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Comparative Estimation of Dental Age by Using Demirjian's and Nolla's Method in Residents of Pune city.

Abstract:

Introduction : Age assessment is an essential part of forensic odontology. It is of importance in medico-legal areas and in mass disasters. Age estimation methods show variation in the reported results.

Aim and Objectives : To evaluate and compare the dental age from orthopantomogram using Demirjian's and Nolla's method in residents of Pune city and to compare the dental age with the chronological age.

Methodology : The study was carried out in the Department of Oral and Maxillofacial Pathology and Oral Microbiology, Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Pune. A total of 100 subjects were enrolled in the study. The diagnostic orthopantomograms (OPGs) were evaluated as per the Demirjian's and Nolla's method.

Statistical methods : The pair-wise statistical comparison of distribution of means of continuous variables was tested using paired t-test. The results of our study suggest that the Demirjian's method is applicable to higher age groups in both genders with a better accuracy than Nolla's method. Nolla's method has a better accuracy in the lower age group than the Demirjian's method.

Keywords : Age estimation, Demirjian, Nolla.

Introduction:

Forensic Odontology is that branch of dentistry which in the interest of justice deals with proper handling and examination of dental evidence and presentation of dental findings.[1] It utilizes the knowledge of a dentist in forensic research to serve the judicial system.[2]

Forensic odontologists are often called for age estimation of the unknown deceased and living individuals. Age estimation(AE) plays a crucial role in the recognition of unknown corpses and the skeletal remains of crimes, accidents and disaster victims.[3] In children and adolescents it is essential for many legal procedures such as child labour, employment, rape, status of majority, adoption, eligibility for marriage and when birth certificate is not available.[4]

Dental age assessment can be done by clinical or visual methods, radiographic methods, histological methods and physical methods.[5,6]

In children and adolescents, AE methods are based upon the developmental stages of deciduous and permanent teeth. Radiographic development of teeth and their comparison with standard diagrams collected from a large number of population in a well-defined geographic region forms the basis of most of the methods.[7]

Demirjian et al developed a radiological AE method based on the scoring of the seven mandibular teeth on the left side according to an eight tier staging system for the development of teeth. Individual tooth score were summed up to produce a total maturity score from which a conversion table was used to measure the dental age. Demirjian's method has found broad global acceptance for age assessment in different populations

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as it is a simple& realistic method with defined steps and reduced uncertainty. However few authors have recorded an overestimation of age in regional population groups.[8]

A system for dental age assessment using radiographic appearances of maxillary and mandibular teeth is devised by Nolla which is one of the methods for assessing calcification of teeth based on maturation of teeth.[9,10]

Although Demirjian's and Nolla's method are widely used methods for the assessment of dental age, review of literature shows variations in the reported results. With this background the present study was conducted as an attempt to evaluate an accurate method for dental age estimation. The objective of this study was a comparative estimation of dental age by using Demirjian's and Nolla's method in residents of Pune city.

Aim and Objectives:

Aim: To evaluate dental age from orthopantomogram using Demirjian's and Nolla's method in residents of Pune city.

Objectives: 1.To assess theage of an individual using Demirjian'smethod

2. To assess the age of an individual using Nolla's method.

3. To compare them with chronological age.

3. To compare both themethods.

Methodology:

The study was carried out in the Department of Oral and Maxillofacial Pathology, Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Pune after approval from the Institutional Ethics Committee.

The diagnostic orthopantomograms (OPGs) of 100 subjects which included 51 males and 49 females in the age range of 06-16 years were obtained from Department of Oral Medicine and Radiology of Bharati Vidyapeeth Deemed to be University, Dental College and Hospital, Pune for this retrospective study. The subjects were divided into 3 groups, i.e 06-09 years, 10-13 years and 14-16 years.

A code number was given to all the OPGs included in the study. Two researcherscarried out assessment of 100 OPGs by comparing them to the description of stages of tooth development given by Demirjian and Nolla. Age estimation was done using Demirjian's and Nolla's method. The chronological age and gender was hidden from both the researchers and they were blinded from each other.

