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Dental Maturity of Caucasian Children in the Indianapolis Area

Dr. Lauren S. Weddell, DDS, MSD[1] and **Dr. James K. Hartsfield Jr., DMD, MS, MMSc, PhD**[2]

[1]Assistant clinical professor, Department of Pediatric Dentistry, Indiana University School of Dentistry, Riley Hospital for Children, Indianapolis, Ind

[2]Professor and E. Preston Hicks Endowed Chair, Department of Oral Health Science, College of Dentistry, University of Kentucky, Lexington, Ky, and is adjunct professor, Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, Indianapolis, Ind

Abstract

Purpose—The purpose of this study was to compare chronologic and dental age using Demirjian's method.

Methods—Two hundred and fifty-seven panoramic radiographs of healthy 5- to 17.5-year-old Caucasian children in the Indianapolis area were evaluated using Demirjian's 7 tooth method.

Results—The intraclass correlation coefficient (ICC) for agreement with Demirjian was 0.94 (95% confidence interval [CI]: 0.87, 0.97). The ICC for repeatability of the investigator was 0.97 (95% CI=0.95, 0.99). Calculated dental age was significantly greater than chronologic age by 0.59 years (P<.001). There was no significant difference in the mean difference in ages between sexes (P=.73). Medicaid subjects had a significantly higher (P<.001) mean difference (0.82 years) than private insurance subjects (0.32 years). There was a significant negative correlation between the chronologic age and the difference in ages (r=−0.29, P<.001). Overweight (P<.001) and obese (P=.004) subjects were significantly more dentally advanced than normal (P=.35) and underweight (P=.42) subjects.

Conclusions—Demirjian's method has high inter- and intraexaminer repeatability. Caucasian children in the Indianapolis area are more advanced dentally than the French-Canadian children studied by Demirjian. Difference between dental age and chronologic age varies depending on the age of the child, socioeconomic status, and body mass index.

Keywords

DENTAL AGE; GROWTH AND DEVELOPMENT; BODY MASS INDEX; OBESITY

Dental age is an important consideration in staging physical development. Having a reliable method to evaluate dental maturity greatly aids those interested in human growth and development, including those involved in forensics, research, and clinical practice areas such as orthodontics and pediatric dentistry. Many methods have been developed to assess dental age. It is believed that tooth development rather than actual tooth eruption is the more consistent predictor of dental age.[1,2]

Correspond with Dr. Weddell at lweddell@iupui.edu.

Several models to assess dental maturity have been formulated based on various stages of tooth mineralization during development.[1–9] One of the most widely used systems is Demirjian's method (**DM**), which calculates dental age based on the radiographic appearance of either 4 or 7 permanent mandibular left teeth.[1–3] Studies comparing various methods[10,11] have concluded that DM,[1–3] or an adjusted version of it,[12] is the most accurate and reliable model for use when compared to other methods. There is still uncertainty, however, as to whether Demirjian's standards are applicable for all populations.

Studies using DM have assessed many populations, including children in Australia, Belgium, Brazil, Canada, China, Croatia, England, Finland, France, Germany, Hungary, India, Italy, Malaysia, the Netherlands, New Zealand, Norway, Poland, Saudi Arabia, South Korea, Spain, Sweden, Turkey, and the United States.[2,3,10–40, 44,45,48,50,51] In his original works,[1–3] Demirjian hypothesized that the scoring system developed for stages of mineralization should not differ much among populations, but the maturity standards may. Most published studies using DM have found that the method overestimates chronologic age[4,10–33] when compared to the maturity standards based on Demirjian's French-Canadian population. There are a few studies,[24,29] however, that found Demirjian's standards adequate for use in populations other than French-Canadian. Some studies specifically compared different ethnic groups but were unable to find significant differences in age determination.[10,19,33–35] Regardless, many authors[13,19,21,25,26,28,31,32,36–38] have expressed the need for local, population-specific standards for increased validity.

