Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2023 June; 56(2): 87–91

Original article

Using the Demirjian method for estimating the dental age of children in Surabaya, Indonesia

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ABSTRACT

Background: *The Demirjian method is used in assessing the stages of growth and development of teeth to calculate a person's estimated age. In 1973, Demirjian identified the eight stages of tooth growth and development and their respective criteria.* ***Purpose:*** *To analyze the validity of Demirjian's method for estimating dental age among children aged 6–17 years old in Surabaya, Indonesia.* ***Methods:*** *From August–October 2020, 162 panoramic radiographs of patients aged 6–17 years were taken at the radiology department of Airlangga Dental Hospital. Data analysis was conducted using SPSS software for different tests, including a paired t test.* ***Results:*** *Using the Demirjian method, there was no significant dissimilarity between chronological age (CA) and estimated dental age (EDA) in the male group. However, a significant dissimilarity was found between CA and EDA in the female group.* ***Conclusion:*** *Demirjian's method can be used as a tool for estimating the dental age of males age 6-17 years old in Surabaya.*

Keywords: *children; Demirjian method; dental age estimation; forensic odontology; panoramic*
Article history: *Received 6 June 2022; Revised 31 August 2022; Accepted 9 September 2022*

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INTRODUCTION

Indonesia is an archipelago of thousands of islands connected by straits and seas located between the Asian and Australian continents and the Indian and Pacific oceans.[1] Indonesia is prone to natural disasters caused by geographical conditions, climate and geology.[2] In the case of a mass disaster, age estimation can simplify the identification of victims and enable grouping by ages.[3] An estimate of age can also be necessary for living individuals involved in criminal or civil law cases, including falsification of employment age, marriage, athletes, child guardianship, immigration, or rape.[4] Legally valid evidence of age is important to determine whether an individual is legally a child or an adult, and there are differences in legal and judicial processes for children and adults.[5] Age estimation is also valuable evidence when a birth certificate does not exist or is in doubt.

The body parts that are generally used for age estimation are skeletal and dental.[6] Skeletal maturation as a tool for age estimation has limitations because age can only be estimated within a certain range and with a large age standard deviation. In comparison, teeth have several advantages as an age estimation medium, including the ability to estimate the age of an individual from prenatal through to adulthood.[7]

Assessment of tooth growth and development can be performed clinically or radiographically. The radiographic method has advantages because it is easier than other methods, is non-invasive, and can be performed on living or dead humans. One of the radiographic methods used was developed by Demirjian et al.[8] and groups tooth growth and development into eight stages with their respective criteria. The Demirjian method is used in assessing the stages of growth and development of teeth to estimate chronological age, but it can also be used to see how much tooth development and growth has occured.[9]

In this study, panoramic radiograph images were used to assess tooth growth and development via the Demirjian method. Panoramic photos are easy to obtain and simple

DOI: 10.20473/j.djmkg.v56.i2.p87–91

to perform, the dose of X-rays the patient is exposed to is relatively low, and the photos can be used in patients with trismus, are easier to apply to children, are relatively fast and convenient, have minimal distortion, and provide an overall picture of teeth and surrounding tissue.[10,11]

Previous research on estimating dental age has found that the Demirjian approach performs well in a variety of populations. As Indonesia's population has millions of people from different cultural and religious backgrounds, there is an urgent need for a reliable mechanism to identify a range of victims in the event of a large-scale tragedy.[11] This study sought to evaluate the extent of applicability of the Demirjian method for estimating the age of Indonesian children and adolescents in Surabaya.

Prior to this research, there was no dental age estimation method specifically for the Surabaya population and no specific research on applying the Demirjian method in Surabaya. The author carried out this research by adapting an existing dental age estimation method. This study aimed to analyze the accuracy of Demirjian's dental age estimation method for children aged 6–17 in Surabaya, Indonesia.