Inclusion criteria:

1.Full set of mandibular permanent teeth(erupted/unerupted)

2.Age range between 06-16 years

3.Subjects who are residents of Pune city

4. Radiographs for diagnostic use

Exclusion criteria:

1. Unclear or orthopantomograms with errors

2.Dental abnormalities

3. Gross dental pathology

4. Non-residents of Pune city

Demirjian's method

Seven teeth present on the left side of the mandible were assessed. 08 stages of development (A to H),from calcification of the tip of the cusp to the closure of the apex, were determined for each tooth by following the written and diagrammatic criteria given by Demirjian. Depending on the stage, each tooth was given a maturity score according to tables provided for male and females. The total score was compared with the table given by Demirjian and the dental age was calculated.[11]

Nolla's method:

Seven teeth present on the left side of the mandible were considered. Nolla divided the stages of dental development into ten stages through which every tooth passes beginning with the absence of tooth crypt till the completion of root formation. These stages were determined for all the teeth according to pictorial presentation given by Nolla. Each stage had a numerical score. The obtained scores were totaled to give a combined 'sum of stages' score that was then divided by the number of teeth taken into consideration to give the dental age.[12]

The chronological age was obtained from the records in term of years. All the information was tabulated including the registration number,name, gender, chronological age and estimated age by both investigators for both the methods. The data was statistically analyzed.

Statistical analysis:

The statistical analysis was done using Statistical Package for Social Sciences (SPSS ver 21.0, IBM Corporation, USA) for MS Windows. The data on categorical variables was shown as n (% of samples) and the data on continuous variables was shown as mean and standard deviation (SD). The pair-wise statistical comparison of distribution of means of continuous variables was tested using paired t-test.

Results:

This study was conducted by using the diagnostic radiographs of patients visiting the dental O.P.D. pf 100 subjects studied, 51 (51.0%) were male and 49 (49.0%) were females. Male to female ratio in the study group was 1.04:1.00.Of 51 males, 17 (33.3%) had age between 6 – 9 years, 17 (33.3%) had age between 10 – 13 years and 17 (33.3%) had age between 14 – 16 years.of 49 females, 15 (30.6%) had age between 6 – 9 years, 17 (34.7%) had age between 10 – 13 years and 17 (34.7%) had age between 14 – 16 years.(Table 1, Figure 1)

Distribution of mean estimated age by DEMIRJIAN and NOLLA methods by Observer 1 did not differ significantly in the age group 6- 9 years (P-value>0.05). Distribution of mean estimated age by DEMIRJIAN and NOLLA methods by Observer 1 and Observer 2 (average) did not differ significantly in the age group 6- 9 years (P-value>0.05). Distribution of mean estimated age by Observer 1 and observer 2 is significantly lower by NOLLA method compared to DEMIRJIAN method in all age groups (P-value<0.05 for all). (Table 2, Figure 2)

Distribution of mean estimated age by DEMIRJIAN and NOLLA methods by Observer 1 did not differ significantly in the age group 6- 9 years (P-value>0.05).

Distribution of mean estimated age by DEMIRJIAN and NOLLA methods by Observer 2 did not differ significantly in the age group 6- 9 years (P-value>0.05).

Distribution of mean estimated age by DEMIRJIAN and NOLLA methods by Observer 1 and Observer 2 (average) did not differ significantly in the age group 6- 9 years (P-value>0.05).

Distribution of mean estimated age by Observer 1 and observer 2 is significantly lower by NOLLA method compared to DEMIRJIAN method in all age groups (P-value<0.05 for all). (Table 3, Figure 3)

Comparison of Estimated age between DEMIRJIAN and NOLLA methods (All subjects):

Distribution of mean estimated age by Observer 1 and observer 2 is significantly lower by NOLLA method compared to DEMIRJIAN method in all age groups (P-value<0.05 for all). (Table 4, Fig 4)

Comparison of Estimated age with Chronological age (All subjects):

Distribution of mean estimated age by Observer 1 and observer 2 is significantly higher compared to mean chronological age by DEMIRJIAN method in all age groups (P-value<0.05 for all).

