

Estimation of Dental age in Children using Modified Demirjian's Method in Mahe Region

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How to cite this article:

Hajara MC, Rena Ephraim, Ambili Ayilliath *et al.* Estimation of Dental age in Children using Modified Demirjian's Method in Mahe Region. *Ind J Forensic Odontol* 2024;17(1):07-13.

Abstract

Background: Age estimation is one of most important factors employed in establishing the identity of an individual and in dentistry. It is performed to determine dental age of child patient which in many instances is delayed or advanced in relation to their chronological age. Orthodontic and Myofunctional treatments are planned as per dental age rather than chronological age of child. Demirjian's method of age estimation was found to differ in different regions all over world.

Aim: Evaluate the accuracy of dental age estimation, in children aged 6-10 years, using modified Demirjian's Method in region of Mahe and to determine its applicability in Mahe region.

Materials & Methodology: Study sample consisted of orthopantomograms of 160 subjects (80 boys and 80 girls). Using Demirjian's method, modified by Acharya, all OPGs were analysed, in which each tooth stage was rated to obtain a total dental maturity score which was substituted into regression formula to get dental age of each patient. Result was tabulated and statistically analysed. The differences between CA and DA were analysed by the paired sample t-test and Pearson's correlation analysis.

Results: The results of study showed that Demirjian's technique overestimated CA by 2.8(±2.1) years and 2.6(±1.9) years in girls and boys respectively, in children of Mahe. Mahe-specific regression formula was derived as a correction factor.

Conclusion: Modified Demirjian's method is an area specific method of dental age determination and will be applicable to children of Mahe only by using a Mahe specific regression formula.

Keywords: Modified Demirjian's Method; Chronological age; Dental age.

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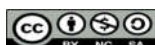
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Received on: 07.08.2024 Accepted on: 16.09.2024

INTRODUCTION

Age estimation is one of the most important factors employed in establishing the identity of an individual and it is performed for various reasons such as mass disasters like fire accidents and crashes.¹ In dentistry as it is performed to determine the dental age of the child patient, which in many instances is delayed or advanced in relation to their chronological age. The



Orthodontic and Myofunctional treatments are planned as per the dental age rather than chronological age of the child. Besides this in living persons, determining the age is vital in individuals without birth certificate, who are getting married, attending school, joining the army, and also in the determination of criminal liability such as forensic purposes, illegal immigration, premature births, developing malocclusions, and paediatric endocrinopathy.^{2,3} Among the various parts of the body, teeth are most commonly used and most reliable indicator in age determination, as teeth are more resistant to taphonomic process after death.

Mayyazhi, increasingly spelled Mahe is a small town at the mouth of the Mayyazhi River and is a rural area situated away from the parent state. Formerly part of French India, Mahe now forms a municipality in Mahe district, one of the four districts of the Union Territory of Puducherry. As an increased prevalence of malocclusion is being noted in children of this area, accurate dental age estimation is much required so as to start intervening the development of malocclusion at the appropriate time. Several methods have been used to estimate the dental age (DA) such as Cameriere's, Willem's, and Demirjian's method for children and adolescents, and Kvall's technique for elderly people. DA estimation using dental calcification and maturity is better than eruption of teeth, because it is not affected by local factors, such as impaction and crowding of permanent teeth, infections, lack of space, ankylosis, and early and delayed extraction of deciduous teeth.⁴

In 1973, Demirjian, Tanner, and Goldstein published the Demirjian's method of age estimation, and it is one of the most frequently used methods for age estimation.⁵ According to the study, a common finding was overestimation of DA when compared to chronological age (CA) and underestimation was also noted. Several authors subsequently modified the original Demirjian's method to bring in more accuracy for their regions. The need for the present study was to evaluate the relationship between DA and CA using modified Demirjian's method and its applicability in Mahe region.

AIM OF THE STUDY

To assess the dental age in children aged 6-10 years using Modified Demirjian's method in a Pediatric dental department and to determine its applicability in the region of Mahe.