MATERIALS AND METHODS

This study was an observational analysis based on the panoramic radiographs of a population of 162 Airlangga Dental Hospital patients aged 6–17 years (80 males and 82 females) from the radiology department, Surabaya, in August–October 2020. The sample for this study was selected based on a purposive sampling technique with key inclusion criteria, including the panoramic radiograph used was not opaque, all parts of the studied teeth are visible on the panoramic radiograph, and there are no missing teeth in the studied region. The key exclusion criteria were radiographs with pathological features on teeth and surrounding tissues, patients using orthodontics or denture appliances, and developmental anomalies.[12] Ethics approval for this study was obtained from the Ethics Committee of the Indonesian Dental Hospital Airlangga University Health Research (001/UN3.9.3/Etik/PT/2021). All sample measurements were checked three times by a single observer at one-week intervals.

All digital panoramic radiographs were scored using the Demirjian method, and the calcification stage of the seven left mandibular teeth was assessed. The radiographic images were used to categorize tooth development into the eight stages (A to H), and Figure 1 illustrates the particular parameters required for each stage for single-rooted and multi-rooted teeth.[13] The score for every tooth was converted into a table based on gender (Table 1),[13] and the scores for the seven teeth were added up by the observer to identify the estimated age.

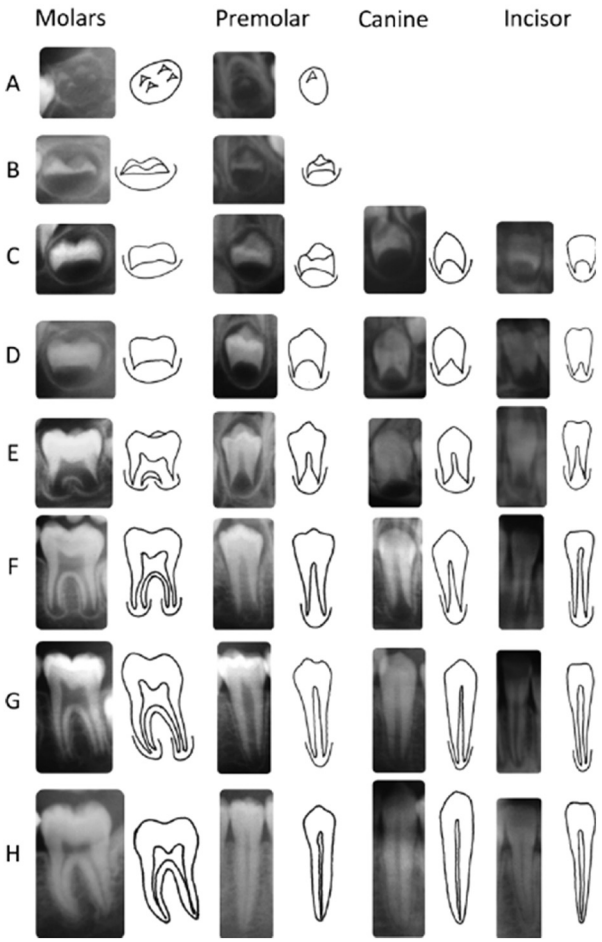

Figure 1. Dental development stages A to H for single and multi-rooted teeth.[13]

Table 1. Maturity score for each stage by Demirjian et al.[13]

Sex	Tooth	Stage							
		A	B	C	D	E	F	G	H
Male	M2	2.1	3.5	5.9	10.1	12.5	13.2	13.6	15.4
	M1				8	9.6	12.3	17	19.3
	P2	1.7	3.1	5.4	9.7	12	12.8	13.2	14.4
	P1				7	11	12.3	12.7	13.5
	C				3.5	7.9	10	11	11.9
	I2				3.2	5.2	7.8	11.7	13.7
	I1					1.9	4.1	8.2	11.8
Female	M2	2.7	3.9	6.9	11.1	13.5	14.2	14.5	15.6
	M1				4.5	6.2	9	14	16.2
	P2	1.8	3.4	6.5	10.6	12.7	13.5	13.8	14.6
	P1			3.7	7.5	11.8	13.1	13.4	14.1
	C				3.8	7.3	10.3	11.6	12.4
	I2				3.2	5.6	8	12.2	14.2
	I1					2.4	5.1	9.3	12.9

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Chronological age (CA) was defined as an individual's date, month, and year of birth, and was calculated by subtracting the patient's recorded date of birth from the date the panorama photo was taken. The estimated dental age (EDA) was the age determined using Demirjian's method and applied on an orthopantomograph with each gender calculated independently.[13]

To extinguish bias, data calculations were performed three times at weekly intervals by a single observer. Samples were analyzed by statistical tests using IBM® SPSS® Statistics version 26.0 (IBM, Armonk, NY, USA). The reliability of each variable was tested using Cronbach's alpha, the normality test was done using the Kolomogorov-Smirnov test, and the homogeneity test used Levene's test. Variables showing $p > .05$ are detailed using the paired *t* test for the comparative test.

