the Journal of CONTEMPORARY DENTAL PRACTICE at www.thejcdp.com
Volume 9 Number 3 March 1, 2008

Dental Age Assessment of 8.5 to 17 Year-old Saudi Children Using Demirjian's Method

Sulaiman Al-Emran, BDS, MSc, PhD

Abstract

Aim: The aim of this study was to assess the dental age in Saudi children aged 8.5 to 17 years using the Demirjian method.

Methods and Materials: Four hundred ninety panoramic radiographs of boys and girls were reviewed retrospectively. All children were placed in the age group closest to their chronological age. The dental age was scored on all seven left mandibular teeth by one examiner.

Results: Both boys and girls in age groups nine to 14 years showed advanced dental age compared to their chronological age which was found to be statistically significant except in age groups nine and 13 years. Saudi boys were 0.3 years and Saudi girls 0.4 years ahead, on average, of French-Canadian children as analyzed by the Demirjian method.

Conclusion: The standard values for French-Canadian children provided by Demirjian vary slightly for application to Saudi children. As a result, new graphs and tables were produced to convert these maturity scores, calculated by the Demirjian method, to the dental age for Saudi children.

Keywords: Demirjian method, dental age, developmental age, dental maturity, orthodontics

Citation: Al-Emran S. Dental Age Assessment of 8.5 to 17 Year-old Saudi Children Using Demirjian's Method. J Contemp Dent Pract 2008 March; (9)3:064-071.

Introduction

Dental maturity often is expressed as an indicator of the biological maturity of growing children because it is more relevant in the study of growth disturbances and clinical orthodontics.[1] Since children with the same chronological age may show differences in their developmental biological stages, estimation of dental development was considered more reliable as an indicator of biological maturity in children than chronological age.[2,3] It is also widely used to estimate the chronological age of children of unknown birth records as it is less affected by nutritional and endocrine status.[2,4,5] Furthermore, assessment of dental calcification is considered a better method to determine the biological age in children rather than the clinical emergence of teeth into the oral cavity which is scarcely influenced by local factors such as lack of space[3] and systemic factors such as nutritional influence.[6]

Several methods have been described in order to assess the dental age according to the degree of calcification observed in radiographic examination carried out in permanent dentition.[7-9] The methods basically define the stages of mineralization of teeth observed in radiographs and code them according to previously determined scores. In addition to the stages observed in radiographs Gustafson and Koch[9] considered the time of eruption in their "tooth development diagram." Mornstad et al.[8] measured the crown height, apex width, and root length of the teeth observed in radiographs. Most methods used panoramic radiographs for the assessment, while Morrees et al.[3] made use of perapical radiographs. However, the left mandibular teeth are seen more clearly and have been widely used to assess the degree of calcification.[9,10,11]

The most widely used method for the comparison between different populations was first described in 1973 by Demirjian et al.[10] His method is based on the development of seven left permanent mandibular teeth. Tooth formation is divided into eight stages and criteria for stages are given for each tooth. Each stage of the seven teeth is given a score according to a statistical model.[12] The sum of the scores of the seven teeth represents the obtained dental maturity that can then be converted into dental age by use of a conversion table. Separate standards are provided for each sex. Later the same

author suggested using a smaller number of teeth to save time and to avoid a situation when it is not possible to visualize all teeth in the left mandibular quadrant. This method has achieved widespread acceptance because of its maturity scoring system that provides for universal application. Although the conversion to dental age depends on the population being considered, it can be accomplished using a relatively small local sample to determine an equivalent dental age when compared to a different population.

