Childhood Obesity and Dental Development

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Abstract

Purpose: The purpose of this study was to determine if increased body mass index (BMI) is associated with accelerated dental development in children ages 8 to 15.

Methods: The dental development ages of 104 children were determined using the Demirjian method and panoramic radiographs. Using the system developed by the International Obesity Task Force, BMI status was determined for each subject (63 normal weight, 23 overweight, and 18 obese subjects). The difference between chronologic age and dental age was analyzed against BMI, age, and gender using 3-way analysis of variance.

Results: Dental development was significantly accelerated with increased BMI, even after adjusting for age and gender ($P<.01$). The mean difference between chronologic and dental age among all subjects was 0.68±1.31 years. The mean dental age acceleration for overweight and obese subjects was 1.51±1.22 years and 1.53±1.28 years, respectively.

Conclusions: Children who were overweight or obese had accelerated dental development, even after adjusting for age and gender. Accelerated dental development in obese children is an important variable to consider in pediatric dental and orthodontic treatment planning where timing is crucial. (Pediatr Dent 2006;28:18-22)

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Due to more sedentary lifestyles and inadequate dietary habits, obesity has become an increasing problem in pediatrics.[1-3] The escalating obesity problem is so severe that the Surgeon General anticipates future obesity-related health care costs and morbidity and mortality rates may exceed those associated with cigarette smoking.[4,5]

Aside from the physical consequences of obesity, mental status is often adversely affected. In fact, many children who are obese suffer from depression and low self-esteem. Unfortunately, treatment of the depression often requires medication, which precipitates further weight gain and may worsen an already low sense of self-esteem.[6,7]

Beyond the immediate health risks such as noninsulin dependent diabetes mellitus, hyperlipidemia, high blood pressure/cardiovascular disease, and obstructive sleep apnea,[8] obesity has been associated with accelerated linear growth and the early onset of puberty in females.[8] In males, the effects of obesity cause considerable variation in the timing of puberty (accelerated or delayed).[8] Both the early onset of puberty (as seen in obese and African American females)[9] and hyperinsulinemia have been associated with increased risk of breast cancer[10-12] and polycystic ovary disease[8] in adulthood. Obese children have also been shown to have decreased levels of growth hormone[13] while sustaining increased levels of free IgF-1 (a main circulating growth factor).[14] Studies suggest that the IgF-1 causes the accelerated growth and suppresses the pituitary hypothalamus, which results in continued low levels of growth hormone and other varied effects.[8,14]

Although obese children may be taller in childhood,[15] they are of normal height in adolescence and adulthood.[16,17] Recent studies also suggest that obese adolescents have early craniofacial growth, which may alter their diagnoses and timing of orthodontic treatment.[18,19] In fact, when incorporating orthodontic therapies such as growth modification[20,21] or serial extractions, the timing of intervention may require recalculation to consider not only gender and race, but also body mass index (BMI [obesity]) of the patient. Unfortunately, no study has evaluated the effect of obesity on dental development. Therefore, the purpose of this study was to determine if obesity affects the dental age/chronologic age relationship.

Methods

This study comprised a chart review of new patients between 7 and 15 years of age who were seen between January 1, 2004, and December 31, 2004, in the Department of Orthodontics and Pediatric Dentistry at the University of Louisville School

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of Dentistry, Louisville, Ky. Appropriate Institutional Review Board approval was received to perform this study.

BMI (kg/m^2) was calculated to determine individuals who were overweight and obese.[22-24] Body adiposity status was determined by the classification system for childhood obesity recommended by the International Obesity Task Force (IOTF).[25] Published age- and sex-matched tables defined subjects as overweight or obese to comprise the study groups. Normal weight subjects who were age- and sex-matched to the study groups comprised the control group. Charts were excluded from review if the patients had multiple congenitally missing teeth or a history of chronic infectious disease, nutritional disturbances, or endocrine disorders.

Patients' dental ages were determined by the primary investigator using the method described by Demirjian in 1973.[26-28] Based on published sex-specific tables, this method evaluates dental eruption patterns on panoramic radiographs to estimate subjects' dental ages.[29] Subjects dental age differences were calculated by subtracting the chronologic age from the calculated dental age. Positive differences reflected acceleration, and negative differences reflected a delay in dental development.

Statistical analysis

The dependent variable (the difference between dental age and chronologic age) was analyzed for statistical significance against the independent variables through a 3-way analysis of variance (ANOVA). The independent variables included: (1) BMI group (obese, overweight, or normal weight); (2) gender; and (3) age (7-10 years, 11-12 years, 13-14 years). The level of significance was set at $P<.05$. To determine intraexaminer reliability, 10 panoramic radiographs were reassessed after 2 weeks and dental ages were compared using Cronbach's alpha.