RESULTS

Cronbach's alpha was used to measure inter-examiner agreement in the grading stages of tooth development ($\alpha = .975$). With a *p* value greater than .05, the Kolmogorov-Smirnov test result indicated a normal distribution of data which was suitable for further statistical analysis. The paired *t* test was employed to examine the significance of differences between CA and EDA.

Table 2 provides a summary of the statistical analysis of CA and EDA by subject totals. The general mean difference between CA and EDA was -0.05 ± 1.31 for males and -0.72 ± 1.15 for females. The paired *t* test for Demirjian's method showed no significant dissimilarity amongst the CA and EDA for males ($p > .05$). The opposite result was found for the female group, with the paired *t* test showing a significant dissimilarity between the CA and EDA ($p < .05$).

Table 3 shows the statistical analysis of CA and EDA by age group. For the 6–11-year-old group, the mean difference between CA and EDA was -0.17 ± 1.00 and -0.46 ± 0.76 for males and females, respectively. In the 12–17-year-old age group, the mean difference between CA and EDA was 0.08 ± 1.60 and -0.96 ± 1.39 for males and females, respectively. The *p* value for males in the 6–11-year-old group and 12–17-year-old group showed that there were no significant differences amongst dental age estimation and chronological age ($p > .05$). In contrast, the *p* value for females aged 6–11 years and 12–17 years showed that there was a significant dissimilarity between EDA and CA ($p < .05$)

DISCUSSION

The Demirjian approach assesses chronological age by using the calcification sequence of a person's teeth as an indicator of age. There is disagreement amongst researchers about whether Demirjian and dental age estimation methods can be applied to all types of populations, as different populations can yield different results between investigators.[13]

The comparative test conducted in this study showed no significant dissimilarity between the CA and the EDA of males across all age groups using the Demirjian method. This agrees with previous research conducted by Sinha et al.,[14] Zhai et al.,[15] and Bagherian and Sadeghi[16] that there is no significant dissimilarity between chronological age and estimated age found using the Demirjian method.

In a study conducted by Sinha et al.,[14] the mean difference between CA and EDA was 0.02 ± 0.31 with $p = .245$, which indicated that Demirjian's method could be used for age estimation among the population of Northern India. This is also in line with research conducted by Zhai et al.[15] about the population of Northern China. In the current study, the mean dissimilarity between CA and EDA was 0.47 ± 1.21 with a *p* value of .072 in the male group. Research by Bagherian[16] on the population in Iran also showed similar results, with the mean dissimilarity between CA and EDA equal to 0.15 ± 0.51 with a *p* value of .075 for the male group.

Table 2. Statistical analysis of CA and EDA by subject totals

Gender	N	CA		EDA		Age Difference			
		Mean	SD	Mean	SD	Mean	SD	p value	Remarks
Male	80	11.41	3.43	11.35	3.45	-0.05	1.31	0.700	Underestimated
Female	82	11.79	3.39	11.07	3.26	-0.72	1.15	0.000*	Underestimated
Total	162	11.60	3.41	11.21	2.35	-0.39	1.27	0.000	Underestimated

Paired *t* test (*$p < .05$)

Table 3. Statistical analysis of CA and EDA of the age group

Gender	Age Group	CA		EDA		Age Difference			
		Mean	SD	Mean	SD	Mean	SD	p value	Remarks
Male	6–11	8.72	1.79	8.54	1.41	-0.17	1.00	0.250	Underestimated
	12–17	14.54	1.86	14.62	1.86	0.08	1.60	0.749	Overestimated
Female	6–11	8.75	1.44	8.28	1.07	-0.46	0.76	0.000*	Underestimated
	12–17	14.69	1.78	13.72	2.27	-0.96	1.39	0.000*	Underestimated

Paired *t* test (*$p < .05$)

DOI: 10.20473/j.djmkg.v56.i2.p87–91

These three studies had a *p* value greater than .05 which indicates no significant dissimilarity between CA and EDA using Demirjian's method.[11] These results are consistent with the findings of this study that the Demirjian method can be applied to the population of Surabaya in Indonesia as the method showed no significant dissimilarity between CA and EDA. In comparison, research by Kurniawan et al.[17] and Agitha et al.[4] showed that Willems' dental age estimation method was applicable to the Surabaya population, with no significant dissimilarity found between CA and EDA.

