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Unveiling dental age patterns in a Chinese population: A study in Surabaya using the Demirjian method

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Abstract

Tooth development can serve as a means to estimate an individual's chronological age, which is crucial in dental treatment planning and understanding individual growth patterns. Demirjian et al. devised a technique to assess dental maturity in Caucasians by evaluating crown and root formation stages on dental radiographs. This study aims to evaluate the suitability of Demirjian's method for age assessment among Chinese children (aged 9-15 years). The present study involved 30 panoramic radiographs of outpatients (15 males and 15 females, aged 9-15 years) at the Dental Hospital Universitas Airlangga, Surabaya. The information, including the sex and chronological age of each subject, was recorded, and the dental age was estimated using the Demirjian method. Statistical analysis was conducted using IBM SPSS Statistics version 23.0. The results indicated that male subjects exhibited a slight overestimation of dental age by 0.34 years, whereas female subjects showed a slight underestimation of 0.51 years, with no statistically significant difference ($p>0.05$). In conclusion, this study suggests that the Demirjian method effectively estimates the dental age of Chinese children in Surabaya. Further research with larger sample sizes and diverse populations is recommended to enhance the method's validity.

Keywords: Age Estimation; Chinese Children; Dental Age; Legal Identity

1. Introduction

Dental age estimation is significant across various disciplines, including forensics, pediatric dentistry, and orthodontic treatment planning. This estimation plays a vital role in determining the optimal timing for initiating orthodontic treatment and assessing the normal progression of tooth development. In forensic odontology, dental age determination is of utmost importance due to its high accuracy and ease of use in predicting an individual's age. Evaluating dental maturity and development provides a reliable method for establishing chronological age, which proves invaluable in population studies, understanding variations in development among different races and genders, and identifying tooth eruption patterns. Furthermore, dental age determination holds particular significance in forensic investigations as it enables the assessment of tooth vitality, facilitating the categorization of victims based on age and streamlining the identification process by narrowing down the search parameters [1–3].

Demirjian introduced a scoring method for dental age based on tooth development observed in radiographs [4]. This method has been studied in various populations, indicating a reliable approach to estimating dental age [5–9]. The Demirjian method is based on the stages of tooth development, and it is considered to be a reliable method for estimating dental age in children of different populations. However, it is important to adapt the method to diverse

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populations to ensure accurate results, as the maturity scores may vary from the chronological age of other populations, either higher or lower [4].

Surabaya is renowned for its diverse population, including a substantial Chinese community. In studying dental development, it is crucial to consider and investigate variations across different populations. Genetic factors predominantly influence these variations, underscoring the significance of incorporating diverse samples to understand dental development patterns comprehensively [10]. Due to the limited dental age estimation study in Indonesia's Chinese population, this preliminary study based on the Demirjian method was conducted in Surabaya. Such research holds potential benefits for forensic odontology and fills a significant research gap in this population.

2. Material and Methods

This study received ethical clearance from the Health Research Ethical Clearance Commission of the Faculty of Dental Medicine, Universitas Airlangga, with the assigned number 121/HRECC.FODM/VIII/2017. This retrospective analysis involved 30 panoramic radiographs (15 males and 15 females, aged 9 to 15 years) of outpatients at the Dental Hospital, Universitas Airlangga. The subjects were specifically selected from the Chinese ethnic group residing in Surabaya. The inclusion criteria for this study were as follows: the availability of high-quality panoramic radiographs with recorded information on sex and age, clear visibility of the seven lower left permanent teeth, and the absence of any apparent abnormalities. The ethnic group information of the subjects was obtained from their respective medical records. The information about the sexes and ages of each subject was recorded and organized in Microsoft Excel.

The chronological age (CA) was determined by calculating the difference between the date of the radiograph examination and the patient's date of birth. The Demirjian method was employed to estimate each subject's dental age (DA). This method involves a comprehensive analysis of panoramic radiographs focusing on the seven lower left permanent teeth while excluding the third molar. It encompasses eight stages of tooth development, represented by letters A to H, corresponding to varying degrees of maturation. These stages are assigned numerical values based on Demirjian et al. (1973) tables. Once the seven values corresponding to the lower left permanent teeth are obtained, they are summed to calculate the dental maturation score, which is then converted into DA using the tables provided by Demirjian [4]. Furthermore, the difference between CA and DA was calculated to obtain the mean age difference, mean absolute error (MAE), and assess any potential underestimation or overestimation of the age. The statistical analysis of this study was conducted using IBM SPSS version 23.0 (IBM, Armonk, USA).