In the dental literature the existence of different patterns of dental maturation among different populations has been reported. In Europe comparisons have been made between the French-Canadian standards reported by Demirjian[7] and Finnish,[13] Swedish,[14] Norwegian,[1] and south German[15] children. The dental ages of these subjects were all different from the French-Canadian children. Since different standards were found in several countries and because dental age assessment is considered important, the aim of the present study was to evaluate the suitability of using French-Canadian standards in a Saudi population and to develop a new dental age standard for the Saudi population using the Deminjian method, if needed.[7]

Methods and Materials

The sample for this study consisted of 490 (225 male and 265 female) diagnostic panoramic radiographs of healthy Saudi individuals aged 8.5 to 17 years old. The radiographs were collected from three large dental centers in Riyadh city. The chronological ages of the children involved in this study were obtained from their date of birth. All radiographs were checked for quality and the presence of all seven left mandibular teeth and were rated by one examiner only. All male and female subjects involved in this study were Saudi in origin, and they were placed in the age

group closest to their chronological age. For example, children aged from 8.5 to 9.4 years old were placed in the age group 9 (Table 1). Dental maturity scores of 490 children were computed by the author (one examiner) using the Demirjian method.[7]

The inter-examiner reliability was assessed by re-computing the dental scores of 35 randomly selected radiographs by another examiner who was calibrated on the use of the Demirjian method. The intra-class correlation coefficient test was used to determine the level of reliability.[16] For both genders within each age group of the study sample, the mean scores of the dental age determined from the French-Canadian standards and the actual chronological age of the child were compared using a paired t-test. To establish a new standard for the Saudi population, a logistic curve with the equation $Y = 100^* \{1/ (1+e^{-\alpha(x-x0)})\}$, where x stands for chronological age, was drawn through all points to determine the mean age for each of the dental maturity scores. In addition to creating new reference graphs for the Saudi child population a table was produced to convert the maturity scores calculated by the Demirjian method into the dental age for male and female Saudi children.

Results

For the statistical analysis, age group 17 for the boys and girls was excluded because of the low number of children. The intra-class correlation coefficient test revealed a high level of inter-examiner reliability of the maturity scores 0.97. Comparisons between dental age in French-Canadian and Saudi children revealed the mean difference between the chronological age found in Saudi children and the dental age in French-Canadian children ranged from -1.97 to +1.26 in boys and from -1.24 to +1.34 in girls.

In boys and girls only age groups 15 and 16 showed a positive difference of delay, which was statistically significant. Both boys and girls age groups nine to 14 showed a negative difference (advance). Only age groups nine and 13 in boys and group 14 in girls showed no statistically significant differences between the chronological age and dental age of Demirjian. On the other hand, age groups 10, 11, 12, 14, 15, and 16 in boys and age groups 9, 11, 12, 13, 15, and 16 in girls (Table 2) indicated a statistically significant difference between the chronological age and dental age of Demirjian. This result confirmed Demirjian's standards are at a slight variance to be used for Saudi children (Table 2).

To build up new standards for the Saudi boy and girl population, a new logistic curve, at the 50th percentile, was drawn through all points to determine the mean age for each of the dental maturity scores (Figure 1a and b). The standard logistic curve for Dental Age and Score for boys was determined by: $y=100^*\{1/ (1+\exp^{-0.4997(x-5.97)})\}$. The standard logistic curve for Dental Age and Score for girls was determined by: $y=100^*\{1/ (1+\exp^{-0.5838(x-6.028)})\}$.

Table 1. Number and distribution of male and female subjects into age groups according to their chronological age.

Gender	Age Groups (years)								Total
	9	10	11	12	13	14	15	16	
Girls	18	27	40	48	40	38	31	20	265
Boys	17	27	32	33	36	35	29	16	225
Total	35	54	72	81	76	73	60	41	490

The standard deviation (SD) for the steepness of the logistic curve for the boys and girls was approximately 0.024. This means there was statistically significance difference between the growth velocities of boys (-0.4997 ± 0.024) and girls (-0.5838 ± 0.024). The 50th percentile curves for boys and girls were drawn, and a separate table was produced to enable converting the dental score to dental age for Saudi boys and girls (Tables 3 and 4).

Table 2. A comparision of chronological and dental age according to Demirjian for Saudi boys and girls along with the mean difference between both ages.