Few studies have evaluated US children using DM. Caucasian, African American, and Latino children living in the Chicago area were more dentally advanced when compared to the French-Canadian standards.[27] In a later study, most Caucasian American males shifted from below Demirjian's median to above the median as they aged.[39] Another study found that Kentucky children were advanced by 0.68 years.[40] This study's purpose was to compare the dental age of Caucasian children in the Indianapolis area with their chronologic age. In addition, a database was created to help establish dental maturity standards for Caucasian children in the Indianapolis area that could be used to compare effects of various diseases and conditions on dental development.

Methods

This study was approved by the Institutional Review Board of Indiana University, Indianapolis, Ind. Lists of patients who received panoramic radiographs during the course of diagnosis and treatment were obtained from multiple private dental practices in the Indianapolis area. Starting with the most recently taken radiograph in 2007 and working sequentially backwards in time, patient charts were reviewed to determine eligibility. An effort was made to select patients from various offices so that approximately half of those selected were covered under Medicaid and half covered by private insurance. Panoramic radiographs of Caucasian patients with an essentially negative medical history between 2.5 and 17.5- years-old were eligible for inclusion. Radiographs of poor quality that inhibited evaluation of the 7 permanent mandibular left teeth were excluded in addition to radiographs with congenitally missing or extracted permanent mandibular teeth (excluding third molars) and/or gross pathology. In total, 257 radiographs were selected. Each selected radiograph was scanned and given a study number.

The following data were collected: study number; sex; chronologic age at time of radiograph; month and year of radiograph; height and weight (for 96 subjects with information available); method of payment; and sibling's study number(s), if applicable.

Prior to scoring the radiographs, the evaluator completed the tutorial on DM found on the Dental Development CD-ROM (Silver Platter Education, Montreal, Quebec, Canada)[41] assessing 7 permanent mandibular left teeth (second molars through central incisors). Each tooth was assigned to 1 of 8 stages: A-H.[2] The evaluator and Demirjian both scored 25 panoramic radiographs, including at least 5 from each of the following age ranges: (1) 5.5- to 8.5-years-old; (2) 8.5- to 11.5- years-old; (3) 11.5- to 14.5-years-old; and (4) 14.5- to 17.5-years- old. Demirjian's Dental Development CD-ROM[41] was used to calculate a dental maturity score and dental age for each subject based on the stages of the 7 permanent mandibular left teeth. These data were used to compare each subject's dental age to his/her chronologic age. To assess intraexaminer repeatability, 25 radiographs were re-examined after evaluation of all 257 radiographs.

Statistical methods

The intraclass correlation coefficient (**ICC**) was estimated to assess the intra- and inter-rater reliability using 25 subjects. Subjects with a dental maturity score of 1,000 ("adult" dental age) were assigned a dental age of 15.8 years and 15.5 years for males and females, respectively, based upon extrapolation from the 50th percentile of Demirjian's dental maturity curves for the 7 tooth method.[3] Basic descriptive statistics were estimated to summarize the mean maturity score, calculated dental age, and actual chronologic age.

The difference between dental age and chronologic age was calculated for each subject, and a paired *t* test was used to determine whether the mean difference in ages was significantly different from 0. To determine the effect of sex or method of payment, a student's 2-sample *t*-test was used. For the 96 subjects with both height and weight available, body mass index (**BMI**) was calculated using the Centers for Disease Control and Prevention's United States Growth Charts on BMI-for-age percentiles for 2- to 20-year-olds. Each patient was classified as underweight (<fifth percentile), healthy (fifth to <85th percentile), over-weight (85th to <95th percentile), or obese (=95th percentile).[42,43] Pearson's correlation coefficient was estimated to assess the strength of the linear association between the difference in the ages and chronologic age and BMI. An analysis of variance model (**ANOVA**) and a student's differences between dental and chronologic age among the 4 BMI classes. For all age-grouped statistical analyses, chronologic age was rounded to the nearest whole integer (eg, 5.5 years was rounded to 6 years). A *P*-value of <.05 was considered significant.

Results

The ICC for agreement between the single evaluator and Demirjian was 0.94 (95% confidence interval [**CI**]=0.87, 0.97). The ICC for repeatability between scores for the 25 radiographs evaluated at the study's beginning and end was 0.97 (95% CI=0.95, 0.99); the stage given for a single tooth never varied by more than 1 stage.

