

# Accuracy of radiographic methods in dental age estimation

## Dental age estimation in Belgian children: Demirjian's technique revisited

Willems G, Van Olmen A, Spiessens B, Carels C

*J Forensic Sci* 2001;46:893-5

The Demirjian method is useful in estimating the chronological age of children based on their dental age, i.e., of children with unknown birth data which are often true for adopted children or of children committing legal offenses. The technique may also be used to estimate the age of unidentified skeletons belonging to children. It is advantageous because it is a scoring system based on the use of developmental stages of teeth and the predicted dental age is relatively accurate since it is not based on the eruption process of teeth.

In the present study, the authors evaluated the accuracy of Demirjian's dental age estimation method in children in a Belgian Caucasian population, to adapt the scoring system in the case of a significant overestimation as frequently reported.

The first sample of the Belgian Caucasian population consisted of 2523 orthopantomograms of 1265 boys (age ranging from 1.8 to 18.0 years) and 1258 girls (age ranging from 2.1 to 18.0 years). Boys and girls with systemic diseases, premature birth, congenital anomalies, unclear orthopantomogram, and aplasia of at least two corresponding teeth bilaterally in the mandible were excluded. Of this sample, 2116 orthopantomograms (1029 boys and 1087 girls) were selected. A second sample of 355 orthopantomograms was used to evaluate the accuracy of the original method and the adapted method.

A signed-rank test was done to search for significant age differences between the obtained dental age and the chronological age. The results showed a consistent

overestimation of the dental age for the first Belgian Caucasian sample, amounting to a median of 0.5 years for boys and a median of 0.6 years for girls. To avoid this, Demirjian's maturity scores were adapted using a weighted ANOVA on the data of the Belgian Caucasian sample. This resulted in new Tables for boys and girls with age scores directly expressed in years.

The accuracy of both methods was also compared using a signed-rank test. The new adapted method resulted in a smaller overestimation for boys and girls and was found to be more accurate in this Belgian Caucasian population.

It was concluded that the adapted method was validated and resulted in more accurate dental age estimation in this population, but may not be valid in other populations.

## Häävikko's method to assess dental age in Italian children

Andrea CB, Alberto C, Monica F, Elena S, Alberto T, Antonino S

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Several methods for assessing dental age have been proposed, the simplest of which is to assess by eruption time. Disadvantage of this method is that it cannot be used in subjects with a complete primary dentition. Dental pantomograms (DPTs) offer an overall view of the maturation of the whole dentition. Several radiographic methods have been proposed to assess dental age.

The aim of the study was to verify if Häävikko's maturation standards are suitable for healthy Italian children. A total of 3000 children were screened for the investigation in the period between 1992 and 2003. Children with a history of congenital anomalies, genetic or acquired syndromes, metabolic disorders, malignancies and previous chemotherapy, or ionizing radiation treatment were excluded from the study (since such conditions may alter the rate of dental development). A total of 500 most recent DPTs of healthy Caucasian children between 3.9 and 15.4 years of age (267 girls and 233 boys) were selected.

All dental ages were assessed from panoramic films by one examiner using Häävikko's method, based on the recognition of 12 radiographic stages of four reference

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teeth. The limited number of age stages is an advantage of Häavikko's method over that of Nolla (1960), which involves up to 40 stages and may result in decreased precision. A second examiner independently assessed 48 panoramic films to evaluate the reproducibility of the dental age measurements. A good correlation (0.95) was found, as shown by Cohen's kappa. To evaluate the relationship between dental age estimated by Häavikko's method and the chronological age, Bland and Altman's graphical method was used. The LMS (L = skewness, M = median, S = coefficient of variation) method of Cole and Green was used to construct centile curves as dental age reference for both Italian girls and boys.

It was found that Häavikko's standards tended to underestimate chronological age in this Italian sample. Centile curves constructed for girls and boys using the LMS method could be used for the estimation of dental age in the Italian population.

### Accuracy of Cameriere *et al.* regression equation in Haryana population

**Rai B, Cameriere R, Ferrante L**

*Rom J Leg Med 2009;17:147-50*

The aim of the study was to determine the accuracy of the Cameriere *et al.* equation in the Haryana population for age estimation from open and closed apices. Orthopantomographs of 259 healthy children aged between 5 and 15 years were selected. Radiographs that were unclear or that showed hypodontia, gross pathology, and previous orthodontic treatment were excluded.