Boys				
Age	**Mean Ch-Age (±SD)**	**Mean Det-Age (±SD)**	**Mean difference**	**P-value**
9	9.07 (0.44)	9.85 (1.09)	-0.77	0.1014
10	9.88 (0.5)	10.82 (1.28)	-0.94	0.0037 *
11	10.80 (0.49)	11.99 (0.90)	-1.197	0.5E-8 *
12	11.96 (0.42)	12.78 (0.75)	-0.79	2.3E-6 *
13	12.94 (0.46)	13.15 (1.8)	-0.21	0.3209
14	13.77 (0.43)	14.09 (0.51)	-0.32	0.022 *
15	14.92 (0.36)	14.40 (0.46)	0.52	5.5E-5 *
16	15.76 (0.41)	14.5 (0.38)	1.26	9.7E-5 *
Girls				
Age	**Mean Ch-Age (±SD)**	**Mean Det-Age (±SD)**	**Mean difference**	**P-value**
9	8.87 (0.45)	9.71 (1.08)	-0.84	0.035 *
10	10 (0.32)	10.74 (1.07)	-0.74	0.0043 *
11	10.91 (0.41)	12.16 (1.12)	-1.244	7.4E-8 *
12	11.98 (0.42)	13.11 (1.02)	-1.14	1.2E-10 *
13	12.90 (0.31)	13.79 (0.77)	-0.9	2.93E-6 *
14	13.87 (0.35)	13.95 (0.68)	-0.086	0.461288
15	14.86 (0.36)	14.56 (0.38)	0.41	3.57E-4 *
16	15.79 (0.35)	14.45 (0.40)	1.341	2.63E-5 *