OBJECTIVES

- 1) To determine the dental age in 6-10 year old children using Modified Demirjian's Method.
- 2) To correlate the dental age with the chronological age using Modified Demirjian's method in children aged 6-10 years.

MATERIALS AND METHODS

After obtaining ethical clearance from the Institutional Ethics Committee, the study was carried out on 160 children of age group 6-10 years. Children reporting to the department for interceptive procedures were selected for study. Parental consent was obtained to include their children in the study. Digital panoramic radiographs taken for interceptive treatment purpose with standardized procedures were selected for study. Chronological age was taken from patient records and Dental age was estimated using modified Demirjian's method by Acharya. Using Demirjian's method, modified by Acharya, all OPGs were analysed, in which each tooth stage was rated to obtain a total dental maturity score which was substituted into the regression formula to get the dental age of each patient. Result was tabulated and statistically analysed. The differences between CA and DA were analysed by the paired sample t-test and Pearson's correlation analysis.

METHODOLOGY

Total sample size of 160 (*i.e.*, N=160) subjects was established with G* Power Software version 3.1.9.7, using a paired t-test model with an effect size of 0.34, alpha error of 0.05, power of 90%, and a two-tailed significance level (α) of 0.05. The effect size was hypothesized based on prior related work.

Dental age estimation using modified Demirjian's method

In which each tooth stage was rated based on a 10-stage scale from 0 to 9. Stages of each tooth were converted into scores by using conversion table specified by Chaillet & Demirjian, for both girls and boys. Scores of left eight mandibular teeth was summed to obtain a total dental maturity score, which is designated as S. In case of unilateral extraction and radiographic errors, same tooth from opposite side was taken into consideration. The "S"

value was substituted in the regression formula to get the DA for both girls and boys.

$$\text{Males} = 27.4351 - (0.0097 \times S^2) + (0.000089 \times S^3)$$

$$\text{Females} = 23.7288 - (0.0088 \times S^2) + (0.000085 \times S^3)$$

Where S is the sum of eight left mandibular teeth maturity scores.

Inclusion criteria

- Children with availability of complete patient records (date of birth and date of Exposure)
- Children of age group 6-10 years
- Children with no systemic diseases affecting growth

Exclusion criteria

- Children with severe malocclusion
- Children with history of previous orthodontic treatment
- Children with history of bilateral extractions
- Children with history of trauma
- Children with developmental abnormalities
- Children with special health care needs

Statistical Analysis

The collected data was tabulated in a spreadsheet using Microsoft Excel 2019 and then statistical analysis was carried out using IBM SPSS Statistics for Windows, Version 26.0. (Armonk, NY: IBM Corp). Graphs, Box plots, and Pie diagrams were constructed using the Graph Pad Prism for Windows, Version 9.5 (Graph Pad Software, La Jolla California USA). A Shapiro-Wilk's test and a visual inspection of the histograms, normal Q-Q

plots, and box plots showed that the collected data were approximately normally distributed for all the groups. Descriptive statistics were used to report quantitative variables in terms of mean/median (central tendency) and Standard deviation (SD)/ Range (measures of dispersion) along with a 95% confidence interval of the mean. The paired samples t-test was used to compare the CA with the DA calculated by Modified Demirjian's method in boys and girls respectively. Pearson's correlation test was used to correlate the CA with dental maturity scores calculated by Demirjian's method modified by Acharya. Mahe-specific regression formula was also derived as a correction factor. The P-value of 0.05 was considered as the level of significance.

RESULTS

The chronological age (CA) of participants ranged from 6-10 years. In these children the Dental age (DA) was found to be having a mean of 11.2±1.578 for girls and 11.41±1.429 for boys, with modified Demirjian's method. That means the dental age was higher than their chronologic age in the children of Mahe.