3. Results and discussion

The durability of human dentition and its protection by the oral cavity's soft tissue makes it a widely recognized primary identifier in forensic identification. Teeth offer valuable information about an individual's sex, age, racial origin, and DNA profile. Dental age estimation is a subfield of forensic odontology that relies on teeth as a highly reliable parameter for accurately predicting an individual's chronological age. Dental age estimation techniques include morphological, radiographic, and DNA-based methods. Morphological techniques rely on the visual inspection of teeth, while radiographic techniques use dental radiographs to estimate age. DNA-based methods use DNA methylation profiling, telomere length, mRNA, DNA rearrangement, sjTREC, and aspartic amino acid (Asp) racemization to estimate age [11–14].

Demirjian devised a method for estimating dental age by evaluating seven specific permanent teeth on the left mandible. When a tooth is missing on the left mandible, the corresponding tooth on the right mandible is used instead. Compared to intraoral radiographs, the Demirjian method employs panoramic radiographs as the preferred imaging modality due to their convenience, especially for pediatric patients. Additionally, panoramic radiographs offer the advantage of lower radiation exposure and minimal distortion, typically ranging from 3% to 10% on the left mandible. The impact of this distortion is deemed negligible as the assessment primarily relies on tooth shape rather than size [15].

Demirjian emphasizes the significance of adapting dental age estimation methods to diverse populations to achieve accurate results. A study specifically investigated children from the Former Yugoslav Republic of Macedonia and revealed a significant overestimation of dental age compared to chronological age using the maturity scores [4, 16]. Additionally, the validity of the Demirjian method has been assessed in other populations, including Romanian children and a Spanish sample of living subjects. These studies highlight the importance of recognizing that maturity scores may differ from the chronological age in various populations, showing higher or lower values. Consequently, alternative methods may be more suitable for age estimation in specific populations [17, 18].

Table 1 Descriptive analysis of the chronological age and dental age using the Demirjian method in Chinese children in Surabaya

Subjects	N	CA	DA	Age Difference	MAE	Sig.	Remarks
Male	15	12.17±1.90	12.51±2.15	0.34	1.01	0.259	Overestimation
Female	15	11.61±1.70	11.09±1.70	-0.51	0.86	0.068	Underestimation
Total	30	11.89±1.79	11.80±2.03	-0.09	0.94	0.682	Underestimation
Age Group							
9.00 – 9.99		9.37±0.43	9.37±1.24	-0.003	0.63	> 0.05	Underestimation
10.00 – 10.99		10.26±0.28	10.67±1.62	-0.191	1.24		Underestimation
11.00 – 11.99		11.22±0.09	11.31±0.78	0.089	0.59		Overestimation
12.00 – 12.99		12.32±0.35	13.08±1.26	0.760	1.23		Overestimation
13.00 – 13.99		13.27±0.33	12.35±2.90	-0.920	1.82		Underestimation
14.00 – 14.99		14.19±0.18	13.54±0.76	-0.650	0.77		Underestimation
15.00 – 15.99		15.24_0.16	15.20±0.99	-0.035	0.82		Underestimation
CA: chronological age; DA: dental age; MAE: mean absolute error							

