

ORIGINAL ARTICLE

Dental Age Estimation in Nepalese Population Using Demirjian's 8 Teeth MethodRadha Baral¹, Samarika Dahal¹, Sirjana Dahal², Sanjay Prasad Gupta³¹Department of Oral Pathology and Forensic Dentistry,²Department of Community Dentistry,³Department of Orthodontics and Dentofacial Orthopaedics, Maharajgunj Medical Campus, Maharajgunj, Kathmandu, Nepal

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ABSTRACT

Introduction: Age estimation plays a crucial role in human identification of living and dead people. Employing a radiographic examination to measure the degree of dental calcification is one of the most common methods for age estimation. A radiological age estimation approach was developed by Demirjian et al. based on the scoring of seven mandibular teeth on the left side, which was later amended to include the third molar. The method has been used to derive population-specific formulas in different contexts.

Aim: To assess the accuracy of Demirjian's 8 teeth method using original, Indian, and Nepalese population-specific formulas in the Nepalese population.

Materials and methods: This is a cross-sectional analytical study done on 140 digital orthopantomograms of patients between 6-20 years of age at Tribhuvan University Teaching Hospital. Dental age estimation was done using the Demirjian 8 teeth method with the application of the original formula, Indian specific formula given by Acharya and Nepalese specific formula given by Subedi et al. Comparison between the chronological and dental age was done using paired t-test. The mean absolute error was used to assess the age prediction accuracy.

Results: The mean chronological age was 13.38 ± 3.5 years. Mean dental age by Demirjian's original formula, Indian-specific formula and Nepalese-specific formula were 12.79 ± 3.18 , 15.48 ± 3.68 and 14.68 ± 4.29 respectively. The mean absolute error of Demirjian's original formula was found to be the lowest (1.28) followed by Nepalese-specific (1.78) and Indian-specific formula (2.35).

Conclusion: Demirjian's original formula was found to be the most accurate followed by Nepalese-specific and Indian-specific formulas. Hence, further studies considering Nepalese population-specific modification of Demirjian's method are required.

Keywords: Demirjian, dental age, estimation, Nepalese population.

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INTRODUCTION

Age estimation plays a crucial role in human identification, both in living and dead subjects [1]. Age determination of unidentified skeletons or individuals with no record of their chronological age is an important aspect of forensic odontology [2]. Age estimation in children, adolescents, and young adults is essential for a number of reasons, including criminal liability, employment (child labor), adoption, illegal immigration, attaining majority status, and marriage eligibility in cases when a birth certificate is not available [3].

Dental evaluation is one of the most reliable and useful scientific methods for assessing age estimation. One of the most employed methods for age estimation is the assessment of the degree of tooth calcification, studied by radiographic examination [1]. Using an eight-tier tooth development staging system, Demirjian et al. have developed a radiological age estimation approach based on the scoring of seven mandibular teeth on the left side [4]. However, Chaillet and Demirjian included the third molar in a revision to address the drawbacks of only evaluating a limited age range of the population [5]. Several authors question the cross-population validity of Demirjian's method and argue for population-specific standards for age estimation [6].

The literature reports on the variation in dental development among populations. Though various ideas involving the interaction of genetic and environmental factors have been put up, the exact cause of the diversity among groups remains unclear [6]. Considering the fact that Demirjian's 8-teeth method needs adaptation prior to use in diverse populations Acharya has developed a regression formula for the Indian population [7] and Subedi et al [8] in the Nepalese population improvising the Demirjian's method. There are also other studies done in the Nepalese population using the Demirjian original formula to estimate the age of children [9,10]. However, there are no studies done to our knowledge comparing Demirjian's revised 8-teeth method with Indian-specific formula and Nepalese-specific formula. Therefore, this study was done to assess and compare the accuracy of Demirjian's 8-teeth method using original, Indian, and Nepalese population-specific formulas in the Nepalese population.