SD = Standard Deviation; * = P-value < 0.05

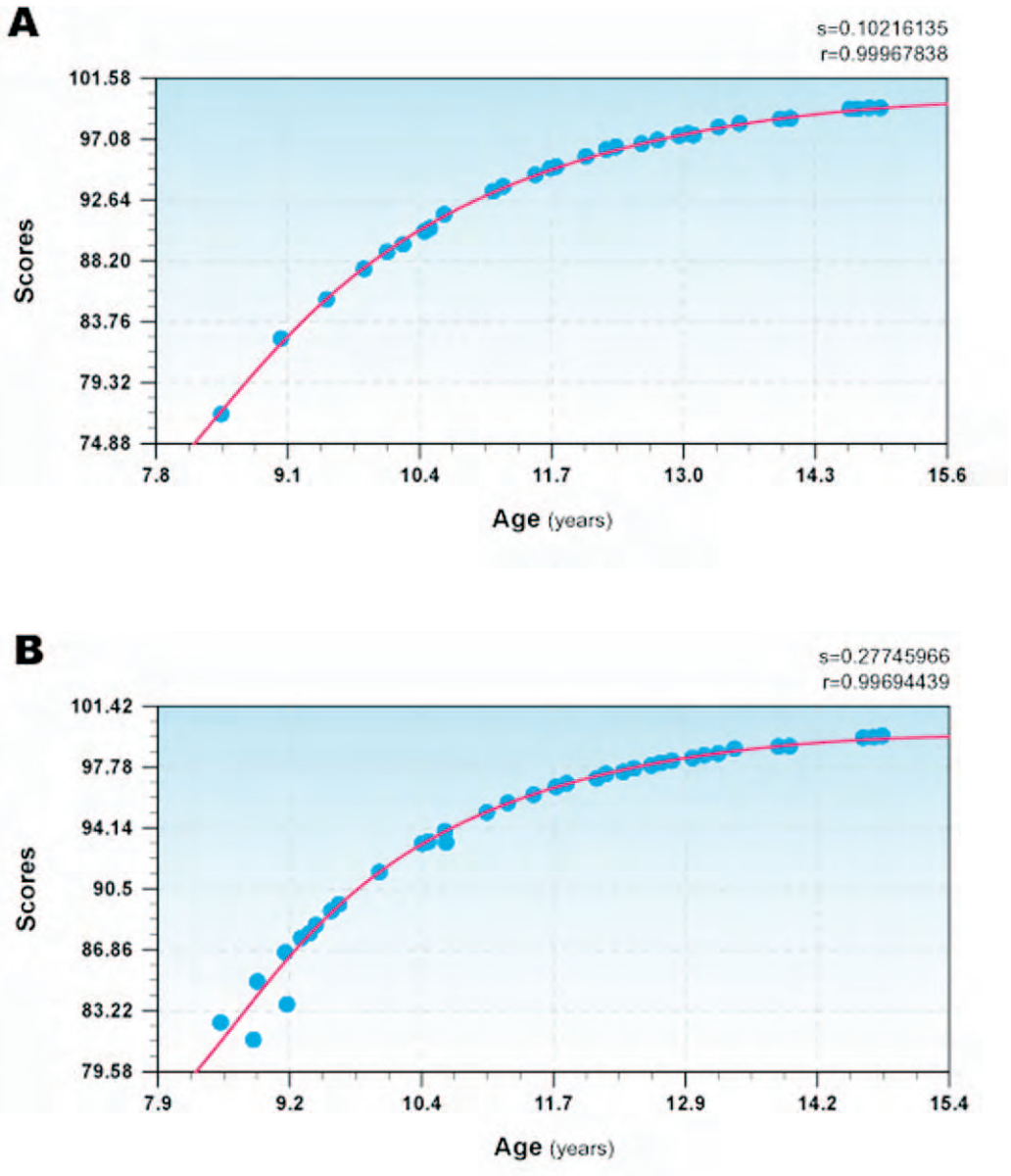

Figure 1. A logistic curve, at the 50th percentile, drawn through all points to determine the mean age for each dental maturity score. **A.** Boys Standard Logistic Curve for Dental Age and Score. **B.** Girls Standard Logistic Curve for Dental Age and Score.

Table 3. Table to convert the maturity score calculated using Demirjian's method into the Saudi dental age for boys.

Age	Score	Age	Score	Age	Score
8.50	77.95	11.10	92.84	13.60	97.84
8.60	78.80	11.20	93.16	13.70	97.94
8.70	79.62	11.30	93.47	13.80	98.04
8.90	81.20	11.40	93.77	13.90	98.13
9.00	81.95	11.50	94.06	14.00	98.22
9.10	82.67	11.60	94.33	14.10	98.31
9.20	83.38	11.70	94.59	14.20	98.39
9.30	84.06	11.80	94.84	14.30	98.46
9.40	84.72	11.90	95.08	14.40	98.54
9.50	85.35	12.00	95.31	14.50	98.61
9.60	85.97	12.10	95.53	14.60	98.68
9.70	86.56	12.20	95.74	14.70	98.74
9.80	87.13	12.30	95.94	14.80	98.80
9.90	87.68	12.40	96.13	14.90	98.86
10.00	88.21	12.50	96.31	15.00	98.91
10.10	88.72	12.60	96.48	15.10	98.97
10.20	89.21	12.70	96.65	15.20	99.02
10.30	89.68	12.80	96.81	15.30	99.06
10.40	90.13	12.90	96.96	15.40	99.11
10.50	90.57	13.00	97.10	15.50	99.15
10.60	90.99	13.10	97.24	15.60	99.19
10.70	91.39	13.20	97.37	15.70	99.23
10.80	91.77	13.30	97.49	15.80	99.27
10.90	92.14	13.40	97.61	15.90	99.30
11.00	92.50	13.50	97.73	16.00	99.34

Table 4. Table to convert the maturity score calculated using Demirjian's method into the Saudi dental age for girls.