Results

One hundred four children (40 males and 64 females) met all inclusion criteria and were included in the study (Table 1). Chronologic ages ranged from 7.8 to 14.9 years, BMI ranged from 10.6 to 38.5, and dental ages ranged from 7.9 to 16. Sixty-three subjects were normal weight, 23 were overweight, and 18 were obese.

The mean difference between estimated dental age and chronologic age (dental age difference) for all subjects was .98 years. Mean differences in dental ages were .63±1.31 (SD) years for normal weight subjects, 1.51±1.22 years for overweight subjects, and 1.53±1.28 years for obese subjects. Mean dental age differences were .99±1.35 years for ages 7 to 10, 1.16±1.37 for ages 11 to 12, and .81±1.33 for ages 13 to 14.

When evaluating for statistical significance, dental age differences varied from -0.09 to 3.33 years and significantly increased as BMI increased (P=.003). In the entire sample, females had significantly larger dental age differences than males (P=.011).

When evaluating intraobserver variability, there was a high degree of consistency. Cronbach's alpha was 0.99 for measuring dental ages for the repeated 10 panoramic radiographs.

Table 1. Average Dental Age Difference by Gender, Age-specific Body Mass Index, and Chronologic Age

Gender*	International BMI index†	Age	n	Mean dental age difference±SD
Male	Normal	7-10	4	-0.09±1.19
		11-12	6	0.06±0.78
		13-14	14	0.30±1.35
		Total	24	0.18±1.17
	Overweight	7-10	2	2.38±1.23
		11-12	4	1.68±1.71
		13-14	2	0.40±0.89
		Total	8	1.54±1.47
	Obese	7-10	1	0.75±0.00
		11-12	3	0.04±0.74
		13-14	4	1.39±1.24
		Total	8	0.81±1.12
Female	Normal	7-10	9	1.28±1.33
		11-12	15	0.87±1.11
		13-14	15	0.72±1.56
		Total	39	0.90±1.33
	Overweight	7-10	3	0.79±1.66
		11-12	7	1.69±1.09
		13-14	5	1.66±0.88
		Total	15	1.50±1.12
	Obese	7-10	1	0.95±0.00
		11-12	4	3.33±0.11
		13-14	5	1.36±0.59
		Total	10	2.11±1.13
Total	Normal	7-10	13	0.86±1.40
		11-12	21	0.64±1.40
		13-14	29	0.52±1.45
		Total	63	0.63±1.45
	Overweight	7-10	5	1.43±1.58
		11-12	11	1.69±1.26
		13-14	7	1.30±1.01
		Total	23	1.51±1.22
	Obese	7-10	2	0.85±0.14
		11-12	7	1.92±1.81
		13-14	9	1.37±0.86
		Total	18	1.53±1.28

*$P<.05$; females had significantly larger dental age differences than males.

†$P<.01$; dental age difference significantly increased with increases in body mass index.

Discussion

The mean dental age difference for all subjects was 0.98 years. Subjects who were overweight and obese had significantly more advanced dental development than normal weight subjects. Although no studies of a Western population have to date been performed, these findings are in agreement with Eid et al, who also found a significant correlation between dental maturity and BMI (0.68 years for males and 0.62 for females.[30]

Some of the observed acceleration across the entire sample may be due to children maturing earlier in general. This also may relate to a general increase in obesity over the years. Since dental acceleration was significantly greater for females than males, this may be particularly pronounced in females. Nadler reported a dental age reduction after evaluating mandibular canine calcification (Demirjian stage G) from 1972-1974 to 1992-1994. On average, males were accelerated 1.21 years and females 1.52 years.[31] Prabhakar et al found that children in India were more dentally advanced than what was reported by Demirjian.[32] Investigators in Australia published similar results.[33] Although genetics may be an important influence on dental maturation,[34] it is possible that the earlier maturation occurs because children today are more overweight than in the past. In fact, the prevalence of childhood obesity in the United States has more than doubled in the past 25 years.[33] The authors' contention would be that the Demirjian maturation scores should be updated to reflect this change.