MATERIALS AND METHOD

An analytical cross-sectional study was conducted from May to August 2023 after obtaining ethical approval from the Institutional Review Committee of Institute of Medicine [Ref. no. 512 (6-11) E2]. A total of 140 digital orthopantomograms (OPGs), 70 each of males and females were taken from different dental departments of Tribhuvan University Teaching Hospital. The OPGs of individuals with known records of chronological age of 6 to 20 years were selected by convenience sampling method.

Sample size calculation was done taking reference from a similar article by Akhil et al.[2]:

$$ss = [(Z_{1-\alpha/2} \times \sigma)/d]^2$$

Where,

ss = calculated sample size

$z_{1-\alpha/2} = 1.96$ (at 95% confidence interval)

$\sigma = 2.076$ for dental age using Demirjian's formula

d= Margin of error = 0.05

Using these values in the formula provided above, calculated sample size (ss)=6622.57

However, the tentative population size is 142 in the study duration. So, by using the sample size calculation formula for finite population,

$$n = ss/[1 + \{(ss-1)/\text{population}\}] = 139.04 \approx 140$$

A total of 140 OPG including 70 males and 70 females of age 6 years to 20 years were included in the study.

The OPGs of adequate quality, a documented age record, and the presence of full complement of mandibular teeth on the left or right side were included. However, the study did not include OPGs of individuals with periapical pathologies, any disease (systemic, nutritional, or endocrine) that could affect a normal growth and development, or any tooth distortion or crowding that could interfere with proper visualization on the radiographs

Table 1. Sample distribution of individuals with different chronological age and sex

Chronological Age	Male	Female	Total
6	1	1	2
7	0	4	4
8	2	0	2
9	11	6	17
10	8	6	14
11	5	2	14
12	1	4	5
13	6	7	13
14	11	12	23
15	9	8	17
16	7	4	11
17	2	2	4
18	4	4	8
19	1	6	7
20	2	4	6
Total	70	70	140

The ten tooth development stages of Demirjian's modified criteria were applied to score the eight mandibular teeth of the left side, and these scores were based on the teeth's calcification status. According to the grade of each tooth, gender-specific French-weighted maturity scores (Chaillet and Demirjian's modification) were entered. Scores were summed up to generate the total maturity score, which was then substituted in the Original Demirjian 8 teeth formula, Indian-specific regression formula developed by Acharya⁷ and Nepalese-specific regression formula developed by Subedi et al.⁸ Chronological age was calculated by subtracting the date of OPG taken from the date of birth.

Data were entered in Microsoft excel sheet and analyzed in Statistical Package of Social Sciences Version 20 (IBM Corp., Armonk, N.Y., USA). Frequency, percentage, mean and standard deviation were calculated depending upon the nature of the data. Paired t-test was used for a pairwise comparison of results. Confidence level was set at 95% for test of significance. The accuracy of age prediction was usually represented by the MAE, which is calculated as the difference between the calculated age and the actual age at the time of exposure. The number of values that fell in the error group of $<\pm 1$ years, within 1.1–2 years, and $>\pm 2$ years was noted. The error of $<\pm 1$ years is considered a good result and an error rate of $>\pm 2$ years is considered inaccurate.

RESULTS

The mean chronological age of males and females was 13.03 ± 3.284 years and 13.73 ± 3.695 years respectively. The mean age of the whole sample was 13.38 ± 3.500 years. The mean dental age calculated from Demirjian's original formula in the male, female and whole sample was 12.66 ± 3.289 , 12.92 ± 3.089 and 12.79 ± 3.182 years respectively. The mean dental age by Indian specific formula in the male, female and whole sample was 15.00 ± 3.512 years, 15.96 ± 3.818 years and 15.48 ± 3.686 years respectively. The mean dental age by Nepalese specific formula in the male, female and whole sample was 14.25 ± 4.388 , 15.11 ± 4.185 and 14.68 ± 4.294 years.