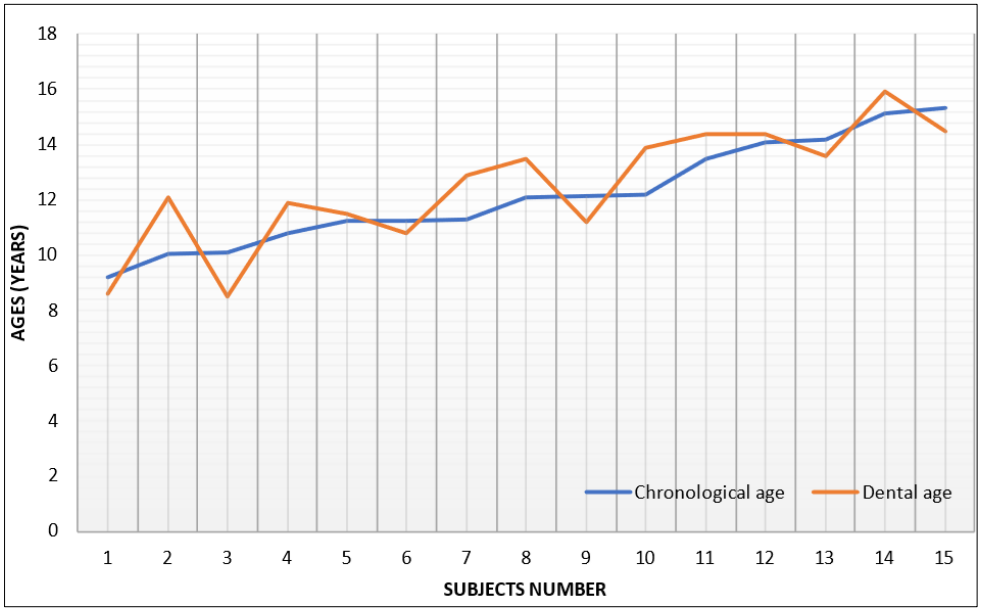

Figure 1 Distribution of chronological age and dental age based on the Demirjian method in male subjects

This study included a sample of 30 panoramic radiographs of outpatients from the Chinese ethnic group residing in Surabaya, Indonesia. The mean chronological age (CA) of the subjects was determined to be 11.89 ± 1.79 years, while the mean dental age (DA) was calculated as 11.80 ± 2.03 years, as presented in Table 1. When considering sex-based age estimation, the analysis revealed a slight overestimation of 0.34 years in males, whereas females exhibited a slight underestimation of -0.51 years. It is noteworthy that the mean absolute difference (MAD) in males was observed to be higher than that in females. However, statistical analysis indicated no significant difference between DA and CA in males, females, or the overall subjects ($p>0.05$).

Figure 1 presents the distribution of age differences between chronological age (CA) and dental age (DA) specifically for males. The majority of values in the distribution indicate that DA exceeds CA, suggesting an overall overestimation of dental age concerning chronological age. Conversely, Figure 2 displays the distribution of age differences between DA and CA for females. In this case, the majority of values indicate that DA is lower than CA, implying an overall underestimation of dental age compared to chronological age.

