in a wider age groups. This revised method was tested by Acharya [8] on an Indian sample which showed recognizable differences and led to the development of India-specific formulas to accurately predict the age in Indians. On this backgroundthis studywas conducted to evaluate the applicability and accuracy of Demirjian's and Acharya's formulas for age estimation on individuals between 8 and 18 years of age attending a tertiary dental health care center in South Kerala,India.
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## II. Methods

Study consisted of 100 randomly selected subjects (50 males and 50 females) with age ranging from 8 to 18years. [Table 1].The study was approved by the Ethical Committee of our institution, and the study participants were of same ethnic origin and from a same geographical area comprising mostly of the South Kerala region. Patients withsignificant systemic illness,history of maxillofacial trauma or extraction of

permanent teeth, with impacted, ankylosed or transposition of teeth and with congenital absence of third molars were excluded from the study. All relevant data including the name, sex and birth date were recorded. The digital orthopantomographs (OPG) were taken with a Planmeca digital machine (Planmeca OY, Asentajankatu 6, FIN-00880 Helsinki, Finland) in Department of Oral Medicine and Radiology.

**Table 1: Distribution of entire sample according to age and sex**

| Age | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| <12 | 7 | 14.0 | 12 | 24.0 | 19 | 19.0 |
| 12-15 | 15 | 30.0 | 20 | 40.0 | 35 | 35.0 |
| >15 | 28 | 56.0 | 18 | 36.0 | 46 | 46.0 |
| Total | 50 | 100.0 | 50 | 100.0 | 100 | 100.0 |

**Dental age determination using Demirjian's 8 teeth method**

Chronological age (CA) of an individual was calculated by subtracting the birth date from the date on which the radiographs were exposed for that particular individual with accurate inclusion of the months and days converted into decimal ages. To avoid observer bias, each digital OPG of an individual was coded with a numerical identity number (1–100) to ensure that the examiner was blind to sex, name and age of subjects. The single evaluator was assessing the dental age by following the drawings and written descriptions of the ten stages of tooth development of Demirjian's 8 teeth method that was supplementedwith graphic representations with archetypical radiographs for each stage. Each tooth was Staged 0–9, depending on the stage of calcification. Each stage of the mandibular eight teeth (central incisor to third molar) was allocated a score and the sum of the scores gave a total maturity score (S), which was then substituted in the regression formulas given by Chaillet and Demirjian's (2004) and Acharya (2010) to estimate age of an individual.
Method 1: Chaillet and Demirjian's regression formulas based on tooth development of French children (original method)
1. For males, age $= (0.000055 \times S^3) - (0.0095 \times S^2) + (0.6479 \times S) - 8.4583$
2. For females, age $= (0.0000615 \times S^3) - (0.0106 \times S^2) + (0.6997 \times S) - 9.3178$
Method 2: Acharya's Indian formulas for age estimation (Indian method)
1. 1. For males, age $= 27.4351 - (0.0097 \times S^2) + (0.000089 \times S^3)$
2. 2. For females, age $= 23.7288 - (0.0088 \times S^2) - (0.000085 \times S^3)$

# III. Results

Comparison of the DA by Demirjian's formula (original method)and the CA and the correlation between DA and CA (DA and CA) of both gender are presented in Table 2,3 and Graph 1. The mean CA was 14.31± 2.66 and the estimated DA by Demirjian's formula (original method) was 12.93 ± 2.08 with a mean difference of 1.38 ±1.78. For males, the mean CA was 14.62 ±2.33 and the estimated DA by Demirjian's formula (original method) was13.26 ±2.28 with a mean difference of 1.36 ±1.17. For females, the mean CA was14.00 ± 2.94 and the estimated DA by Demirjian's formula (original method) was 12.61 ±1.83 with a mean difference of 1.39 ± 2.25. Spearman rank correlation test showed a significant relation between DA and CA (r=0.777; p<0.001).There was a significant relation between DA and CA in both males (r= 0.872; p<0.001) and females (r= 0.645; p<0.001).Demirjian's formula (original method) underestimated the mean age of the study population by 1.38 years and it underestimated the mean age of males by 1.36 years and females by 1.39years.

| | N | Age | | Paired difference | | • Spearman rank correlation |
|---|---|---|---|---|---|---|
| | | Mean | sd | Mean | sd | |
| Chronological age | 100 | 14.31 | 2.66 | 1.38 | 1.78 | =0.777 |
| Dental age-Demirjian's | 100 | 12.93 | 2.08 | | | • p<0.001 |