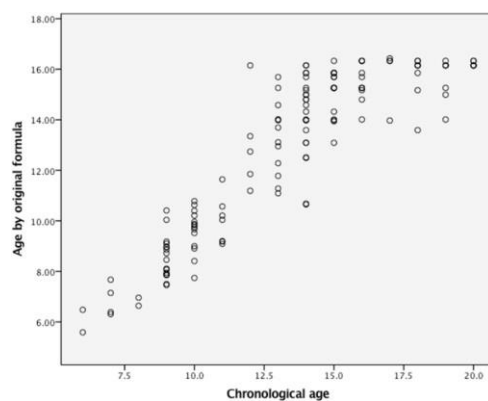
Table 2: Distribution of samples under different error rates %(n)

Method	group	Error rate %(n)		
		$\leq \pm 1$	1.1-2	$\geq \pm 2$
Original formula	Male	55.7(39)	34.2(24)	7(10)
	Female	51.4(36)	22.8(16)	22.7(18)
	Total sample	53.6(75)	28.5(40)	17.8(25)
Indian formula	Male	32.8(23)	21.4(15)	45.7(32)
	Female	32.8(23)	20(14)	47.1(33)
	Total sample	32.8(46)	20.7(29)	46.4(65)
Nepalese formula	Male	42.8(30)	24.2(17)	32.8(23)
	Female	47.1(33)	14.2(10)	38.5(27)
	Total sample	45(63)	19.2(27)	(35.7)50

Table 3: Comparison of chronological age with Dental age derived from Demirjian method using different formulas.

Method	Group	N	Chronological age	Dental age	MAE	P Value
Demirjian method with original formula	Male	70	13.03 \pm 3.284	12.66 \pm 3.289	1.08	<0.001
	Female	70	13.73 \pm 3.695	12.92 \pm 3.089	1.47	<0.001
	Total sample	140	13.38 \pm 3.500	12.79 \pm 3.182	1.28	<0.001
Demirjian method with Indian specific formula	Male	70	13.03 \pm 3.284	15.00 \pm 3.512	2.28	<0.001
	Female	70	13.73 \pm 3.695	15.96 \pm 3.818	2.48	<0.001
	Total sample	140	13.38 \pm 3.500	15.48 \pm 3.686	2.35	<0.001
Demirjian method with Nepalese-specific formula	Male	70	13.03 \pm 3.284	14.25 \pm 4.388	1.76	<0.001
	Female	70	13.73 \pm 3.695	15.11 \pm 4.185	1.81	<0.001
	Total sample	140	13.38 \pm 3.500	14.68 \pm 4.294	1.78	<0.001

Mean absolute error by the original formula was the lowest followed by Nepalese specific formula and Indian- specific formula. A total of 140 orthopantomograms including 70 males and 70 females were used in the study. Sample distribution of individuals with different chronological ages and sex are given in Table 1.

**Figure 1: Graphical representation of the relationship between the dental age derived from the Demirjian original formula and the chronological age.**

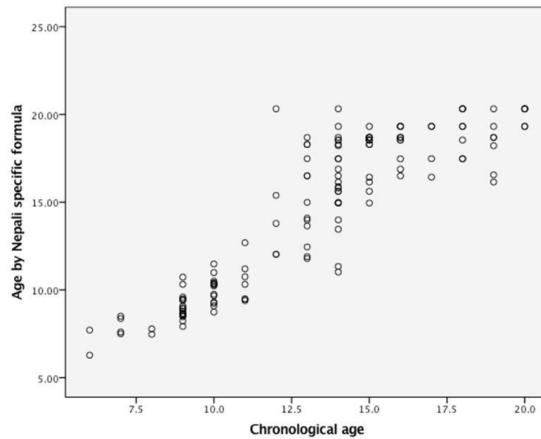


Figure 2: Graphical representation of the relationship between the dental age derived from the Indian-specific formula and the chronological age.