Age	Score	Age	Score	Age	Score
8.50	80.89	11.10	95.08	13.60	98.81
8.60	81.78	11.20	95.34	13.70	98.88
8.70	82.63	11.30	95.60	13.80	98.94
8.90	84.25	11.40	95.84	13.90	99.00
9.00	85.00	11.50	96.06	14.00	99.06
9.10	85.73	11.60	96.28	14.10	99.11
9.20	86.43	11.70	96.48	14.20	99.16
9.30	87.10	11.80	96.67	14.30	99.21
9.40	87.74	11.90	96.86	14.40	99.25
9.50	88.36	12.00	97.03	14.50	99.29
9.60	88.95	12.10	97.19	14.60	99.33
9.70	89.51	12.20	97.35	14.70	99.37
9.80	90.04	12.30	97.49	14.80	99.41
9.90	90.55	12.40	97.63	14.90	99.44
10.00	91.04	12.50	97.76	15.00	99.47
10.10	91.51	12.60	97.89	15.10	99.50
10.20	91.95	12.70	98.01	15.20	99.53
10.30	92.37	12.80	98.12	15.30	99.56
10.40	92.77	12.90	98.22	15.40	99.58
10.50	93.15	13.00	98.32	15.50	99.60
10.60	93.52	13.10	98.41	15.60	99.63
10.70	93.86	13.20	98.50	15.70	99.65
10.80	94.19	13.30	98.59	15.80	99.67
10.90	94.50	13.40	98.67	15.90	99.69
11.00	94.80	13.50	98.74	16.00	99.70

Discussion

A general trend of the present findings revealed the Saudi children indicated a more advanced dental age compared to French-Canadian children as presented by Demirjian.[7] This is in agreement with other authors[13-18] who obtained an overestimation of dental age ranging from 0.02 to 3.04 years in their population when using Demirjian's method. A possible explanation for the differences between Saudi and French-Canadian children might be attributed to the different ethnic group and/or effect of the considerable time gap between the two studies on the dental development of these children.[19] Only boys and girls at age groups 15 and 16 years showed a delayed dental age compared to French-Canadian children. This may be due to fewer numbers of 15 and 16 year-old children being included in the analysis, since most of them reached a dental score of 100 and were not analyzed. However, in the present study the calculation of dental age for children in the age group from nine to 14 years was more precise because of the larger number of children involved. The age range from nine to 14 years remains the most critical with regard to estimating a child's dental age and, consequently, to determine the proper timing for initiating orthodontic therapy. Children with missing teeth due to either extraction or tooth agenesis were excluded in this study. This was done to avoid drawbacks as much as possible on the precision of newly established Saudi dental age standards.

Although Demirjian[20] developed a modified scoring system for cases of missing teeth based on four teeth, this study preferred to adhere to the original method of the same author where dental age scoring was based on seven mandibular teeth. The age of the investigated sample in this study started at 8.5 year-olds. Although involving younger age groups is recommended, providing dental age standards starting with 2-year-old children is difficult to implement in practical terms. This study was carried out retrospectively and radiographs were obtained from dental patient's files; for children below 8.5, years panoramic radiographs were rarely taken as routine dental radiographs to provide material for such a study. However, the majority of patient population age groups attending the orthodontic clinic ranged from nine to 16 years. During this age range it is important to evaluate the developmental age for these children to determine the proper treatment method and the timing of orthodontic intervention.

The SD for the steepness of the logistic curve for the boys and girls was approximately 0.024 which indicated a statistically significance difference between the growth velocities of boys and girls. The difference between boys and girls is most likely biological as often observed for the entire growth period between boys and girls. In this study girls indicated advanced dental development in all age groups and reached dental age maturation earlier than boys. This is in accord with earlier maturation of other parameters of development in girls, such as height,[21] sexual maturation,[22] and skeletal development.[23] The logistic curve showed good adaptation of observed value and the predicted value for both boys and girls (Figure 1). This might be because the age of the examined children started at 8.5 years in this study. This is the age at which dental development is more advanced and suitable for carrying out more accurate dental scoring.

Conclusion

The standard values for French-Canadian children provided by Demirjian vary slightly for application to Saudi children. As a result, new graphs and tables were produced to convert these maturity scores calculated by the Demirjian method to the dental age for Saudi children.