In girlsage difference of DA was seen to be 2.73±2.02 years, more than their chronologic age, and 2.65±1.9 years more in boys, when compared to their chronological age while using modified Demirjian's method. On comparative evaluation statistically, estimated DA was found to be significantly higher than CA. (P<0.01) Pearson correlation test was employed to test association between CA and DA estimated by this method and no correlation was found between two variables for girls (r=0.05) and boys (r=-0.02), and the overall subjects (r=0.02).(Table 1)

Table 1: Descriptive statistics of the Chronological Age (CA) and the Dental Age (DA) estimated by Demirjian's method modified by Acharya for females, males, and all the subjects

	Age (in years)	Mean ± SD	95% CI	Median	Min-Max	Difference of DA-CA (in years)	Correlation (r) a
Females (n=80)	DA	11.2±1.578	10.85-11.55	11	17-Oct	2.73±2.02*	0.05ns
	CA	8.475±1.359	8.173-8.777	9	10-Jun		
Males (n=80)	DA	11.41±1.429	11.09-11.73	11	16-Oct	2.65±1.9*	-0.02ns
	CA	8.76±1.275	8.479-9.046	9	10-Jun		

n=sample size per gender; N:total sample size

DA: Dental age estimated by Demirjian's method modified by Acharya

CA: Chronological age

SD: Standard Deviation; CI: Confidence Intervals; Min-minimum; Max-Maximum

A: Pearson's correlation between CA and the Dental maturity scores

ns: not significant (P>0.05),*: highly statistically significant (P<0.01)

The year-wise differences were also calculated according to the difference between the DA and the CA. It was seen that 45% of females and 51.2% of males examined, had a discrepancy of more than 2 years when dental age was estimated by the Modified method. A difference of 1 to 2 years was found in 43% of the girls and 38% of the boys

examined. A difference of less than 1 year was found in only 8 to 9% of girls and boys respectively. (Table 2 & Fig. 1) Gender wise difference was almost equal in all the other ages of 6-10 years, except in 9 year age group where the difference was found to be extremely large.

Table 2: Frequency distribution of the difference in DA and the CA estimated by Demirjian’s method modified by Acharya for females, males, and all the subjects

Difference (in years)	Females (n=80)	Males (n=80)	Total (N=160)
<1 year	9 (11.3%)	8 (10%)	17 (10.6%)
1-2 years	35 (43.8%)	31 (38.8%)	66 (41.3%)
>2 years	36 (45%)	41 (51.2%)	77 (48.1%)

n=sample size per gender; N: total sample size

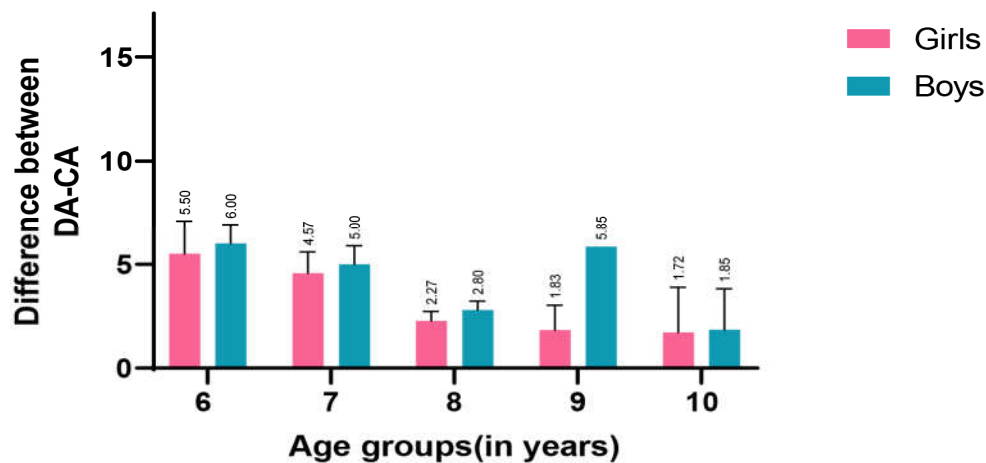


Fig. 1: Gender-wise Differences in the Mean Chronological Age (CA) and the Dental Age (DA) estimated by Demirjian’s method modified by Acharya

A Mahe-specific regression formula was derived by adding the individual scores corresponding to the tooth’s developmental stages yielding the total maturity score “S” on the x-axis and the CA on the y-axis.