Differences in the determination of age estimates can reflect a child's general developmental shift and various factors that contribute to changes in dental development.[18] An individual's growth and development depend on intrinsic and extrinsic factors. For example, variations in nutritional selection can significantly alter individual growth.[5] Few studies have considered the timing of relationships of tooth formation which can vary widely among population groups. Previous studies have consistently overestimated age-related changes, and this suggests that genetic and environmental factors may influence variation in the timing of tooth development.[19]

The age difference found between the male and female samples in the current study may be due to gender-specific factors, and adjustments made for other maturation parameters in female developmental stages, such as sexual maturation, skeletal development and height.[20] The growth spurt process causes an acceleration of tooth maturation and is often associated with a spike in tooth age within one age group. Growth spurts occur early after birth and again at the age of about 6–7 years, and last for approximately 3–4 months. However, there are differences in the later growth spurts of males and females. Accelerated growth occurs in females at approximately 12 years of age and at age 14 years in males. There is also a large variation in growth acceleration, with a standard deviation of one year, and sometimes growth spurts occur in males over the age of 16 years.[21]

Estimates of dental age must be as detailed as possible to undertake forensic examinations.[8] Based on the results of this study, Demirjian's method showed no significant dissimilarity in the EDA and the CA of males therefore, it could be used in Surabaya as a method for estimating the age of children and adolescents aged 6–17 years.

If the result of the difference between CA and EDA is closer to zero, the higher the precision of age estimate for that method when applied to certain populations. In addition, the use of the mean error prediction, which shows a maximum result of 1, can be considered accurate.[22] The process of age identification can be done using a combination of several methods, such as teeth and bones. This can increase the reliability of age identification for more accurate results than using only one method.[22]

Maber et al.[23] and Liversidge[11] highlight that research results can differ based on variations between the sample population and general population standards, such as age, sample size, sample bias, sample population biological variations, environment, eating habits, and accuracy in evaluating the method used. Although there are differences in the results of this study, the difference between chronological age and dental age in each age group is still within the limits determined by forensic anthropology, which is between ± 0.5 years to ± 1 year in adult and child populations.[24]

In conclusion, the Demirjian method can be utilized to calculate the estimated dental age of children from Surabaya, Indonesia; however, further research is needed for females in this population. The results obtained in this study may differ when applied to other populations due to various factors. Further explorations with larger sample sizes will strengthen the reliability of using the Demirjian approach in Indonesia.