Table 1 presents the demographics for the 257 subjects. Dental age was greater than chronologic age by 0.59 years (P<.001; Table 2), even after excluding the 23 "adult" dental subjects (0.62 years, P<.001). Dental age was significantly advanced in both males and females and in Medicaid and private insurance subjects (Table 3). There was no difference in the mean difference in ages (P=.73) between males and females, but Medicaid subjects had a significantly higher mean difference (P<.001) than subjects with private insurance. The mean chronologic age of males and females was not significantly different, nor was the mean chronologic age of Medicaid and private insurance subjects.

For the 96 subjects with BMI available, there was no significant correlation of BMI regarding difference in ages (r=0.06; P=.54). ANOVA showed that mean differences between dental and chronologic age were not significantly different (P=.18) among the 4 BMI classes (Table 4). Obese and overweight subjects had significant differences, however, while no significant differences were found in healthy and underweight subjects. Similarly, a student's t test found a significant dental advancement (P=.009) in combined overweight and obese subjects versus combined underweight and healthy subjects.

There was a significant negative correlation (r=−0.29; P<.001) between the chronologic age and the difference in ages, even after excluding the "adult" dental subjects (r=−0.26; P<.001). The difference in mean dental age and chronologic age separated by age and sex are shown in Table 5. The following age groups were excluded due to a low number of subjects (N<5): age groups 5, 15, 16, and 17 in males and age groups 5, 16, and 17 in females. There was an overestimation of chronologic age in all age groups. The overestimation, however, was significant only in age groups 6 through 11 in males and 6 through 8, 10, and 13 in females; these groups did not change after excluding the "adult" dental subjects.

Discussion

Reliability

As has been reported in previous studies,[11, 13,18,21,22,25,26,29,33,36,44,45] DM had high inter- and intraexaminer repeatability. This is partially attributed to his descriptions of individual stages of tooth mineralization being more detailed than those of any other method. The high reliability makes DM a useful tool for researchers.

Caucasian children in the Indianapolis area included in this study were more dentally advanced than the French-Canadian children studied by Demirjian, as has been found in almost all populations evaluated.[4,10–33] Many authors have suggested the overestimation of chronologic age is due to a secular trend associated with changes in subject characteristics between those used by Demirjian in the 1970s to create the standards and the subjects of modern day. To determine the presence of a secular trend, DM was used to evaluate the permanent mandibular canine of Caucasians treated between 1972 and 1974 with Caucasians of the same ages treated between 1992 and 1994.[45] Mineralization occurred earlier in the subjects from 1992 to 1994, 1.21 years earlier in males and 1.52 years earlier in females.

These data support the theory that adolescents are maturing earlier dentally compared to those in the 1970s, which correlates with the secular trends of decreasing age of menarche and earlier appearance of pubescent characteristics that has been observed in females. Other possible explanations for the overestimation of chronologic age include: limitations inherent in earlier studies; population differences, such as ethnic origin, environment, socioeconomic status, nutrition, diet and culture; and biological variation. While dental development is thought to be less affected by extrinsic or environmental factors, such as nutrition, when compared to other growth measures, it is known to be influenced by genetic and ecological factors.[1,46,47]

Gender

Overall, gender did not affect the extent of dental advancement; there was no difference in the overestimation seen in males and females. Demirjian[1–3,41,48] gives separate standards for each sex, accounting for sexual differences. Although the mean chronologic age of the male and female subjects was not significantly different, there were differences in dental advancement when divided into specific age groups. This has also been found in other studies.[19,31] Sexual dimorphism is thought to occur during root development but not crown development.[36,48] Both males and females were more advanced from ages 6 through 8. The advancement in males continued through age 11, but females were not advanced at ages 9 or 11. This difference may be explained by a later growth spurt in French-Canadian females since it appears that they mature later than the females in this study.