The following polynomial regression equation was derived:

Girls: $CA = 0.07673 * S + 3.170$

Boys: $CA = 0.06353 * S + 4.310$

Fig. 2 illustrates a line graph showing the differences from the actual age as estimated by Acharya’s formula and the Mahe-specific formula in girls and boys respectively. Difference in the CA and DA was reduced from excess of 2 to 6 years of age to -1 to -2 years of age after applying the Mahe specific regression formula.

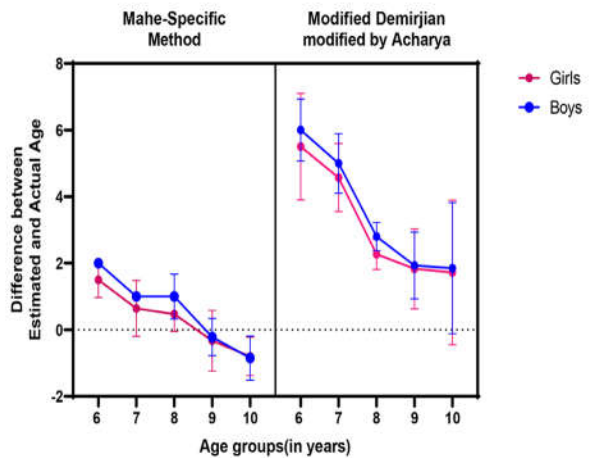


Fig. 2: Line graph showing the differences from the actual age as estimated by Acharya’s formula and the Mahe-specific formula in girls and boys

DISCUSSION

Age determination is one of the most crucial techniques used in forensic odontology. When a birth certificate is unavailable or records are questioned due to possible medical-legal concerns, an estimate of dental age is necessary.⁶

An individual's CA should be calculated from their birthdate, which is typically verified by birth certificate documentation. Biological ages such as skeletal age, morphological age, secondary sex character, and DA have been created as maturity markers to estimate age in the context of an unknown birthdate.^{4,7}

DA evaluation is acknowledged as the most accurate, dependable, and quick method of estimating age, particularly in developing children.⁸ Compared to other biological maturity measures, DA has the strongest correlation with CA because it is thought to be the least impacted by malnutrition.

Numerous authors have reported several methods for estimating dental maturity (DA) using teeth. Most of them are time-consuming, costly, and harmful, and they usually is a need for extraction and the fabrication of microscopic sections. The approach described by Demirjian *et al.*, which created a standard based on a large sample that included 1446 boys and 1482 females of French-Canadian heritage, is one of the most widely used radiography based procedures for dental age estimation.⁸ While using Demirjian's approach, observer agreement is typically recorded; nevertheless, there is a clear tendency towards overestimation of a subject's age⁹, which might be attributed to secular trends over the last 50 years that have been favourable and ethnic disparities amongst populations.^{10,11} Demirjian's method has some limitations, but it is nonetheless worthwhile to consider because of its merits, which include explicit definitions of radiographs, diagrams, and written requirements.¹² However, the use of standards designed for the European population to the Indian population may cause results to be misrepresented. Thus, Acharya¹³ examined radiographs of a population that was primarily from southwest India to determine whether the aforementioned two approaches were appropriate for use in India and developed an Indian regression formula. According to research, this regression method, which is unique to India, can estimate age in a few different regions of the country.^{14,15,6,7}

Nevertheless, a comprehensive review of the literature revealed differences in dental development

between and within populations. Thus, the lack of any study on the Mahe population formed the premise for studying the applicability of Demirjian's method modified by Acharya on the latter.