REFERENCES

1. Badan Pusat Statistik. Statistik Indonesia 2018. Subdirektorat Publikasi dan Kompilasi Statistik, editor. Jakarta: BPS-Statistics Indonesia; 2018. p. 1–762.
2. Pusat Penanggulangan Krisis Kesehatan. Pedoman teknis penanggulangan krisis kesehatan akibat bencana: Technical guidelines for health crisis responses on disaster. Jakarta: Kementerian Kesehatan Republik Indonesia; 2010. p. 1–170.
3. Prakoeswa BFWR, Kurniawan A, Chusida A, Marini MI, Rizky BN, Margaretha MS, Utomo H, I'zaaz Darmawan A, Aisyah AKN, Alias A, Wahjuni OR, Marya A. Children and adolescent dental age estimation by the Willems and Al Qahtani methods in Surabaya, Indonesia. Dias FJ, editor. Biomed Res Int. 2022; 2022: 1–4.
4. Agitha SRA, Sylvia M.A.R M, Utomo H. Estimasi usia anak etnis Tionghoa di Indonesia dengan menggunakan metode Willems. J Biosains Pascasarj. 2016; 18(1): 35–9.
5. Swastirani A, Utomo H, Sylvia MAR M. Estimsasi usia dengan orthopantomogram pada pasien Rumah Sakit Gigi dan Mulut Pendidikan Universitas Airlangga. E-Prodenta J Dent. 2018; 2(1): 124–9.
6. Putri AS, Nehemia B, Soedarsono N. Prakiraan usia individu melalui pemeriksaan gigi untuk kepentingan forensik kedokteran gigi (Age estimation through dental examination in forensic denstistry). J PDGI. 2013; 62(3): 55–63.
7. Kurniawan A, Chusida A, Atika N, Gianosa TK, Solikhin MD, Margaretha MS, Utomo H, Marini MI, Rizky BN, Prakoeswa BFWR, Alias A, Marya A. The applicable dental age estimation methods for children and adolescents in Indonesia. Pucci CR, editor. Int J Dent. 2022; 2022: 6761476.
8. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973; 45(2): 211–27.
9. Boel T, Bahri TA. Age estimation using Schour-Massler method compared to the Demirjian method. Dentika Dent J. 2019; 22(1): 15–9.
10. Larasati AW, Irianto MG, Bustomi EC. Peran pemeriksaan odontologi forensik dalam mengidentifikasi identitas korban bencana masal. Major Med J Lampung Univ. 2018; 7(3): 228–33.
11. Liversidge HM. The assessment and interpretation of Demirjian, Goldstein and Tanner's dental maturity. Ann Hum Biol. 2012; 39(5): 412–31.
12. Apriyono DK. Metode penentuan usia melalui gigi dalam proses identifikasi korban. Cermin Dunia Kedokt. 2016; 43(1): 71–4.
13. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Biol. 1976; 3(5): 411–21.
14. Sinha S, Umapathy D, Shashikanth M, Misra N, Mehra A, Singh A. Dental age estimation by Demirjian′s and Nolla′s method: A comparative study among children attending a dental college in Lucknow (UP). J Indian Acad Oral Med Radiol. 2014; 26(3): 279.

DOI: 10.20473/j.djmkg.v56.i2.p87–91

15. Zhai Y, Park H, Han J, Wang H, Ji F, Tao J. Dental age assessment in a northern Chinese population. J Forensic Leg Med. 2016; 38: 43–9.
16. Bagherian A, Sadeghi M. Assessment of dental maturity of children aged 3.5 to 13.5 years using the Demirjian method in an Iranian population. J Oral Sci. 2011; 53(1): 37–42.
17. Kurniawan A, Agitha SRA, Margaretha MS, Utomo H, Chusida A, Sosiawan A, Marini MI, Rizky BN. The applicability of Willems dental age estimation method for Indonesian children population in Surabaya. Egypt J Forensic Sci. 2020; 10(1): 0–3.
18. Sykes L, Bhayat A, Bernitz H. The effects of the refugee crisis on age estimation analysis over the past 10 years: a 16-country survey. Int J Environ Res Public Health. 2017; 14(6): 630.
19. Kumaresan R, Cugati N, Chandrasekaran B, Karthikeyan P. Reliability and validity of five radiographic dental-age estimation methods in a population of Malaysian children. J Investig Clin Dent. 2016; 7(1): 102–9.
20. Nik-Hussein NN, Kee KM, Gan P. Validity of Demirjian and Willems methods for dental age estimation for Malaysian children aged 5-15 years old. Forensic Sci Int. 2011; 204(1–3): 208.e1-6.
21. Rahardjo P. Diagnosis ortodontik. Surabaya: Airlangga University Press; 2008. p. 1–100.
22. Koç A, Özlek E, Öner Talmaç AG. Accuracy of the London atlas, Willems, and Nolla methods for dental age estimation: a cross-sectional study on Eastern Turkish children. Clin Oral Investig. 2021; 25(8): 4833–40.
23. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int. 2006; 159: S68–73.
24. Ambarkova V, Galić I, Vodanović M, Biočina-Lukenda D, Brkić H. Dental age estimation using Demirjian and Willems methods: Cross sectional study on children from the Former Yugoslav Republic of Macedonia. Forensic Sci Int. 2014; 234: 187.e1-187.e7.

DOI: 10.20473/j.djmkg.v56.i2.p87–91