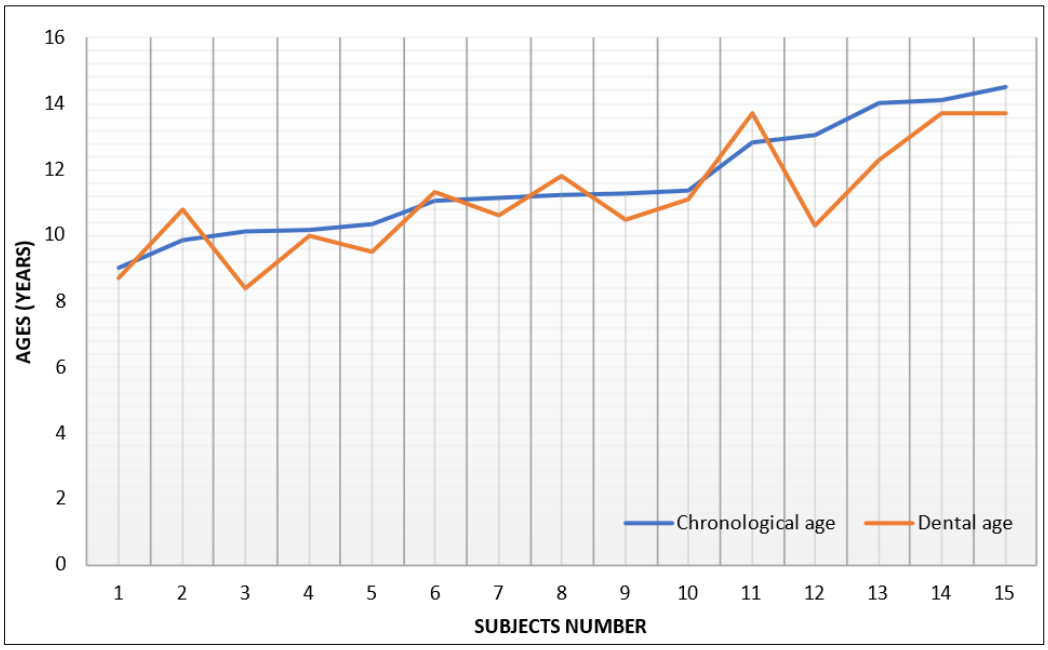

Figure 2 Distribution of chronological age and dental age based on the Demirjian method in female subjects

The subjects of this study consist of individuals who are of pure Chinese descent (Mongoloid) and have resided in Surabaya for at least two generations. These stringent inclusion criteria are essential to consider the potential variations in growth and development observed across diverse populations. For instance, it has been documented that the timing of tooth eruption varies among individuals of European and American European descent (Caucasian) compared to individuals of Negroid American (Negroid) and Indian American (Mongoloid) descent. This study aims to minimize confounding factors by selecting a homogeneous Chinese population and providing focused insights into dental growth and development within the Surabaya context [19].

The present study includes subjects from the middle-upper socioeconomic class, aged between 9 and 15 years. The selection of subjects based on socioeconomic status is based on previous research indicating that children from lower socioeconomic backgrounds may exhibit delayed tooth eruption compared to their middle-upper socioeconomic backgrounds. This discrepancy can be attributed to individuals from middle to upper-class families typically having better access to adequate nutrition, which plays a significant role in promoting normal dental development [20].

The current study's findings indicated an overall underestimation of age across the specific age group, ranging from -0.920 to -0.003 years. Notably, an overestimation was observed specifically within the age range of 11.00 to 12.99 years, although this difference was not statistically significant (p>0.05). The results also uncovered a distinct pattern in applying the Demirjian method, indicating a tendency for age overestimation in males and age underestimation in females. This divergence can be attributed to the substantial influence of sex on the overall process of growth and development, specifically concerning teeth eruption. Extensive research consistently supports the notion that girls generally undergo earlier teeth eruption than boys. Consequently, our findings suggest that hormonal factors may not significantly influence the outcomes derived from the Demirjian method. This finding contrasts with prior studies proposing a correlation between tooth development and a growth spurt, which typically manifests more prominently in boys than in girls. The intricate interplay between sex and hormonal factors in dental development underscores the importance of considering sex as a significant variable in studies investigating tooth eruption patterns and associated processes [19].

This study also highlights significant variations between dental and chronological age within specific age groups. Among these groups, the 13-year-old cohort exhibited the highest mean absolute error (MAE) with a value of 1.82 years. The observed differences in dental age indicate accelerated teeth maturation within these particular age groups. This acceleration can be attributed to a growth spurt, resulting in a substantial increase in dental age during a specific period. These findings align with prior research indicating that girls experience this growth spurt earlier than boys. In girls, the prepubertal growth spurt typically manifests between the ages of 10 and 12, while in boys, it occurs between the ages of 12 and 14. During this time, there is a close correlation between dental age and skeletal development in children of 12-14 years of age of both sexes [21].

4. Conclusion

The study found differences between dental age and chronological age, with boys having slightly older dental age and girls having slightly younger dental age. These findings challenge the idea that hormonal factors affect early teeth eruption in girls. Additionally, certain age groups showed faster teeth maturation during the prepubertal growth spurt. Further research is needed to validate and expand the use of the Demirjian method across different ages, ethnicities, and populations. Enhancing dental age assessment techniques will have practical implications in clinical and forensic settings.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Statement of ethical approval

This study was approved by the Health Research Ethical Clearance Commission of the Faculty of Dental Medicine, Universitas Airlangga (number: 121/HRECC.FODM/VIII/2017).

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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