Distribution of mean estimated age by Observer 1 and observer 2 did not differ significantly compared to mean chronological age by NOLLA method in the age group 6 – 9 years (P-value>0.05 for all).

Distribution of mean estimated age by Observer 1 and observer 2 is significantly lower compared to mean chronological age by NOLLA method in the age groups 10 – 13 years and 14 – 16 years (P-value<0.05 for all).

Comparison of Estimated age between two observers (All subjects):

Distribution of mean estimated age by Observer 1 did not differ significantly compared to mean estimated age by Observer 2 by DEMIRJIAN and NOLLA methods in the age group 6 – 9 years (P-value>0.05 for all).

Distribution of mean estimated age by Observer 1 did not differ significantly compared to mean estimated age by Observer 2 by DEMIRJIAN method in the age group 10 – 13 years (P-value>0.05).

Distribution of mean estimated age by Observer 1 is significantly higher compared to mean estimated age by Observer 2 by NOLLA method in the age group 10 – 13 years (P-value<0.01).

Distribution of mean estimated age by Observer 1 did not differ significantly compared to mean estimated age by Observer 2 by DEMIRJIAN and NOLLA methods in the age group 14 – 16 years (P-value>0.05 for all).
(Table5, Figure 5)

On comparison of the estimated age from chronological age,using Demirjian's and Nolla's methods, the mean estimated age is significantly higher compared to mean chronological age by Demirjian's method in all age group. The mean estimated age did not differ significantly compared to mean chronological age by Nolla's method in the age group 6 – 9 years while the mean estimated age is significantly lower compared to mean chronological age by NOLLA method in the age groups 10 – 13 years and 14 – 16 years.

	Male (n=51)		Female (n=49)		Total (n=100)	
Age Group (years)	**n**	**%**	**n**	**%**	**n**	**%**
6 – 9 years	17	33.3	15	30.6	32	32.0
10 – 13 years	17	33.3	17	34.7	34	34.0
14 – 16 years	17	33.3	17	34.7	34	34.0
Total	**51**	**100.0**	**49**	**100.0**	**100**	**100.0**

Table 1) Age and sex distribution of subjects studied

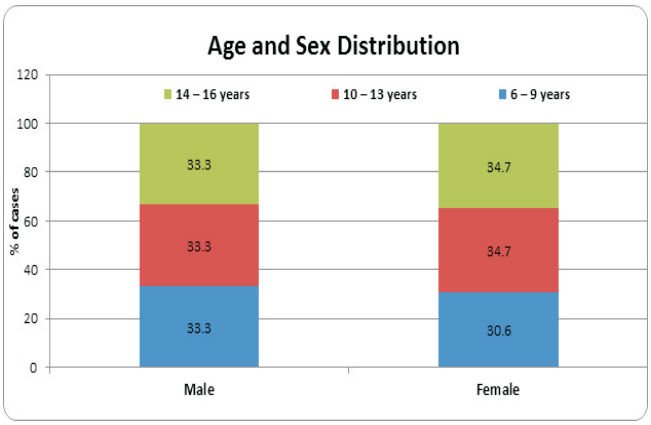

Figure 1) Age and sex distribution of subjects studied

	Method	Chronological Age (n=51)		Estimated Age (Observer 1) (n=51)		Estimated Age (Observer 2) (n=51)		Average (Observer 1 And Observer 2) (n=51)	
Age Group (years)		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
6 – 9 years	DEMIRJIAN	7.56	1.03	8.28	1.66	8.25	1.71	8.25	1.68
	NOLLA	7.56	1.03	7.85	0.86	7.61	0.75	7.71	0.77
P-value	**DEMIRJIAN v NOLLA**	--		**0.125^{NS}**		**0.040***		**0.065^{NS}**	
10 – 13 years	DEMIRJIAN	11.24	1.03	12.33	1.13	12.32	1.16	12.32	1.15
	NOLLA	11.24	1.03	9.45	0.40	9.24	0.48	9.33	0.43
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	
14 – 16 years	DEMIRJIAN	14.47	0.62	15.23	1.02	15.31	1.08	15.27	1.05
	NOLLA	14.47	0.62	9.80	0.23	9.86	0.24	9.83	0.23
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	

P-value by Paired t test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically non-significant.