Socioeconomic status (SES)

Low SES (Medicaid) was associated with more advanced dental development than higher SES (private insurance). No studies using DM have specifically evaluated this variable. Intuition may suggest that the higher SES children should be more advanced than lower SES children due to environmental factors, including access to care and nutrition. Previous studies, however, have found that the developing dentition is less sensitive to physiologic factors like nutrition and endocrine stresses.[46,47] Medicaid and private insurance groups were different in terms of their BMI composition, which may partially explain the advancement of the lower socioeconomic group. Seventy-three percent of obese subjects were covered by Medicaid and 20% by private insurance. Furthermore, 67% of healthy subjects were covered by private insurance versus only 26% by Medicaid. Sixty-three percent of overweight subjects, however, were covered by private insurance and only 38% by Medicaid. Underweight subjects were 50% private insurance and 38% Medicaid. If the 96 subjects with BMI available are representative of this population, dental age may be advanced in the Medicaid subjects because they are more likely to be obese and less likely to be a healthy weight compared to the private insurance subjects.

BMI

Overall, BMI among all 4 classifications was not correlated with a significant change in the difference between dental and chronologic age. This agrees with the concept that dental development is minimally affected by endocrine and nutritional factors compared with other maturity measurements.[47] Similarly, no significant correlation was found between dental maturity and BMI in samples of Brazilian[16] and Malay[18] children. There was a significant correlation, however, between BMI and the difference in ages in Malay boys using the Willems method (an adjusted version of DM). While overall BMI was not a significant factor in dental maturity, overweight and obese children as a group were significantly more dentally advanced than the French-Canadian standard, while healthy and underweight children grouped together were not. Similarly, advanced dental development was seen in Kentucky children with increased BMI even after adjusting for age and sex.[40] Anecdotally, overweight and obese children often appear more advanced in dental development in clinical practice. Low SES may partially explain the advancement seen in the overweight and obese, especially the obese (73% of whom were Medicaid subjects). BMI may play a role in dental maturity, which would explain some of the overestimation of chronologic age found in this study, as overweight has increased dramatically in US children in recent years.

Age

Chronologic age had a significant effect on the difference between dental and chronologic age, as has been found in previous studies.[10–13,15,17–19,25,29–31,33,39] There was more variation in the difference of ages from 11 to 15 years of age. This may be explained by the older ages: as a subject ages, more teeth reach the final stage of mineralization—thus, fewer teeth contribute to changes in Demirjian’s scoring method. Small changes in a single tooth have a larger impact on the maturity score at older ages than at younger ages when more teeth are still in the process of developing.[10,21] Furthermore, biological variation increases with age, especially around puberty.[11,15,21] At older ages (eg, 12 and 14 years of age), the Caucasian children were not significantly different from the French-Canadian in dental maturity. As children get older, more teeth have finished all of Demirjian’s stages; thus, regardless of the population, all children should eventually have a more similar dental maturity score as they near the end of mineralization. Younger children (eg, 6- to 8-year-olds) were more dentally advanced, suggesting that this population of children begins dental development and puberty earlier than the French-Canadian children.

Limitations

There are limitations to the applicability of this study’s results. While the sample was systematically chosen, it was not necessarily randomized or representative of the local population. An effort was made to include children of all SES based on method of payment and location of dental practice (downtown, inner city, and suburban). Furthermore, it must be noted that regional variations in dental maturation exist.[38] Thus, the dental maturity of the children in this study may not compare to children in other US regions. In one study, Midwest (Ohio) children achieved tooth mineralization stages at least 1.5 years earlier on average than Midsouth (Tennessee) children.[49]

Error may arise from self-reported health histories, height, and weight, although some weights were measured. An inherent limitation of this study is the number of subjects used. Increasing the sample size, especially the number of subjects at the upper and lower extremities of age, would increase the data’s validity and precision. Including different races and medical conditions would assess genetic, ethnic, and physiologic differences in dental development. Studies have already used DM to compare dental maturity in children with different conditions, including: osteogenesis imperfecta[50]; cleft lip and palate; delayed growth; thalassemia major; prematurity; fragile X syndrome; Apert syndrome; and acute lymphoblastic leukemia.[51]

Conclusions

Based on this study's results, the following conclusions can be made:

1. The Demirjian method has high inter- and intra- examiner reproducibility.
2. Caucasian children in the Indianapolis area are dentally advanced compared to the French-Canadian population studied by Demirjian.
3. The accuracy of Demirjian's method in estimating chronologic age varies depending on the child's chronologic age.
4. Low socioeconomic status is associated with advanced dental age.
5. Overweight and obesity are associated with advanced dental age.