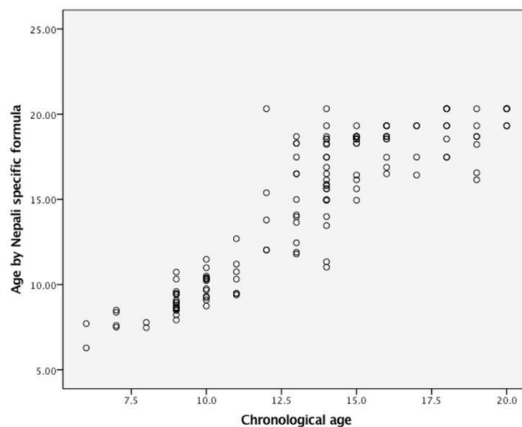


Fig 3: Graphical representation of the relationship between the dental age derived from the Nepali formula and the chronological age.

DISCUSSION

Demirjian's original method has been tested in the Nepalese population in different studies. In the study by Limbu et al., in 280 OPGs of age between 5-14 years underestimation of the age was found by the original 7 teeth method [10]. Similarly, another study by Nyachhyon et al. also concluded that the standard provided by Demirjian for French Canadian children is not suitable for Nepalese children as this showed underestimation of age in all age groups except for 7- and 9-years age groups [11]. Another study done in age estimation using Demirjian's and Nolla's method also reported delayed dental age compared to chronological age. In contrast, other studies showed a more advanced dental age compared to chronological age in Nepalese children by Demirjian's 7 teeth method [12].

Demirjian method has been shown to underestimate the age of Turkish children [13] and overestimate the age of Chinese children [14] In a study done in the Spanish population however Demirjian method was useful in determining the actual age with a sensitivity of 97.5% [15] These contrasting findings suggest population-specific modification in Demirjian's original formula.

Few studies have been done on the Nepalese population using the modified Demirjian method. A comparison of dental age assessment using Demirjian's eight teeth method and Willems method in a tertiary hospital in Nepal showed an underestimation of the dental age by Demirjian method. The difference in mean

chronological age and dental age was statistically significant. These findings are similar to the present study [16]. Subedi et al. tested the Demirjian 8 teeth method in the Nepalese population and reported inferior age estimation in the Nepalese population. In their study, the difference between chronological age and dental age was statistically significant by the original formula. These findings are in accordance with the present study.

To overcome the problem with the original Demirjian formula, Subedi et al have proposed a new regression formula for the Nepalese population. The mean difference between chronological and dental age in their study was not statistically significant by their new formula. In our study, we tested the Nepalese-specific formula of age group 5 to 23 [17]. The result of our study was in contrast with their study. The mean absolute error obtained from their formula was 1.024 and 1.231 for males and females respectively in their study. In the present study, the Mean absolute error for males and females was 1.76 and 1.81 for males and females respectively. These differences in findings might be because of differences in age distribution and inter-observer variability while staging the teeth. In addition to that, consideration of different ethnic groups was not done in the study which could be the confounding factor.

In different studies done, the Demirjian 8 teeth method with the original equation provided inferior age prediction of the Indian population [18]. To resolve this issue Indian population-specific formula was proposed by Acharya et al. Indian specific formula developed by Acharya predicted a more accurate result in age estimation compared to the original formula in the Indian population of different regions [19]. In contrast, some studies have also reported overestimation of age by Acharya's formula in different regions of India [20].

The present study showed an overestimation of age by Indian formula and the mean absolute error of age in each gender was also higher compared to the original formula. To our knowledge, no studies have been done testing Indian-specific formulas in the Nepalese population. The result of our study suggests that the Indian population-specific formula derived by Acharya is not suitable for the Nepalese population.

CONCLUSION

Among the three formulas, Demirjian's original formula was found to be the most accurate followed by Nepalese-specific and Indian-specific formulas. Hence, more research is necessary to modify the Demirjian method specifically for the Nepalese population.

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Conflict of Interest – There are no conflicts of interest

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