Table 2) Comparison of mean estimated age between two methods of estimation in each age group (Male subjects)

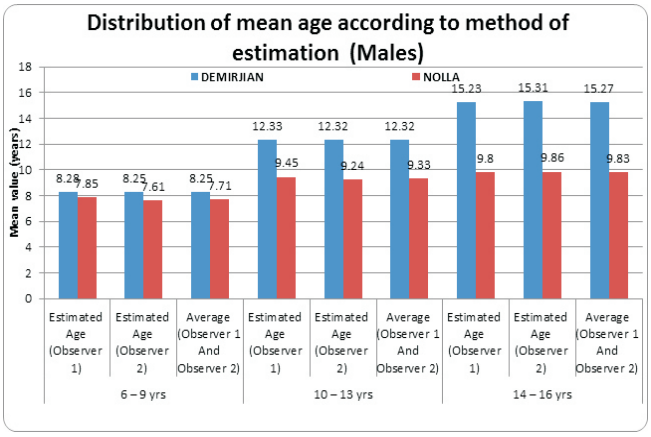

Figure 2) Distribution of mean age according to method of estimation in each age group (Male subjects)

	Method	Chronological Age (n=49)		Estimated Age (Observer 1) (n=49)		Estimated Age (Observer 2) (n=49)		Average (Observer 1 And Observer 2) (n=49)	
Age Group (years)		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
6 – 9 years	DEMIRJIAN	7.87	1.06	8.29	1.47	8.25	1.49	8.27	0.15
	NOLLA	7.87	1.06	7.99	1.13	7.98	1.16	7.98	1.14
P-value	**DEMIRJIAN v NOLLA**	--		**0.142^{NS}**		**0.162^{NS}**		**0.157^{NS}**	
10 – 13 years	DEMIRJIAN	11.53	1.18	11.73	2.00	11.46	1.72	11.58	1.82
	NOLLA	11.53	1.18	9.33	0.67	9.28	0.83	9.29	0.75
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	
14 – 16 years	DEMIRJIAN	14.88	0.86	15.00	0.94	15.11	1.11	15.05	0.95
	NOLLA	14.88	0.86	9.92	0.10	9.84	0.34	9.87	0.18
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	

P-value by Paired t test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically non-significant.

Table 3) Comparison of mean estimated age between two methods of estimation in each age group (Female subjects).

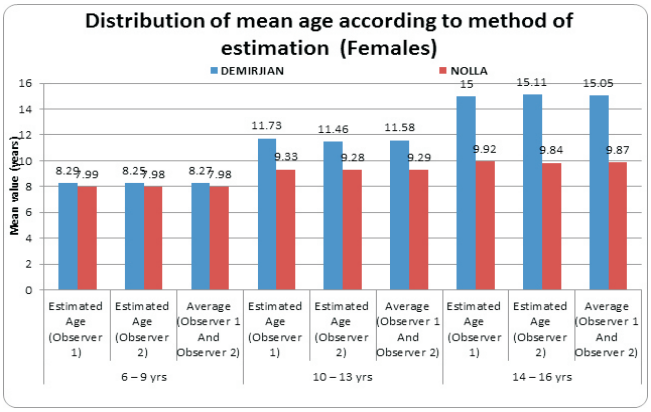

Figure 3) Distribution of mean age according to method of estimation in each age group (Female subjects)

	Method	Chronological Age (n=100)		Estimated Age (Observer 1) (n=100)		Estimated Age (Observer 2) (n=100)		Average (Observer 1 And Observer 2) (n=100)	
Age Group (years)		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
6 – 9 years	DEMIRJIAN	7.70	1.04	8.29	1.55	8.25	1.58	8.26	1.56
	NOLLA	7.70	1.04	7.91	0.98	7.78	0.96	7.84	0.95
P-value	**DEMIRJIAN v NOLLA**	--		**0.033***		**0.012***		**0.018***	
10 – 13 years	DEMIRJIAN	11.38	1.10	12.02	1.63	11.89	1.51	11.95	1.54
	NOLLA	11.38	1.10	9.39	0.55	9.26	0.67	9.31	0.60
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	
14 – 16 years	DEMIRJIAN	14.68	0.77	15.11	0.97	15.21	1.08	15.16	0.99
	NOLLA	14.68	0.77	9.86	0.18	9.85	0.29	9.85	0.20
P-value	**DEMIRJIAN v NOLLA**	--		**0.001*****		**0.001*****		**0.001*****	

P-value by Paired t test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically non-significant.