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References

1. Demirjian, A. Dentition. In: Falkner, FaTJM., editor. Human Growth: A Comprehensive Treatise. 2. New York, NY: Plenum Press; 1986. p. 269-98.
2. Demirjian A, Goldstein H, Tanner JM. A new system of dental age assessment. Hum Biol. 1973; 45:211–27. [PubMed: 4714564]
3. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Biol. 1976; 3:411–21. [PubMed: 984727]
4. Foti B, Lalys L, Adalian P, et al. New forensic approach to age determination in children based on tooth eruption. Forensic Sci Int. 2003; 132:49–56. [PubMed: 12689751]
5. Gustafson G, Koch G. Age estimation up to 16 years of age based on dental development. Odontol Revy. 1974; 25:297–306. [PubMed: 4530955]
6. Haavikko K. The formation and the alveolar and clinical eruption of the permanent teeth: An orthopantomographic study. Suom Hammaslaak Toim. 1970; 66:103–70. [PubMed: 4917152]
7. Haavikko K. Tooth formation age estimated on a few selected teeth: A simple method for clinical use. Proc Finn Dent Soc. 1974; 70:15–9. [PubMed: 4821943]
8. Liliequist B, Lundberg M. Skeletal and tooth development: A methodologic investigation. Acta Radiol Diagn (Stockh). 1971; 11:97–112. [PubMed: 4326497]
9. Nolla C. The development of the permanent teeth. J Dent Child. 1960; 27:254–66.
10. Maber M, Liversidge HM, Hector MP. Accuracy of age estimation of radiographic methods using developing teeth. Forensic Sci Int. 2006; 159(suppl 1):S68–73. [PubMed: 16533584]
11. Hagg U, Matsson L. Dental maturity as an indicator of chronological age: The accuracy and precision of three methods. Eur J Orthod. 1985; 7:25–34. [PubMed: 3856522]
12. Willems G, Van Olmen A, Spiessens B, Carels C. Dental age estimation in Belgian children: Demirjian's technique revisited. J Forensic Sci. 2001; 46:893–5. [PubMed: 11451073]

