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Forensic Anthropology Population Data

Dental age assessment among Iranian children aged 6–13 years using the Demirjian method

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ABSTRACT

Background: Many methods of age estimation have been suggested, and of these, the Demirjian method is the most frequently used. The objective of the present study is to test the accuracy of the Demirjian method for age estimation in an Iranian population.
Materials and methods: A cross-sectional study involving 141 boys and 170 girls selected by a convenience sampling method was carried out. Panoramic radiography was used to score the left mandibular teeth and to obtain the Demirjian tooth age.
Results: The Demirjian method overestimated the age of boys by 0.34 years and girls by 0.25 years. The scatter plots showing the difference between estimated dental age and chronological age for boys and girls showed that the regression lines had a decreasing trend with age. The mean difference between estimated dental age and chronological age in boys decreased with age (except in the oldest age group of boys). In contrast, it increased in girls between the ages of 6–8 years old, and then decreased.
Conclusion: The results show that the Demirjian method is appropriate for estimating the dental age of patients, especially those belonging to the 9–13 year old age group. However, in the younger age groups, further study involving more cases is required.

1. Introduction

Human biologists, medical and dental clinicians, physical anthropologists, and forensic scientists have long recognised the importance of variations in human growth and development [1]. Developing teeth are thought to be useful indicators of maturation (and hence, of biological age), since they are less affected than other body tissues by endocrine diseases and environmental damage [2]. Developing teeth may be measured in two ways: formation or eruption. Tooth eruption is a discontinuous and variable measurement affected by such factors as malnutrition, premature loss of primary teeth, crowding, and dental decay. On the other hand, tooth formation is seen as a better measurement, enjoying high reliability, a low coefficient of variation, and resistance to environmental effects [3–6]. Moreover, dental maturation is an index of growth in children and may be used in orthodontics [7].

One of the most well-known methods for ascertaining dental age is the Demirjian method, set forth in 1973 following a study of a large sample of Canadian children [8,9]. This method evaluates the development of seven left mandibular permanent teeth from a panoramic radiograph. The developmental stage of each tooth is converted to a score using the conversion table for boys or girls, provided by Demirjian and Goldstein. The scores of all seven teeth are added together to give the total maturity score, which is then converted to dental age by referring to the Demirjian table.

Hägg and Matsson [10] found a high precision and accuracy with Demirjian's method when applied to the younger age groups rather than to the older ones. The authors concluded that age estimation should preferably be performed during early childhood. Nystrom et al. [11] found a more advanced dental maturation in Finnish children than was that found in French-Canadian children by Demirjian et al., and concluded that maturity standards should be based on studies made on the population to which they are going to be applied. While testing a Chinese population, Davis and Hägg [12] found that, due to racial differences, Demirjian's system could not be accurately applied to other population groups. Staaf et al. [13] inferred that the Canadian research gives a consistent overestimation of about 6–10 months when applied to a Scandinavian population.

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The present study has two goals:

1. To determine dental age from panoramic radiographs using the Demirjian method; and
2. To test the accuracy of the Demirjian method for estimation of chronological age when applied to a group of Mashhad (Iranian) boys and girls.

2. Materials and methods

A cross-sectional study was performed on a sample of 311 orthopantomographs taken from 141 boys and 170 girls aged between 6 and 13 years (Table 1). A convenience sampling method was used. All of them attended the Oral Radiology Department of Mashhad Dental School in Iran. The children studied came from families that had resided in Mashhad for at least two generations. The children selected were healthy, without any growth disorders, and all had mandibular permanent teeth (erupted or unerupted). The orthopantomographs were taken as part of their routine treatment from October 2007 to April 2008. All the radiographs were performed with a Planmeca 2002 CC (Helsinki, Finland) panoramic machine, and suitable exposure factors (with respect to the age and size of the patients) were applied. Unclear radiographs, or those showing hypodontia and gross pathologic problems, were excluded. The chronologic age of an individual was calculated by subtracting his or her birth date from the date on which the radiographs were obtained. Decimal ages were recorded to facilitate statistical calculation, and ages were estimated on a yearly basis (e.g., 7 years 3 months was recorded as 7.25 years and was included in the 7 year age group).

To avoid observer bias, each orthopantomograph was coded with a numerical ID. Age and sex of the subjects were thus unknown to the observer, and the dental age was calculated using the Demirjian [1] method. All teeth of the lower left jaw (with the exception of the third molar) were assessed, and estimated dental age was calculated based on the tables proposed by Demirjian et al. In the absence of any left mandibular teeth, they were replaced by symmetric right ones.

The measurements were implemented by only one observer (AB). Intra-observer error was calculated by re-scoring a random sample of 35 radiographs after an interval of at least 2 weeks. Both readings were then analysed by paired *t*-test. The two readings were computed for percentage agreement, and the remainder was evaluated by figuring the over- and under-stage assessments.

Table 1
Age groups and sex distribution of studied children.