Table 4) Comparison of mean estimated age between two methods of estimation in each age group (All subjects).

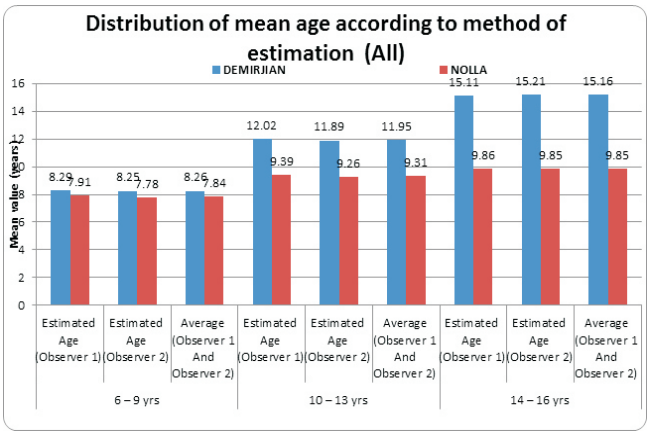

Figure 4) Distribution of mean age according to method of estimation in each group (All subjects)

Age Group/ Method	Chronological Age (n=100)		Estimated Age (Observer 1) (n=100)		Estimated Age (Observer 2) (n=100)		Average (Observer 1 And Observer 2) (n=100)		P-value (Inter-Observer)			
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Chr. Age v Est. Age (Obs 1)**	**Chr. Age v Est. Age (Obs 2)**	**Chr. Age v Est. Age (Avg.)**	**Obs1 v Obs2**
6 – 9 yrs												
DEMIRJIAN	7.70	1.04	8.29	1.55	8.25	1.58	8.26	1.56	0.017*	0.028*	0.024*	0.414^{NS}
NOLLA	7.70	1.04	7.91	0.98	7.78	0.96	7.84	0.95	0.192^{NS}	0.657^{NS}	0.415^{NS}	0.069^{NS}
10 – 13 yrs												
DEMIRJIAN	11.38	1.10	12.02	1.63	11.89	1.51	11.95	1.54	0.002**	0.016*	0.005**	0.187^{NS}
NOLLA	11.38	1.10	9.39	0.55	9.26	0.67	9.31	0.60	0.001***	0.001***	0.001***	0.004**
14 – 16 yrs												
DEMIRJIAN	14.68	0.77	15.11	0.97	15.21	1.08	15.16	0.99	0.037*	0.013*	0.019*	0.346^{NS}
NOLLA	14.68	0.77	9.86	0.18	9.85	0.29	9.85	0.20	0.001***	0.001***	0.001***	0.903^{NS}

P-value by Paired t test. P-value<0.05 is considered to be statistically significant. *P-value<0.05, **P-value<0.01, ***P-value<0.001, NS-Statistically non-significant.

Table 5) Inter-observer comparison of mean estimated age in each age group (All subjects).

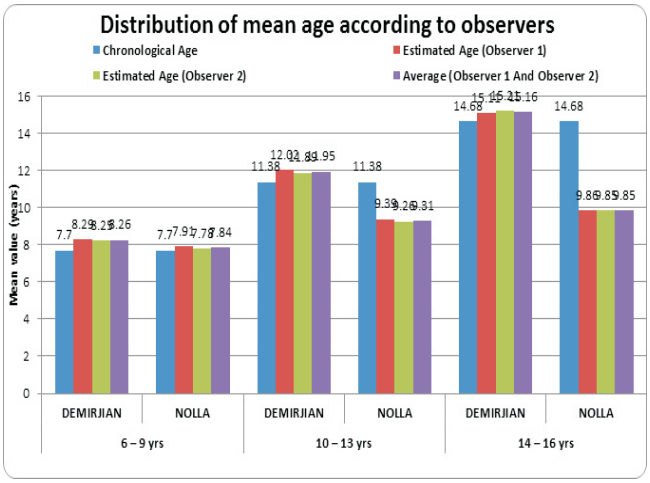

Figure 5) Distribution of mean age according to observers in each age group (All subjects)