The results of this study show that Demirjian's technique overestimated CA by 2.8(\pm 2.1) years and 2.6(\pm 1.9) years in girls and boys, respectively, which was significantly different from the CA. This is consistent with the majority of studies on populations across several states in India.^{6,7,10,16,17,18}

In our study the discovery that the forecast accuracy of Acharya's approach grows with age was significant. This result was consistent with that of Khorate *et al.*¹⁰ who studied the Goan population and found that the mean absolute error for the age group of 10.01 to 19 years was less than 1.5 years. However, the Gujarati population's age was found to be underestimated by the Acharya method, despite the approach's applicability due to the lower mean absolute error value.²⁰ While Acharya's method was applied to an age group of 6-10 years in this study, Acharya's method was applied to a wider age group of 7-25 years in his study²¹ in a population in southwest India.¹³ A mean absolute error of less than a year which is calculated by subtracting the CA from the DA, is usually considered within acceptable limits, however, in this study, 48.1% of the cases found a discrepancy above two years, and 43.8% in females and 38.8% showed a discrepancy of 1-2 years, which is indicative of an imprecise age estimation using the above method, on Mahe children.

Because more teeth are still forming and the time between morphologic phases is shorter, it is possible to determine dental age younger and more accurately with this method.²² However, in this study, the respondents who were between the ages of 6-8 years showed dramatically higher error rates, which significantly reduced the predicted accuracy. The age at which the mandibular third molar crypt development occurs is estimated to be 8 or 9 years on average, with significant variance ranging from roughly 6 to 14 years^{23,24} Mishra *et al.* reported a similar finding in a Central Indian population. However, the individuals in this age group, in our study, exhibited a delayed rate of crypt formation, which suggests a delayed pace of third molar growth. The information on dental age changes at these younger ages was inadequate due to the relative scarcity of individuals in this age group which also found by Mishra et al also.²⁵

Gender distribution was taken into account in the current study also, owing to the existence of sexual dimorphisms. Girls mature at a faster rate

than boys for the majority of maturational events.²⁶ This is consistent with our study's findings, which show that girls' dental ages are higher at 2.8(±2.1) years against 2.6(±1.9) years in boys, in comparison to the chronologic age.

Demirjian's approach modified by Acharya appears to be therapeutically inapplicable given the degree of discrepancies between estimated dental and chronological age in this study as we found no correlation between the CA and DA estimated by the above-mentioned method ($r=0.0017$); hence, a new formula was developed for age estimation in Mahe children. Similar study conducted by Shivakumar *et al.* in Bengaluru population also found that using revised Demirjian's India formula reduced the mean absolute error in age estimation compared to the age estimation by Demirjian's formula alone.²⁷

CONCLUSION

Modified Demirjian's method is an area specific method of dental age determination and was found to be applicable to the children of Mahe only by using a Mahe specific regression formula.

A Mahe specific regression formula of dental age estimation for girls was seen to be $CA = 0.07673 * S + 3.170$ and for Boys it is $CA = 0.06353 * S + 4.310$. A larger sample size and analysis of alternative age determination methods, particularly for a wider age range should be the main goals of future research.