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 Odontol Scand. 1986; 44:193–8. [PubMed: 3465190]
14. Te Moananui R, Kieser JA, Herbison P, Liversidge HM. Advanced dental maturation in New Zealand Maori and Pacific Island children. Am J Hum Biol. 2008; 20:43–50. [PubMed: 17929243]
15. Koshy S, Tandon S. Dental age assessment: The applicability of Demirjian's method in South Indian children. Forensic Sci Int. 1998; 94:73–85. [PubMed: 9670486]
16. Eid RM, Simi R, Friggi MN, Fisberg M. Assessment of dental maturity of Brazilian children aged 6 to 14 years using Demirjian's method. Int J Paediatr Dent. 2002; 12:423–8. [PubMed: 12452984]
17. Cameriere R, Ferrante L, Liversidge HM, Prieto JL, Brkic H. Accuracy of age estimation in children using radiograph of developing teeth. Forensic Sci Int. 2008; 176:173–7. [PubMed: 17949930]
18. Mani SA, Naing L, John J, Samsudin AR. Comparison of two methods of dental age estimation in 7–15-year- old Malays. Int J Paediatr Dent. 2008; 18:380–8. [PubMed: 18284472]
19. McKenna CJ, James H, Taylor JA, Townsend GC. Tooth development standards for South Australia. Aust Dent J. 2002; 47:223–7. [PubMed: 12405462]
20. Al-Emran S. Dental age assessment of 8. 5 to 17 year-old Saudi children using Demirjian's method. J Contemp Dent Pract. 2008; 9:64–71. [PubMed: 18335121]
21. Chaillet N, Nystrom M, Demirjian A. Comparison of dental maturity in children of different ethnic origins: International maturity curves for clinicians. J Forensic Sci. 2005; 50:1164–74. [PubMed: 16225225]
22. Davis PJ, Hagg U. The accuracy and precision of the "Demirjian system" when used for age determination in Chinese children. Swed Dent J. 1994; 18:113–6. [PubMed: 8085218]
23. Farah CS, Booth DR, Knott SC. Dental maturity of children in Perth, Western Australia, and its application in forensic age estimation. J Clin Forensic Med. 1999; 6:14–8. [PubMed: 15335504]
24. Hegde RJ, Sood PB. Dental maturity as an indicator of chronological age: Radiographic evaluation of dental age in 6 to 13 years children of Belgium using Demirjian methods. J Indian Soc Pedod Prev Dent. 2002; 20:132–8. [PubMed: 12587748]
25. Leurs IH, Wattel E, Aartman IH, Etty E, Prahl-Andersen B. Dental age in Dutch children. Eur J Orthod. 2005; 27:309–14. [PubMed: 15947233]
26. Liversidge HM. Dental maturation of 18th and 19th century British children using Demirjian's method. Int J Paediatr Dent. 1999; 9:111–5. [PubMed: 10530220]
27. Loevy HT. Maturation of permanent teeth in Black and Latino children. Acta Odontol Pediatr. 1983; 4:59–62. [PubMed: 6587828]
28. Nyarady Z, Mornstad H, Olasz L, Szabo G. Age estimation of children in southwestern Hungary using the modified Demirjian method. Fogorv Sz. 2005; 98:193–8. [PubMed: 16315855]
29. Nykanen R, Espeland L, Kvaal SI, Krogstad O. Validity of the Demirjian method for dental age estimation when applied to Norwegian children. Acta Odontol Scand. 1998; 56:238–44. [PubMed: 9765017]
30. Prabhakar AR, Panda AK, Raju OS. Applicability of Demirjian's method of age assessment in children of Davangere. J Indian Soc Pedod Prev Dent. 2002; 20:54–62. [PubMed: 12435018]
31. Rozylo-Kalinowska I, Kiworkowa-Raczkowska E, Kalinowski P. Dental age in Central Poland. Forensic Sci Int. 2008; 174:207–16. [PubMed: 17540524]
32. Tunc ES, Koyuturk AE. Dental age assessment using Demirjian's method on northern Turkish children. Forensic Sci Int. 2008; 175:23–6. [PubMed: 17560060]
33. Liversidge HM, Speechly T, Hector MP. Dental maturation in British children: Are Demirjian's standards applicable? Int J Paediatr Dent. 1999; 9:263–9. [PubMed: 10815584]
34. Liversidge HM, Chaillet N, Mornstad H, Nystrom M, Rowlings K, Taylor J, Willems G. Timing of Demirjian's tooth formation stages. Ann Hum Biol. 2006; 33:454–70. [PubMed: 17060069]
35. Liversidge HM, Speechly T. Growth of permanent mandibular teeth of British children aged 4 to 9 years. Ann Hum Biol. 2001; 28:256–62. [PubMed: 11393333]