Discussion:

AE by teeth inscientific and forensic fields has been used since years.[13] In addition to its importance in medico-legal areas, it is also essential while administering justice to an individual involved in civil and criminal litigation[14]

Calcification of dental tissues and eruption have been used to estimate the dental age. Calcification of tooth is a continuous process that can be studied by permanent records such as X-rays. Different exogenous factors such as infection or premature extraction, crowding, ankylosis, etc disturb tooth eruption. Furthermore, if clinical emergence is used as the criterion for dental age assessment, it can only be applied to the age of 30 months(completion of deciduous dentition) and after the age of 6 years (eruption of first molar) till approximately 12 years of age (last permanent tooth eruption) excluding third molars. Thus, the dental maturity of the child between 2½ and 6 years and after 12 years of age, is difficult to assess.[15]

Radiographs help in assessment of the stages of tooth calcification. Radiographic findings of teeth are the main source of information in age determination in forensics. The A Emethods identify the stage of mineralization on radiographic images which are compared with standard stage to know the approximate age range.[16]

In 1973, Demirjian first described a method on a sample of French-Canadian children. It is one of the most widely applied methods. Many researchers have applied this method worldwide. The differences in the results have been interpreted as true population differences. Although observer agreement is usually reported when using Demirjian's method, there is an evident tendency towards overestimation of a subject's age which may be result of ethnic differences between populations.[17]

There is an overestimation of the reported age among various populations by using Demirjian's method and accordingly have developed their own population-based specific standards. According to studies, Indian population also shows overestimation of the reported age.[18]

Nolla introduced a method in 1960. The staging is done on the basis of calcification of individual tooth from Stage 0 to stage [10,19]

The Nolla method requires very consistent discrimination by the observer in assessing dental maturity through radiography. Despite its effectiveness it is one of the least frequently used and tested across populations.[20]

Though literature supports many methods of A Ebeen tested and reported for different ethnic groups, the aim of an ideal AE method is to arrive at an age as close to the chronological age as possible.[21]

This study of a comparative estimation of dental age by using Demirjian's and Nolla's method in residents of Pune city (Maharashtra) was deemed necessary as there were relatively few studies reported in the Maharashtrian population.

The results of our study suggest that the Demirjian's method is applicable to higher age groups(10-13 years) and (14-16 years) in both genders with a better accuracy than Nolla's method. Nolla's method has a better accuracy in the lower age group (6-9 years) than the Demirjian's method. Also the mean estimated age by Nolla's method is lower as compared to Demirjian's method.

The results of this study are not in accordance with the study carried out by Koshy S and Tandon S in 1998, where they concluded overestimation of age by Demirjian method.21According to the study carried out by Shruti Sinhaet al in Uttar Pradesh, Demirjian's method is suitable for all age groups and is more accurate than Nolla's method.12 The results of our study suggest applicability of Demirjian's method to higher age groups. Under estimation of age by Nolla's method and an increase in the underestimation of age chronological age increased was observed by Nandlal B in his study.[8] In 2006, Rai B and Anand SC concluded that Demirjian's and Nolla's method were not very accurate methods for age estimation.[22]

Conclusion:

The results of this study suggest that Demirjian's method is more suitable than Nolla's method for higher age groups 10-13 years and 14-16 years. However it is observed that Nolla's method is more accurate for a younger age group of 6-9 yearsand Demirjian's method showed overestimation of age in this group. These dissimilarities may be due to cultural and ethnic differences in the populations involved in the study.

Further studies with a larger sample size in different population groups are necessary in understanding the accuracy of these methods for age estimation.

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