REFERENCES

1. Saxena S, Sharma P, Gupta N. Experimental studies of forensic odontology to aid in the identification process. *J Forensic Dent Sci.* 2010;2(2):69.
2. Bagh T, Chatra L, Shenai P, Veena KM, Rao PK, Prabhu RV, Kushraj T, Shetty P. Age estimation using Cameriere's seven teeth method with Indian specific formula in south Indian children. *Int J Adv Health Sci.* 2014;1(2):2-10.
3. Sood R, Mamachand P, Sood R, Parasher P. Role of odontology in determination of identity in forensic science—An overview. *J Adv Med Dent Scie Res.* 2014;174-80.
4. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. *Human biology.* 1973;211-27.
5. Bijjaragi SC, Sangle VA, Saraswathi FK, Patil VS, Rani SA, Bapure SK. Age estimation by modified Demirjian's method (2004) and its applicability in Tibetan young adults: A digital panoramic study. *J Oral Maxillofac Surg Med Pathol.* 2015;19(1):100-5.
6. Priyanka M, Kiran G, Poornima R, Shrivani R, Shobhita KC, Preethi P. Age estimation by modified Demirjian's method in children and adolescents of hyderabad population—a panoramic study. *J Forensic Odontostomatol.* 2018;10(2):63-8.
7. Mohanty I, Panda S, Dalai RP, Mohanty N. Predictive accuracy of Demirjian's, Modified Demirjian's and India specific dental age estimation methods in Odisha (Eastern Indian) population. *J Forensic Odontostomatol.* 2019;37(1):32.
8. Demirjian, A., Buschang, P. H., Tanguay, R. & Patterson, D. K. Interrelationships among measures of somatic, skeletal, dental, and sexual maturity. *Am. J. Orthod.* 1985;88:433-38.
9. Jayaraman, J., Wong, H. M., King, N. M. & Roberts, G. J. The French-Canadian data set of Demirjian for dental age estimation: a systematic review and meta-analysis. *J. Forensic Leg. Med.* 2013;373-81.
10. Koshy, S. & Tandon, S. Dental age assessment: the applicability of Demirjian's method in south Indian children. *Forensic Sci. Int.* 1998;94:73-85.
11. 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;21;5:2.
12. 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.
13. Acharya AB. Age estimation in Indians using Demirjian's 8-teeth method. *J Forensic Odontostomatol.* 2011;56(1):124-7.
14. Tandon A, Agarwal V, Arora V. Reliability of India-specific regression formula for age estimation of population in and around Bahadurgarh, Haryana (India). *J Oral Biol Craniofac Res.* 2015;5(3):193-7.
15. Kumar VJ, Gopal KS. Reliability of age estimation using Demirjian's 8 teeth method and India specific formula. *Journal of forensic dental sciences.* 2011;3(1):19-22.
16. 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. *Journal of the Indian Society of Pedodontics and Preventive Dentistry.* 2002;20(4):132-8
17. Prabhakar AR, Panda AK, Raju OS. Applicability of Demirjian's method of age assessment in children of Davangere. *Journal of the Indian Society of Pedodontics and Preventive Dentistry.* 2002;20(2):54-62
18. Gupta S, Mehendiratta M, Rehani S, Kumra M, Nagpal R, Gupta R. Age estimation in Indian

- children and adolescents in the NCR region of Haryana: A comparative study. *Journal of Forensic Dental Sciences*. 2015;7(3):253-258.
19. Khorate MM, Dinkar AD, Ahmed J. Accuracy of age estimation methods from orthopantomograph in forensic odontology: a comparative study. *Forensic science international*. 2014;234:184 e1-8.
 20. Gandhi N, Jain S, Kumar M, Rupakar P, Choyal K, Prajapati S. Reliability of third molar development for age estimation in Gujarati population: A comparative study. *Journal of forensic dental sciences*. 2015;7(2):107-113
 21. Kirzioglu Z, Ceyhan D. Accuracy of different dental age estimation methods on Turkish children. *Forensic science international*. 2012;216(1-3):61-67.
 22. U. Hägg, L. Matsson, Dental maturity as an indicator of chronological age: the accuracy and precision of three methods. *Eur. J. Orthod*.1985;7(1):25-34.
 23. H.M. Liversidge, Timing of human mandibular third molar formation. *Ann. Hum. Biol.* 2008;294-321.
 24. Y. Sisman, T. Uysal, F. Yagmur, S.I. Ramoglu, Third-molar development in relation to chronologic age in Turkish children and young adults. *Angle Orthod*. 2007;1040-1045.
 25. Mishra SS, Parakh A. Accuracy of Chaillet and Demirjian's 8-teeth method in dental age estimation of Central Indian population using India specific regression formulae. *Forensic Science International: Reports*. 2020;2:100152.
 26. Blankenship JA, Mincer HH, Anderson KM, Woods MA, Burton EL. Third molar development in age estimation of chronologic age in American blacks as compared with whites. *J Forensic Sci* 2007;52:428-433.
 27. Shivakumar B, Arunakshi, Niveditha, Shivaprasad, Manjuprasad. Validation of demirjian's 8-teeth method of age estimation in the population of Bengaluru. *J Oral MaxillofacPathol*. 2021;25(3):499-502.

