



Dental Age Estimation Using the Demirjian Method in Javanese Children in Jember, Indonesia

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Abstract

Accurate assessment of chronological age in children is critical for both clinical dentistry and forensic applications. This study aimed to evaluate the applicability and accuracy of the Demirjian method for dental age estimation in Javanese children residing in Jember, Indonesia. The results indicated that the Demirjian method consistently overestimated chronological age in this population, with a mean difference of 0.68 ± 0.42 years. The overestimation was slightly higher in girls (0.74 ± 0.39 years) than in boys (0.63 ± 0.45 years), though the difference was not statistically significant. Despite this, a strong positive correlation ($r = 0.91$, $p < 0.001$) was observed between dental age and chronological age, demonstrating that the Demirjian method is a reliable predictor of developmental stage, though minor population-specific adjustments may enhance precision. The findings suggest that dental age estimation using the Demirjian method can be effectively applied to Javanese children in Jember, but practitioners should be aware of a tendency for slight overestimation. Future research is recommended to develop localized conversion tables to improve accuracy for forensic and clinical use.

Keywords: Dental age estimation, Demirjian method, Javanese children, chronological age, panoramic radiography, forensic dentistry

Introduction

Age estimation plays a crucial role in both clinical and forensic dentistry, as well as in broader areas such as pediatric medicine, orthodontics, and legal identification. Chronological age is typically determined based on birth records; however, in many instances—such as undocumented births, migration, or forensic cases—accurate birth data may be unavailable or unreliable. In these contexts, biological markers of growth and development, particularly dental development, serve as practical and reliable alternatives for estimating age. Among these markers, dental age estimation has gained significant attention due to the relatively predictable and sequential pattern of tooth formation, which is less influenced by environmental factors compared to skeletal development.

Dental age estimation is widely used in pediatric dentistry to guide treatment planning, such as timing for orthodontic interventions, eruption guidance, and management of mixed dentition. It is also critical in forensic applications, including the identification of unknown individuals, assessment of legal age in cases of age-related responsibilities, and disaster victim identification. Given the growing diversity of populations globally, it is important to validate existing dental age estimation methods in specific ethnic and regional groups, as variations in genetic, nutritional, and environmental factors can affect tooth development.

One of the most commonly used methods for dental age estimation is the Demirjian method, developed in 1973 based on a French-Canadian population. This method involves assessing the developmental stages of seven permanent mandibular teeth on the left side using panoramic radiographs. Each tooth is scored according to an eight-stage scale, and the cumulative score is then converted into a dental age using standardized tables. The Demirjian method is widely recognized for its simplicity, reproducibility, and high correlation with chronological age

across various populations. However, several studies have shown that the method may overestimate or underestimate age depending on ethnic and regional differences, highlighting the necessity of population-specific validation. Indonesia, as the largest archipelagic country with a highly diverse population, exhibits considerable variation in genetic backgrounds, nutrition, and socio-economic factors that may influence dental development. Javanese children, who represent the largest ethnic group in Indonesia, have been underrepresented in studies validating dental age estimation methods. Specifically, in Jember, East Java, there is limited research examining the accuracy and applicability of the Demirjian method. Evaluating dental age in this population is particularly significant for clinical pediatric dentistry, orthodontics, and forensic identification in the region. Understanding potential discrepancies between dental and chronological age can improve the accuracy of treatment planning, legal age assessments, and age-related health interventions.

Previous research in other populations has demonstrated that the Demirjian method tends to slightly overestimate chronological age in Asian populations, while some European populations show closer alignment with actual age. These findings suggest that ethnic and regional differences must be considered when applying the method. Moreover, sex differences in dental development have been observed, with girls generally exhibiting earlier tooth maturation than boys. Therefore, examining both sex-specific and overall population trends is necessary for comprehensive validation.

In summary, the rationale for this study lies in the critical importance of accurate age estimation for clinical and forensic purposes, the widespread use of the Demirjian method, and the need to validate its accuracy for Javanese children in Jember. By addressing this knowledge gap, the study aims to improve dental age estimation practices in Indonesia, provide guidance for pediatric dental care, and

enhance forensic identification methods tailored to the local population.

Methods

Research Design

This study employed a cross-sectional quantitative research design to evaluate the accuracy and applicability of the Demirjian method for dental age estimation in Javanese children. The cross-sectional design was selected to allow simultaneous assessment of chronological age and dental development, providing a snapshot of the correlation between these two variables within the target population. This approach is appropriate for validating existing age estimation methods in specific populations, as it allows for the collection of standardized radiographic data across a defined age range, facilitating statistical comparison and analysis.

Data Collection Procedures

Panoramic radiographs (orthopantomograms) were obtained for all participants using standardized radiographic equipment and exposure protocols to minimize radiation dose while ensuring image clarity. Each radiograph was assessed independently by two calibrated examiners trained in the Demirjian method. The developmental stages of the seven permanent mandibular teeth on the left side were evaluated using the Demirjian eight-stage scoring system (stages A–H). Any discrepancies between examiners were resolved through discussion and consensus.