36. Frucht S, Schnegelsberg C, Schulte-Monting J, Rose E, Jonas I. Dental age in southwest Germany: A radiographic study. J Orofac Orthop. 2000; 61:318–29. [PubMed: 11037684]
37. Kataja M, Nystrom M, Aine L. Dental maturity standards in southern Finland. Proc Finn Dent Soc. 1989; 85:187–97. [PubMed: 2594746]
38. Nystrom M, Ranta R, Kataja M, Silvola H. Comparisons of dental maturity between the rural community of Kuhmo in northeastern Finland and the city of Helsinki. Community Dent Oral Epidemiol. 1988; 16:215–7. [PubMed: 3165747]
39. Loevy HT, Goldberg AF. Shifts in tooth maturation patterns in non-French Canadian boys. Int J Paediatr Dent. 1999; 9:105–10. [PubMed: 10530219]
40. Hilgers KK, Akridge M, Scheetz JP, Kinane DE. Childhood obesity and dental development. Pediatr Dent. 2006; 28:18–22. [PubMed: 16615371]
41. Demirjian, A. Dental Development. Montreal, Quebec, Canada: Silver Platter Education; 1993–94. CD-ROM
42. Statistics NCfH. Two to 20 Years: Boys, Body Mass Index-for-age Percentiles. Hyattsville, MD: National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion; 2000. http://www.cdc.gov/growthcharts
43. Statistics NCfH. Two to 20 Years: Girls, Body Mass Index-for-age Percentiles. Hyattsville, MD: National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion; 2000. http://www.cdc.gov/growthcharts
44. Levesque GY, Demirjian A. The interexaminer variation in rating dental formation from radiographs. J Dent Res. 1980; 59:1123–6. [PubMed: 6929805]
45. Nadler GL. Earlier dental maturation: Fact or fiction? Angle Orthod. 1998; 68:535–8. [PubMed: 9851351]
46. Garn SM, Lewis AB, Blizzard RM. Endocrine factors in dental development. J Dent Res. 1965; 44(suppl):243–58.
47. Garn SM, Lewis AB, Kerewsky RS. Genetic, nutritional, and maturational correlates of dental development. J Dent Res. 1965; 44(suppl):228–42.
48. Demirjian A, Levesque GY. Sexual differences in dental development and prediction of emergence. J Dent Res. 1980; 59:1110–22. [PubMed: 6966636]
49. Mappes MS, Harris EF, Behrents RG. An example of regional variation in the tempos of tooth mineralization and hand-wrist ossification. Am J Orthod Dentofacial Orthop. 1992; 101:145–51. [PubMed: 1739069]
50. Sheppard, G. The Effects of Osteogenesis Imperfecta and Bisphosphonate Therapy on Dental Development: Indiana University School of Dentistry [master's thesis]. Indiana University School of Dentistry Library; Indianapolis, Ind: 2007.
51. Vasconcelos NP, Caran EM, Lee ML, Lopes NN, Weiler RM. Dental maturity assessment in children with acute lymphoblastic leukemia after cancer therapy. Forensic Sci Int. 2009; 184:10–4. [PubMed: 19147312]

Table 1

NO. OF SUBJECTS PER AGE GROUP

	Sex			Payment method			
Age	**Male**	**Female**	**Total (%)**	**Cash**	**Insurance**	**Medicaid**	**Total**
5	1	1	2 (1)		1	1	**2**
6	8	8	16 (6)		4	12	**16**
7	20	26	46 (18)	1	19	26	**46**
8	20	34	54 (21)	2	28	24	**54**
9	14	17	31 (12)	1	15	15	**31**
10	11	6	17 (7)		8	9	**17**
11	13	11	24 (9)		10	14	**24**
12	10	8	18 (7)		5	13	**18**
13	6	9	15 (6)	1	4	10	**15**
14	7	7	14 (5)	1	5	8	**14**
15	2	7	9 (4)		4	5	**9**
16	4	3	7 (3)	1	5	1	**7**
17	1	3	4 (2)		3	1	**4**
Total (%)	**117 (46)**	**140 (54)**	**257**	**7 (3)**	**111 (43)**	**139 (54)**	**257**

Table 2

MEAN DIFFERENCES BETWEEN DENTAL AND CHRONOLOGIC AGES

	N	**Mean±(SD)**	**Minimum**	**Maximum**	**Median**	**95%confidence interval**		***P*-value**
Chronologic age (ys)	257	9.71±2.84	5.25	17.47	8.92	9.36	10.06	
Dental age	257	10.30±2.72	5.90	15.80	9.60	9.97	10.64	
Dental age to chronologic age	257	0.59±0.98	−3.29	3.13	0.62	0.47	0.71	<.001
Dental maturity score	257	845.42±134.63	420.00	1,000.00	878.00	828.88	861.96	

