

Childhood body mass index is associated with early dental development and eruption in a longitudinal sample from the Iowa Facial Growth Study

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Introduction: Children with high body mass index (BMI) values have been demonstrated to have precocious dental development. Research has largely focused on cross-sectional data sets, leaving an incomplete understanding of the longitudinal relationship between BMI and dental maturation. **Methods:** We used a pure longitudinal growth series to examine the relationship between dental development and childhood BMI. Periapical radiographs from 77 children from the Iowa Growth Study were used to estimate dental development for those with high BMI values. **Results:** We confirmed prior studies in finding that children with higher BMI values were more likely to have advanced dental development for their ages ($P < 0.001$). BMI at age 4 years was predictive for the timing of dental development at age 12 ($P = 0.052$). The precocity of the rate of dental development accelerated across growth. Overall dental development scores also correlated with the age of dental eruption for the mandibular canines and first premolars ($P < 0.001$). **Conclusions:** High BMI values at young ages predict advanced dental development at later times, suggesting a long-term effect of BMI on dental maturation and implying the need for earlier orthodontic interventions in obese children. These results corroborate those of previous studies, building further evidence that relatively early dental eruption is another consequence of childhood obesity. (Am J Orthod Dentofacial Orthop 2018;154:72-81)

Childhood obesity is a pressing national health concern, with more than 30% of children and adolescents in the United States estimated to be overweight or obese.¹ Although the poor are statistically more likely to be overweight or obese,²⁻⁵ childhood obesity among all socioeconomic groups has been on the rise^{6,7} (but see the study of Ogden et al¹ for a discussion of how this trend has recently plateaued in some age groups). High body mass index (BMI) in childhood has many important health—and public

health—implications, and researchers have asked the question: how does this influence dental development? Over the last decade, a number of studies have addressed this topic,⁸⁻¹⁷ and nearly all have found an association between being overweight or obese and having earlier tooth development (although not all studies have shown this difference to be clinically significant^{16,17}). For example, in one of the first studies to investigate this topic, Hilgers et al⁸ found that being overweight was associated with an average of a year and a half of advancement in dental development, and being obese had a similar effect. These researchers also found that both boys and girls who were overweight or obese had precocious dental development, a result that has been corroborated by several other studies in different populations.^{13,14,18,19} Moreover, thin children were found to have the slowest rate of dental eruption, and overweight children have the most advanced dental eruptions. This pattern exists as a gradient, where being “at risk” for being overweight (having a BMI value at the upper extreme of scores in the normal-weight range) implicates a more precocious dental development than values in children with lower or

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average weight. A high body mass value may influence dental eruption directly (since overall growth seems to be accelerated in obese children, including skeletal growth and age at first menarche in girls)²⁰; however, this is not the only possible explanation. Factors caused by, or correlating with, obesity may be, at least partially, to blame.

A recent study looked at diabetes, BMI, and dental eruption.⁹ Diabetes was found to be associated with earlier tooth eruption in the later stages of permanent tooth eruption (10–14 years of age). The authors also looked at gingival inflammation. They found that in both the control and case groups, gingival inflammation was correlated with early tooth eruption (although not necessarily advanced tooth calcification). This demonstrates that the association between obesity and dental maturation may be correlative and not necessarily causative.

Many previous studies have focused on dental eruption,^{9,10,13,21,22} in contrast to dental development (but see the studies of Hilgers et al,⁸ Mack et al,¹⁴ and Weddell and Hartsfield¹⁶). This is important because the actual biologic pathway causing this early eruption is currently not known, and thus early eruption may not indicate early development (ie, teeth may be developing normally but erupting underdeveloped). It is currently unknown whether early dental eruption is associated with early dental development in obese children. Although the evidence supporting the correlation between obesity and early eruption tends to make this possibility less likely, this has not been empirically tested.^{8,14,16} Of the studies that looked at dental development, nearly all were cross-sectional and therefore did not definitively address individual-level development of the teeth.^{8–19,21–25} The 1 exception to this was the study of Sanchez-Perez et al,¹⁰ which included multiple time points of dental eruption data (tooth counts) of Mexican schoolchildren.

Although there is a relationship between BMI and dental development and eruption, previous studies have largely focused on later age groups. Because the frequency of overweight and obese children across all age groups has increased over the past 40 years,² it is vitally important to examine the relationship between body mass and dental development at younger ages. The purpose of this study was to examine whether variations in BMI have a longitudinal influence on dental development and the timing of dental eruption. We tested the null hypothesis that childhood BMI is not statistically associated with the timing of dental development and addressed the following research questions. (1) Does BMI influence dental development so that overweight children are characterized by precocious tooth

development as shown in prior studies? (2) Is the effect of BMI on dental development static across growth (ie, can BMI at age 4 predict the timing of dental development at later ages)? (3) As a corollary, does a child with a given rate of dental development at 1 age have a similar rate (advanced, delayed, or normal) at later ages, regardless of BMI? (4) Are overweight children characterized by faster rates of tooth eruption (in contrast to tooth calcification)?

Prior studies have focused on either eruption or development (calcification) and have not resolved the possibility that children with high BMI whose teeth erupt early may have underdeveloped teeth. In this study, we combined dental developmental data and dental eruption data to test the hypothesis that they strongly covary in obese children, using data from a pure longitudinal growth series that included periapical radiographs (Iowa Growth Study). We further examined the relationship between dental development and timing of dental eruption in our sample to draw broader conclusions about the applicability of dental eruption data to questions about developmental changes associated with high BMI values.

MATERIAL AND METHODS

Our sample consisted of 77 children from the Iowa Growth Study. The University of Iowa conducted this study from 1946 to 1960, and it is a pure longitudinal growth study. The subjects entered the study between the ages of 3 and 5 years and were followed continuously for the next 14 years. Full records were taken on the subjects every 3 months until age 5, every 6 months between 5 and 12 years, and then every year after age 12. The records include health history, height, weight, alginate impressions from both arches, complete mouth series radiographs, lateral cephalometric radiographs, and posteroanterior cephalometric radiographs.²⁶

To assess dental eruption, we examined both periapical radiographs and posteroanterior cephalograms for each subject. Dental development was scored by 1 observer (K.K.) from the periapical radiographs using the method of Demirjian et al²⁷ at approximately ages 4, 8, and 12 years. These ages were chosen as representative time points for fully deciduous dentition (age 4), early mixed dentition (age 8), and late mixed dentition (age 12). Using the Iowa Growth Study records, the observer was blinded to the BMI values of the subjects. The first 10 subjects were rescored 2 weeks after their original scoring, and the agreement between the scores for each tooth was 0.97. Dental eruption was assessed for the mandibular left canines and first premolars by viewing periapical radiographs and posteroanterior cephalograms for each subject and identifying the

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