**Table 2: Correlation between chronological age and Dental age (Demirjian's)**
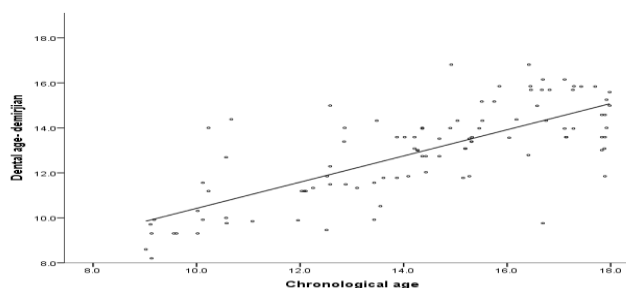


**Graph 1: Correlation between chronological age and Dental age (Demirjian's)**

| Male | N | Age | | Paired difference | | • Spearman rank correlation =0.872 |
|---|---|---|---|---|---|---|
| | | Mean | sd | Mean | sd | |
| Chronological age | 50 | 14.62 | 2.33 | 1.36 | 1.17 | |
| Dental age-demirjian | 50 | 13.26 | 2.28 | | | • p<0.001 |
| Female | N | Age | | Paired difference | | • Spearman rank correlation =0.645 |
| | | Mean | sd | Mean | sd | |
| Chronological age | 50 | 14.00 | 2.94 | 1.39 | 2.25 | • p<0.001 |
| Dental age-demirjian | 50 | 12.61 | 1.83 | | | |

**Table 3: Correlation between chronological age and dental age-Indian Demirjian'sfor males and females**

The comparison of DA using Indian formula and the CA and the correlation between DA and CA of both gender are presented in [Table 4,5] and Graph 2. The mean CA was 14.31± 2.66 and the estimated DA by Indian formula was 14.73 ± 2.90 with a mean difference of 0.42 ±2.21. For males, the mean CA was 14.62 ± 2.33 and the estimated DA by Indian formula was14.69 ±2.77 with a mean difference of 0.07 ± 1.49. For females, the mean CA was14.00 ± 2.94 and the estimated DA by Indian formulawas 14.78 ±3.05 with a mean difference of 0.78± 2.71`. Spearman rank correlation test showed a significant relation between DA and CA (r=0.707; p<0.001).There was a significant relation between DA and CA in both males (r= 0.843; p<0.001) and females (r= 0.591; p<0.001). Demirjian method using Indian formula overestimated the mean age of the study population by 0.42 years and it overestimated the mean age of males by 0.07 years and females by 0.78 years.

| | N | Age | | Paired difference | |
|---|---|---|---|---|---|
| | | Mean | sd | Mean | sd |
| Chronological age | 100 | 14.31 | 2.66 | 0.42 | 2.21 |
| dental age-Indian | 100 | 14.73 | 2.90 | | |

**Table 4: Correlation between chronological age and dental age-Indian**
**Spearman rank correlation =0.707          p<0.001**

| Male | N | Age | | Paired difference | | • Spearman rank correlation =0.843 |
|---|---|---|---|---|---|---|
| | | Mean | sd | Mean | sd | |
| Chronological age | 50 | 14.62 | 2.33 | -0.07 | 1.49 | |
| Dental age-demirjian | 50 | 14.69 | 2.77 | | | • p<0.001 |
| Female | N | Age | | Paired difference | | • Spearman rank correlation =0.591 |
| | | Mean | sd | Mean | sd | |
| Chronological age | 50 | 14.00 | 2.94 | -0.78 | 2.71 | • p<0.001 |
| Dental age-demirjian | 50 | 14.78 | 3.05 | | | |

**Table 5: Correlation betweenChronological age and dental age for males and females –Indian method**
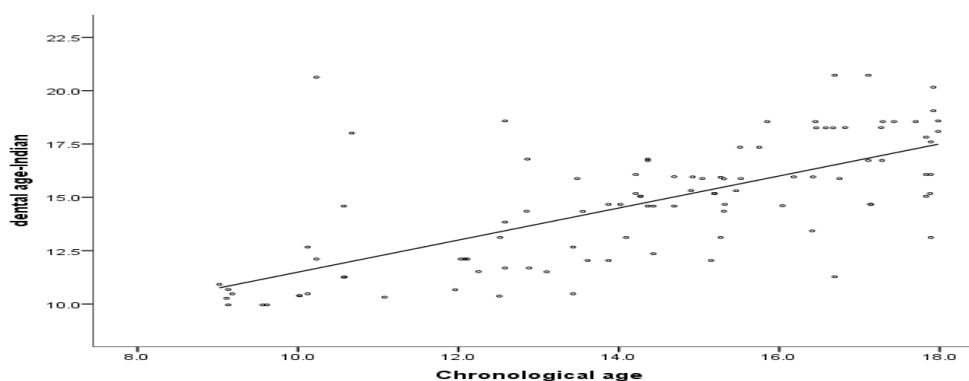


**Graph 2: Correlation between chronological age and dental age-Indian**

## IV. Discussion

Demirjian's method is one of the widely useddental age estimation technique in children and adolescents because of the simplicity of the method, as well as radiographic and schematic illustrations of tooth development with descriptions provided in all works.[5,7,10] Various studies reported [5,9,11] wide variations between estimated and actual age;which suggest the use of population specific standards.Previous studies [4,5,6] on Indian population have shown overestimation of age by applying the Demirjian's 7 teeth method. Chaillet and Demirjian's[8] method utilized third molar and developed new maturity scores for age estimation in French children and regression formulas derived in this study were used by Acharya[8] in Indians, as resulted in discrepancies in estimated age, led to development of India-specific regression formulas to predict age.