Chronological age was calculated based on the official date of birth recorded in birth certificates or school documents, and the date of radiographic examination. Chronological age was expressed in years with two decimal points to ensure precision. Dental age was calculated by summing the maturity scores assigned to each tooth and converting the total score into dental age using the standard Demirjian tables.

The study also examined the accuracy of the Demirjian method in predicting age by calculating the percentage of children whose dental age fell within ± 1 year of chronological age. Inter-examiner reliability for dental stage assessment was determined using Cohen's kappa coefficient, with values above 0.8 considered indicative of excellent agreement.

Summary of Methodological Rigor

This methodology ensured that the study was robust, reproducible, and applicable to clinical and forensic contexts. Stratified random sampling minimized selection bias, dual examiner assessment enhanced reliability, and the use of official records guaranteed accurate chronological age determination. By adhering to established radiographic and ethical standards, the study maintained high scientific integrity while providing meaningful data for population-specific validation of the Demirjian method.

Results

Participant Characteristics

A total of 238 Javanese children were included in the final analysis, consisting of 120 boys (50.4%) and 118 girls (49.6%), with ages ranging from 5.0 to 15.0 years. The mean chronological age of the participants was 10.2 ± 3.1 years. Age distribution was evenly represented across the

study population due to the stratified random sampling, with approximately 16–22 children per yearly age group.

Accuracy Within Age Intervals

The percentage of children whose dental age fell within ± 1 year of chronological age was calculated. Overall, 72% of participants were within this range. For boys, 70% were within ± 1 year, while 74% of girls met this criterion. Children in the younger age groups (5–8 years) showed slightly higher accuracy (78%) compared to older children (12–15 years), where the accuracy decreased to 65%, suggesting a minor tendency for overestimation in older age groups.

Sex Differences in Tooth Development Stages

Analysis of individual mandibular teeth revealed that girls tended to reach developmental stages earlier than boys, particularly in the second premolar and second molar teeth. Mean stage scores for these teeth were 0.2–0.3 stages higher in girls than in boys within the same age group, though differences for anterior teeth were minimal.

Inter-Examiner Reliability

Inter-examiner reliability for dental stage scoring was assessed using Cohen's kappa coefficient. Excellent agreement was observed, with kappa values ranging from 0.82 to 0.91 for the seven evaluated teeth. The highest agreement was found for central and lateral incisors, while slightly lower agreement was observed for second premolars and second molars due to subtle radiographic differences in root development.

Summary of Key Findings

1. The Demirjian method overestimated chronological age by an average of 0.68 ± 0.42 years in Javanese children in Jember.
2. Overestimation was slightly higher in girls (0.74 ± 0.39 years) than boys (0.63 ± 0.45 years).
3. Strong positive correlations between dental age and chronological age were observed for both sexes ($r = 0.90$ – 0.92).
4. Approximately 72% of children had dental age within ± 1 year of chronological age, with higher accuracy in younger age groups.
5. Girls exhibited slightly earlier tooth maturation than boys, especially in premolars and molars.
6. Inter-examiner reliability was excellent, supporting the consistency of dental stage assessment.

Tables and Figures

Table 1: Descriptive Statistics for Chronological Age, Dental Age, and Δ Age

Group	n	Chronological Age (mean $\pm$ SD)	Dental Age (mean $\pm$ SD)	Δ Age (mean $\pm$ SD)
Total	238	10.2 ± 3.1	10.9 ± 3.2	0.68 ± 0.42
Boys	120	10.1 ± 3.2	10.8 ± 3.3	0.63 ± 0.45
Girls	118	10.3 ± 3.1	11.0 ± 3.1	0.74 ± 0.39

Table 2: Pearson Correlation Between Dental Age and Chronological Age

Group	Correlation Coefficient (r)	p-value
Total	0.91	<0.001
Boys	0.90	<0.001
Girls	0.92	<0.001

Table 3: Accuracy of Dental Age Within ±1 Year of Chronological Age

Group	Percentage Within ±1 Year
Total	72%
Boys	70%
Girls	74%

Conclusion

This study evaluated the applicability of the Demirjian method for dental age estimation in Javanese children in Jember, Indonesia. The findings demonstrate that the method strongly correlates with chronological age, with Pearson correlation coefficients of 0.91 for the total sample, indicating its reliability in reflecting dental development trends. However, the method consistently overestimates chronological age by an average of 0.68 ± 0.42 years, with slightly higher overestimation in girls (0.74 ± 0.39 years) compared to boys (0.63 ± 0.45 years). Accuracy was highest in younger children (5–8 years) and decreased slightly in older age groups (12–15 years), suggesting the need for careful interpretation when applied to adolescents. Girls exhibited slightly earlier dental maturation than boys, particularly in premolars and molars, highlighting the importance of sex-specific considerations in age estimation. Inter-examiner reliability was excellent, supporting the reproducibility and consistency of dental stage assessments using panoramic radiographs.

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