Table 3

COMPARISON OF DIFFERENCES IN AGE BY SEX AND PAYMENT METHOD

		Mean±(SD)	**95% confidence interval**		***P*-value**
Female	Chronologic age (CA)(ys)	9.69±2.94	9.19	10.18	
	Dental age (DA)	10.25±2.87	9.78	10.73	
	DA to CA	0.57±1.03	0.40	0.74	<.001
Male	CA	9.75±2.72	9.25	10.24	
	DA	10.36±2.54	9.89	10.82	
	DA to CA	0.61±0.91	0.44	0.78	<.001
	Females (DA to CA)	−0.04±0.98	−0.29	0.20	.73
	Males (DA to CA)				
Private insurance	CA	9.79±2.98	9.23	10.35	
	DA	10.11±2.64	9.61	10.61	
	DA to CA	0.32±1.11	0.11	0.53	<.001
Medicaid	CA	9.60±2.71	9.15	10.06	
	DA	10.42±2.76	9.95	10.88	
	DA to CA	0.82±0.82	0.68	0.95	<.001
	Private insurance (DA to CA)	−0.50±0.96	−0.74	−0.26	<.001
	Medicaid (DA to CA)				

Table 4

BODY MASS INDEX (BMI) AND DENTAL MATURITY (N=96)

BMI classification		Mean±(SD)	Maximum	Minimum	*P*-value
Underweight (N=8)	Chronologic age (CA)(ys)	9.81±3.31	6.91	17.47	
	Dental age (DA)	10.15±2.59	7.70	15.50	
	Dental maturity score (DMS)	850.13±120.03	645.00	1,000.00	
	DA to CA	0.34±1.14	−1.97	2.07	.42
Healthy (N=57)	CA (ys)	11.69±3.34	6.27	17.33	
	DA	11.84±3.12	7.20	15.80	
	DMS	898.75±123.49	568.00	1,000.00	
	DA to CA	0.16±1.21	−3.29	2.77	.33
Overweight (N=16)	CA (ys)	9.10±2.38	6.21	13.01	
	DA	9.76±2.13	7.40	13.30	
	DMS	833.50±123.29	598.00	984.00	
	DA to CA	0.66±0.53	−0.71	1.32	<.001
Obese (N=15)	CA (ys)	10.29±2.82	6.84	15.50	
	DA	11.00±3.00	7.10	15.80	
	DMS	877.33±129.55	540.00	1,000.00	
	DA to CA	0.71±0.80	−1.15	2.04	.004

Table 5

DIFFERENCES IN DENTAL AGE AND CHRONOLOGIC AGE BY GENDER AND AGE

Age	Mean chronologic age±(SD)	Mean dental age±(SD)	Mean difference (dental to chronologic)±(SD)	*P*-value
Males				
6	6.27±0.17	7.64±0.24	1.37±0.29	<.001 *
7	7.06±0.25	7.83±0.48	0.76±0.50	<.001 *
8	7.94±0.34	8.49±0.87	0.54±0.76	.005 *
9	9.16±0.21	10.13±1.09	0.97±0.97	.003 *
10	10.00±0.32	10.89±1.04	0.89±1.12	.024 *
11	10.81±0.26	11.35±0.58	0.55±0.63	.008 *
12	11.94±0.28	12.15±0.65	0.21±0.73	.39
13	12.91±0.21	13.37±1.60	0.45±1.45	.48
14	13.90±0.34	14.03±1.53	0.13±1.58	.84
Females				
6	6.04±0.31	6.95±0.47	0.91±0.45	<.001 *
7	7.01±0.30	7.68±0.49	0.67±0.55	<.001 *
8	8.04±0.29	8.65±0.86	0.61±0.86	<.001 *
9	8.91±0.27	9.35±1.09	0.44±1.07	.11
10	9.83±0.19	11.07±0.60	1.23±0.63	.005 *
11	10.91±0.29	11.66±1.44	0.75±1.36	.10
12	11.93±0.35	12.09±1.61	0.16±1.49	.77
13	13.19±0.31	14.48±1.03	1.29±0.83	.002 *
14	13.92±0.31	14.37±1.46	0.45±1.70	.51
15	14.92±0.27	15.00±0.68	0.08±0.89	.83

* Statistically significant ($P<.05$).