In the present study, for males, the mean (standard deviation [SD]) CA was $14.62 \pm (2.33 years)$. The mean DA was 13.62 years (2.28 years) with a mean difference of 1.36 years according to the Demirjian'smethod; and the mean DA was 14.69 years (2.77 years) with a mean accuracy of 0.07 years according to the Indian method. For girls, the mean (SD) CA was 14.00 years (2.94years). The mean DA was 12.61 years (1.83 years) with a mean difference of 1.39 years according to the Demirjian's method and the mean DA was 14.78 years (3.05years) with a mean accuracy of 0.78 years according to the Indian method.

The present study resulted in better age prediction in males compared to females according to both Demirjian's formula and Indian formulas similar to previous study,[8] where Indian formula was used. However, in contrast to present study, females were accurately predicted in other study, where only Indian formulas were used.[12] The present study also showed that Indian formulas were more accurate (0.42 years) in predicting age compared to Demirjian's (1.38 years) formulas similar to previous study[8]where Indian formula was used. However, in contrast to present study, females were accurately predicted in other study, where only Indian formulas were used. [8] The present study also showed that Indian formulas were more accurate (0.42 years) in predicting age compared to Demirjian's (1.38 years) formulas similar to previous study[8]. Significant correlation was found between the estimated DA, according to Demirjian's formulas (r= 0.777) and Indian formulas (r = 0.707), and CA.

Acharya compared the Indian as well as Chaillet and Demirjian's cubic equations on a 9–18 years age group of 70 Indian individuals. The test of the Indian regression formulas revealed better age prediction compared to Demirjian's formulas in terms of mean absolute error (MAE), similar to present study. The Indian formulas resulted in an MAE of 0.87 years (0.7 years in males, 0.99 years in females) and Demirjian formulas deduced an MAE of 1.29 years (0.94 in males and 1.55 in females). However, Acharya[8] also tested the Indian regression equations on a sample of 461 Indian individuals aged between 7 and 25 years and resulted in an MAE of 1.43 years (1.17 years for males and 1.6 years for females).. Kumar and Gopal[12] utilized only Indian regression formulas for age estimation in 7–23 year age individuals, resulted in an MAE of 1.18 years for the total sample.

In the present study, Demirjian's cubic equations showed an underestimation of age in agreement with the previous study.[8] This can be attributed to the addition of the third molar, which may have resulted in an underestimation of age in all age groups. This may imply that the third molar contributes to an overall slowing down of dental development in Indians. On the other hand, in the present study, use of Indian specific formulas tends to slightly over estimate the age. Overall, the average age of the total sample was 14.31 years, whereas the mean of the estimated age using the Indian formulas was 14.73 years. In this study, the test of the India-specific cubic functions and the original formulas revealed better ability of the former to predict age accurately in South Indians in agreement with previous study.[8]

Conclusion

Age estimation using Demirjian's 8 teeth method seems to be applicable in a wider age range because of the inclusion of third molars. In this study, Demirjian's regression equations resulted in underestimation of age and Indian specific cubic equations resulted in mild overestimation of age. However, both the methods tested using Demirjian's 8 teeth method were found to be reliable in assessing age.Method using India specific formula was most accurate for predicting the age.

## References

[1]. Chaillet N, Willems G, Demirjian A. Dental maturity in Belgian children using Demirjian's method and polynomial functions: New standard curves for forensic and clinical use. J Forensic Odontostomatol. 2004;22:18–27.
[2]. Eid RM, Simi R, Friggi MN, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. Int J Paediatr Dent. 2002;12:423–8.
[3]. Sciulli PW. Relative dental maturity and associated skeletal maturity in prehistoric native Americans of the Ohio valley area. Am J Phys Anthropol. 2007;132:545–57.
[4]. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973;45:211–27.
[5]. Prabhakar AR, Panda AK, Raju OS. Applicability of Demirjian's method of age assessment in children of Davangere. J Indian SocPedodPrev Dent. 2002;20:54–62.
[6]. Hegde RJ, Sood PB. Dental maturity as an indicator of chronological age: Radiographic evaluation of dental age in 6 to 13 years children of Belgaum using Demirjian methods. J Indian SocPedodPrev Dent. 2002;20:132–8.

[7].    Chaillet N, Demirjian A. Dental maturity in South France: A comparison between Demirjian's method and polynomial functions. J Forensic Sci. 2004;49:1059–66.
[8].    Acharya AB. Age estimation in Indians using Demirjian's 8-teeth method. J Forensic Sci. 2011;56:124–7. [PubMed]
[9].    Chaillet N, Nyström M, Kataja M, Demirjian A. Dental maturity curves in Finnish children: Demirjian's method revisited and polynomial functions for age estimation. J Forensic Sci. 2004;49:1324–31.
[10].   Levesque GY, Demirjian A. The inter-examiner variation in rating dental formation from radiographs. J Dent Res. 1980;59:1123–6.
[11].   Tunc ES, Koyuturk AE. Dental age assessment using Demirjian's method on northern Turkish children. Forensic Sci Int. 2008;175:23–6.
[12].   Kumar VJ, Gopal KS. Reliability of age estimation using Demirjian's 8 teeth method and India specific formula. J Forensic Dent Sci. 2011;3:19–22.