References

1. Nykanen R, Espeland L, Kvaal SI, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odont Scan. 1998; 56:238-244.
2. Lewis A, Garn S. The relationship between tooth formation and other maturational factor. Angle Orthod. 1960; 30:70-77.
3. Moorrees C, Flanning E, Hunt E. Age variation of formation stages of ten permanent teeth. J Dent Res. 1963; 42:1490-1502.
4. Marcondes E, Rumel A, Schvartsman S. Determinacao da idade ossea e dental, pelo exame radiografico, em criancas de meio socio-economico baixo. Review of the Faculty of Odontology of Sao Paulo. 1965; 3:185-191.
5. Nykanen R, Espeland L, Kvaal S, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odont Scan. 1998; 56:238-244.
6. Infante P, Owen G. Relation of chronology of deciduous tooth emergence to height, weight and head circumference in children. Arch Oral Biol. 1973; 18:1411-1417.
7. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Bio. 1976; 3:411-421.
8. Mornstad H, Staaf V, Welander U. Age estimation with aid of tooth development a new method based on objective measurements. Scandinavian J Dent Res. 1994; 102:137-143.
9. Gustafson G, Koch G. Age estimation up to 16 years of age based on dental development. Odontol Rev. 1974; 25:297-306.
10. Demirjian A, Goldstein H, Tanner J. A new system of dental age assessment. Hum Biol. 1973; 45:211-227.
11. Haavikko K. Tooth formation age estimated on a few selected teeth. A simple method for clinical use. Proc Finn Dent Soc. 1974; 70:15-19.
12. Tanner J, Whitehouse R, Marshall W. Assessment of skeletal maturity and prediction of adult height. TW2 method. New York: Academic Press. 200, 1975.
13. Nystrom M, Haataja J, Kataja M, Evalahti M, Peck L, Kleemola-Kujala E. Dental maturity in Finnish children, estimated from the development of seven permanent mandibular teeth. Acta Odont Scan. 1986; 44:193-198.
14. Mornstad H, Reventlid M, Teivens A. The validity of four methods for age determination by teeth in Swedish children: a multicentre study. Swed Dent J. 1995; 19: 121-130.
15. Frucht S, Schnegelsberg C, Schulte-Monting J, Rose E, Jonas I. Dentalage in Southwest Germany, a radiographic study. J Orofac Orthop 2000; 61:318-329.
16. Fleiss J, Slakter M, Fischman S, Park M, Chilton N. Inter-examiner reliability in caries trial. J Dent Res. 1979; 58:604-609.
17. Eid R, Simi M, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. Int J of Paediatr Dent. 2002; 12:423-428.
18. Leurs I, Wattel E, Aartman I, Etty E, Prahl-Andersen B. Dental age in Dutch children. Eur J Orthod. 2005; 27:309-314.
19. Nadler G. Earlier dental maturation: fact or fiction? Angle Orthodt. 1998; 68: 535-538.
20. Demirjian A. Dentition. In: Falkner F, Tanner JM (eds) Human growth, Vol. II, Postnatal growth. Plenum Press, New York. 1978; 413-444.
21. Al-Shehri M, Mostafa O, Al-Gelban K, Hamdi A, Almbarki M, Altrabolsi H, Standards of growth and obesity for Saudi children (aged 3- 18 years) living at high altitudes. West Afr J Med. 2006; 25:42-51.
22. Prahl-Andersen B, Kowalski C, Heydendaal P. A mixed-longitudinal interdisciplinary study of growth and development. Academic Press, New York. 491-536, 1979.
23. Venrooij-Ysselmuiden M, Ipenburg A. Mixed longitudinal data on skeletal age from a group of Dutch children living in Utrecht and surroundings. Ann Hum Bio. 1978; 5:359-380.

About the Author

Sulaiman Al-Emran, BDS, MSc, PhD

Dr. Al-Emran is an Associate Professor in the Department of Preventive Dental Sciences of the Collage of Dentistry at King Saud University in Riyadh, Saudi Arabia. His research interests include the clinical orthodontic sciences. Dr. Al-Emran is a member of the Saudi Dental Society, the Saudi Orthodontic Society, and the World Federation of Orthodontists (WFO).

e-mail: selemran@yahoo.com