The Cameriere *et al.* regression equation was used to assess the dental age. The median of the absolute values of the residuals was 0.6 years for girls and 0.7 years for boys. The mean prediction error was 0.75 years for girls and 0.87 for boys. The concordance correlation coefficient was 0.89 indicating very good agreement between the two raters.

The results showed a significant difference between European countries, so this regression equation could not be applied to the Indian population. Hence, a new equation will be required for the Indian population. The method should be used together with other methods of age estimation to increase the accuracy.

### Comparison between two methods of dental age estimation among Egyptian children

**El-Bakary AA, Hammad SM, Ibrahim FM**

*Mansoura J Forensic Med Clin Toxicol 2009;17:75-86*

The most common method for dental age assessment was first published by Demirjian *et al.* (1973). Willems *O.* (2001) adapted a method for dental age estimation in a Belgian Caucasian population. It is a modification of the

Demirjian method (new Tables for boys and girls with age scores directly expressed in years). The adapted method was validated and resulted in more accurate dental age estimation in this population.

Cameriere *et al.* (2006a) took a completely different approach and published a mathematical formula for calculating dental age on teeth for some European countries. The method is based upon measuring the completeness of apical development by a computer method and all studies to date show a very strong correlation with chronological age.

The aim of this work was to evaluate the applicability of using these two methods for Egyptian children. Digitalized panoramic radiographs taken from 286 Egyptian children (134 boys, 152 girls) with age range from 5 to 16 years were analyzed. The seven left permanent mandibular teeth were evaluated using the two methods.

The results showed that dental age estimated by both methods was significantly correlated with real age. However, the Willems method was slightly more accurate (98.62%) compared to the Cameriere method (98.02%). Therefore, the authors recommend both the methods for practical application in clinical dentistry and forensic procedures on the Egyptian population.

### Tooth developments: Accuracy of age estimation of radiographic methods

**Rai B, Anand SC**

*World J Med Sci 2006;1:130-2*

Research on accuracy of dental age estimation methods is complicated by different sample sizes, age structures, grouping, and statistical analysis making comparisons difficult. The majority of studies have investigated a single method, some on live children and some on skeletal remains.

The present study aimed to evaluate the accuracy of five methods of age estimation using developing teeth from panoramic radiographs.

A total of 75 healthy children (40 boys and 35 girls) aged between 5 and 14 years were selected. Radiographs that were unclear or that showed hypodontia, gross pathology, and previous orthodontic treatment were excluded. Selected radiographs were assessed to determine the developmental stages of teeth according to the Demirjian, Nolla, Haavikko, Willems, and Cameriere methods. Dental age estimated using each method was compared with chronological age for each subject. The significance of the difference was tested using Student's *t*-test.

Results revealed that the method of Willems was the most accurate, followed by Haavikko, Cameriere, Nolla, and Demirjian.

## Accuracy of Cameriere, Haavikko, and Willems radiographic methods on age estimation on Bosnian-Herzegovian children age groups 6-13

Galić I, Vodanović M, Cameriere R, Nakaš E, Galić E, Selimović E, Brkić H

*Int J Legal Med* 2011;125:315-21

In this study, the authors tested the repeatability and accuracy of the Cameriere European formula (Cameriere), adopted the Haavikko method from 1974 (Haavikko), and the revisited Demirjian method by Willems (Willems) for age estimation on orthopantomograms (OPGs) of Bosnian-Herzegovian (BH) children aged 6-13 years.

The accuracy was determined as difference between estimated dental age (DA) and chronological age (CA) and the absolute accuracy (absolute difference) was assessed by analyzing OPGs of 591 girls and 498 boys.

The Cameriere method overestimated the mean age by 0.09 year for girls and underestimated by -0.02 year for boys. The Haavikko method underestimated the mean age by -0.29 year for girls and -0.09 year for boys. The Willems method overestimated the mean age by 0.24 year for girls and by 0.42 year for boys. The absolute accuracies for the Cameriere method were 0.53 year for girls and 0.55 year for boys; for the Haavikko method were 0.59 year for girls and 0.62 year for boys; and for the Willems method were 0.69 year for girls and 0.67 year for boys.

It was concluded that the Cameriere method using the European formula is the most accurate for both genders, followed by the Haavikko method and the Willems method.

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