Chronological age	Gender		Total (%)
	Male (%)	Female (%)	
6.00–6.99	8 (2.6)	9 (2.9)	17 (5.5)
7.00–7.99	25 (8.0)	27 (8.7)	52 (16.7)
8.00–8.99	29 (9.3)	37 (11.9)	66 (21.2)
9.00–9.99	20 (6.4)	32 (10.3)	52 (16.7)
10.00–10.99	23 (7.4)	25 (8.0)	48 (15.4)
11.00–11.99	20 (6.4)	21 (6.8)	41 (13.2)
12.00–12.99	16 (5.1)	19 (6.1)	35 (11.3)
Total	141 (45.3)	170 (54.7)	311 (100)

2.1. Statistical analysis

SPSS 11.5 for Windows (SPSS Inc., Chicago, IL) [14] was used for analysis. The One-sample Kolmogorov–Smirnov test showed that the difference between the estimated dental age (EDA) and the chronological age (CA), or EDA–CA, had normal distribution ($p = 0.85$). Thus, we applied paired-sample *t*-tests for determining the accuracy of the Demirjian method, with the null hypothesis that EDA would not differ from CA.

The results of the Mann–Whitney *U*-test showed no statistically significant difference between the chronological ages of the two genders (mean ranks were 157.87 and 154.45 between males and females, respectively: $p = 0.74$). When the *p*-value was less than 0.05, the results were considered statistically significant.

3. Results

Intra-observer reproducibility was calculated by re-examining 35 orthopantomographs. The difference between dental and chronological age (EDA–CA) on the first and second readings was not significant ($p = 0.12$). The percentage agreement at the second reading of stage assessments in a total of 245 teeth was 91%, with 9 being one stage ahead and 14 being one stage behind.

Table 2 compares the estimated dental age (EDA) and the chronological age (CA), applying the Demirjian method to boys and

Table 2
Comparison between the estimated dental age (EDA) using the Demirjian method and chronological age (CA) (in years) among the studied children.

Age Groups	Genders	Mean (S.D.)			95% CI of EDA–CA	*p*-Value*
		CA	EDA	EDA–CA		
6.00–6.99	Male	6.51 (0.24)	7.55 (0.40)	1.04 (0.55)	(0.58, 1.50)	0.001**
	Female	6.49 (0.29)	6.73 (0.49)	0.24 (0.32)	(−0.01, 0.48)	0.06**
	Combined	6.50 (0.26)	7.12 (0.61)	0.61 (0.60)	(0.31, 0.92)	0.001**
7.00–7.99	Male	7.54 (0.28)	8.33 (0.61)	0.78 (0.68)	(0.50, 1.06)	<0.0001
	Female	7.49 (0.29)	7.90 (0.68)	0.41 (0.70)	(0.14, 0.69)	0.005
	Combined	7.51 (0.29)	8.11 (0.68)	0.59 (0.71)	(0.40, 0.79)	<0.0001
8.00–8.99	Male	8.50 (0.27)	8.93 (0.84)	0.44 (0.74)	(0.16, 0.72)	0.004
	Female	8.45 (0.26)	8.95 (0.70)	0.50 (0.69)	(0.27, 0.73)	<0.0001
	Combined	8.47 (0.26)	8.94 (0.76)	0.47 (0.71)	(0.30, 0.65)	<0.0001
9.00–9.99	Male	9.43 (0.25)	9.82 (1.01)	0.39 (0.93)	(−0.05, 0.83)	0.08
	Female	9.37 (0.31)	9.61 (0.99)	0.23 (0.91)	(−0.10, 0.56)	0.16
	Combined	9.40 (0.28)	9.70 (0.99)	0.29 (0.91)	(0.04, 0.55)	0.02
10.00–10.99	Male	10.52 (0.25)	10.64 (0.95)	0.12 (0.97)	(−0.30, 0.54)	0.56
	Female	10.42 (0.28)	10.53 (0.82)	0.11 (0.85)	(−0.24, 0.46)	0.53
	Combined	10.47 (0.27)	10.58 (0.87)	0.11 (0.90)	(−0.15, 0.38)	0.38
11.00–11.99	Male	11.34 (0.26)	11.10 (0.56)	−0.24 (0.63)	(−0.54, 0.05)	0.10
	Female	11.38 (0.29)	11.45 (0.77)	0.08 (0.87)	(−0.32, 0.47)	0.69
	Combined	11.36 (0.27)	11.28 (0.69)	−0.08 (0.77)	(−0.32, 0.16)	0.51
12.00–12.99	Male	12.47 (0.25)	12.61 (1.00)	0.13 (0.88)	(−0.33, 0.60)	0.55
	Female	12.45 (0.28)	12.39 (0.72)	−0.07 (0.65)	(−0.38, 0.25)	0.66
	Combined	12.46 (0.27)	12.49 (0.85)	0.03 (0.76)	(−0.24, 0.29)	0.84
Total	Male	9.53 (1.77)	9.88 (1.65)	0.34 (0.86)	(0.20, 0.49)	<0.0001
	Female	9.47 (1.73)	9.72 (1.73)	0.25 (0.78)	(0.13, 0.37)	<0.0001
	Combined	9.50 (1.75)	9.79 (1.69)	0.29 (0.81)	(0.20, 0.38)	<0.0001

CI: confidence interval; S.D.: standard deviation.
* Paired *t*-test.
** The *p*-values are not statistically meaningful because of small sample size in this age group.