The Demirjian method, used to determine dental age, is considered highly accurate[26] and is one of the most frequently used systems. The method, however, is based on a survey of 1,446 French Canadian males and 1,482 French Canadian females ages 2 to 20 in the St. Justine Hospital and Growth Centre, Montreal, Quebec, Canada.[35] It is less precise than skeletal, somatic, or sexual indicators with peak height velocity,[36] but no other method is currently accepted based on US children. Demirjian and Goldstein later developed a simpler analysis that only required the presence of 4 teeth on the left mandible, but the 8 stages and maturational scores are essentially the same. The newer method simply allowed the analysis to be completed on subjects with congenitally missing mandibular teeth.[37] Since exclusion criteria for the current sample included dental deficiency, the original classification assessing 7 teeth was used. Other methods exist for predicting dental age. Liversidge et al found that developing tooth length correlated well with radiographic tooth length. It can be used as an easy method to predict age from any developing permanent tooth by measuring tooth length from isolated teeth or unmagnified radiographs.[25]

It is possible that, while excessive BMI may be related to precocious development, inadequate nutritional status may be related to delayed development. In Latin America, where there is a nearly 34% prevalence of growth stunting due to nutritional deficiency, Flores-Mir et al evaluated Peruvian children with stunted growth to determine whether skeletal maturation and dental development were delayed. They used Fishman's analysis[38] to assess skeletal maturation and the Demirjian method[27] to asses dental development. Unlike the current study, they found no statistically significant difference for the skeletal maturation or the dental development stages according to nutritional status (determined by BMI status). Differences between their findings and the current study may be related to ethnic differences, since the current study had no ethnic information available.

Although BMI is widely used to screen adults for obesity, its use in adolescents is controversial. BMI is a commonly used measure of adiposity, because it is easy to calculate, quick to measure, and noninvasive. Unfortunately, it is a fairly poor index in individual children unless age and gender are taken into consideration. More accurate methods than BMI are available. They are impractical, however, for epidemiological use.[27,39-44]

Childhood BMI significantly changes with age. At birth, the median is as low as 13 kg/m^2—increasing to 17 at age 1, decreasing to 15.5 at age 6, and increasing to 21 at age 20. The age increases in BMI during both later childhood and adolescence can be attributed primarily to increases in fat-free tissue rather than fat.[40] Therefore, to more accurately define childhood obesity, a cutoff point relative to age is necessary. In the United States, the 85th and 95th percentiles of BMI for age and sex are commonly used and are based on nationally represented survey data. Unfortunately, however, BMIs are increasing in children nationwide, and many children are not properly categorized as overweight due to a relatively heavy American population.

An international survey, recommended by the International Obesity Task Force,[45] has established a standard definition for childhood obesity for the purpose of global monitoring,[25] clinical practice, and public health measures.[46] It provides cutoff points for BMI in childhood that are based on international data and linked to the widely accepted adult cutoff points of a BMI of 25 and 30 kg/m^2.[25] It is highly specific in both sexes.[45]

The current study involved several limitations. No subject socioeconomic or ethnic information was available for analysis. Subjects were selected from a patient base treated within a dental school in an urban area. Therefore, the sample may be of a lower-than-average socioeconomic status, although it did provide the authors with a range of subjects of differing ages, BMI, and dental development to address the effect of obesity on dental and chronologic age. Furthermore, several were very limited in number when separated by age, gender, and BMI status. Two groups included only 1 subject (obese males and females 7-10 years old). Finally, study design utilized the Demirjian method, which was developed many years ago and may not accurately translate dental age in today's population.[35]

Pediatric dental practitioners should provide regular obesity screenings simply by recording the height and weight of all patients and calculating BMI status. This would allow the early detection of weight gain and further intervention.

As health care providers, we should provide dietary education not only to promote oral health, but also to maintain healthy body adiposity levels. Such simple measures may increase awareness and limit the long-term health consequences associated with childhood obesity.[27]

Additionally, accelerated dental maturation may affect treatment timing and treatment options. For example, patients who are overweight may require earlier orthodontic consultation. Serial extraction timing may be altered, as may space maintenance and growth modification. Furthermore, when permanent teeth erupt earlier in children at a time when they may not have proper oral hygiene, caries incidence may increase.

Future studies are warranted in a larger population to determine if ethnicity in coordination with obesity has an effect on dental development. In addition, investigators should evaluate whether obesity affects the timing of skeletal development.

Conclusions

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

1. Dental development was accelerated in children who had increased BMIs, even after adjusting for gender and age.
2. When evaluating dental age differences by gender only, dental development was accelerated in females.
3. Pediatric dentists play a role in promoting oral and physical health. Regular check ups should include obesity screenings and diet counseling to prevent obesity as well as dental caries.

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