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Relationship between body mass and dental and skeletal development in children and adolescents

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Introduction: The purpose of this investigation was to determine whether a relationship exists between body mass and dental and skeletal development in children and adolescents. A sample of 197 orthodontic patients (82 boys, 115 girls) was selected. Ethnicity was recorded, and body mass index (BMI) was calculated according to the standard equation from the Centers for Disease Control and Prevention, and then a BMI percentile according to sex and age was obtained. The panoramic radiographs were used to calculate the dental ages with an index. The chronologic ages were subtracted from the calculated dental ages to determine a "dental age difference" for each subject. The lateral cephalogram radiographs were analyzed for skeletal development using the cervical vertebral maturation stage method. **Results:** The white population (60%) had an average BMI percentile of 53.6 and was statistically different from the Hispanic/black population (40%), which had an average percentile of 64.3. There were no significant differences for boys and girls for the BMI percentile and dental age difference, or for the BMI percentile and cervical vertebral stages. The multiple regression model showed that BMI percentile and ethnicity were statistically significant explanatory variables for the dental age difference. **Conclusions:** A relationship exists between body mass and dental and skeletal development. BMI percentile, dental age difference, and cervical vertebral stage are weakly correlated. No significant differences existed between boys and girls in any variables. BMI percentile and ethnicity are weak predictors of the discrepancy between dental age and chronologic age. (Am J Orthod Dentofacial Orthop 2016;150:268-73)

To achieve ideal orthodontic results, one must not deem treatment complete until all the permanent teeth (excluding third molars) have erupted and are aligned. Knowing exactly the right time to initiate treatment with fixed appliances is a balancing act between potential somatic growth and the timing of tooth emergence.

Tooth development and emergence timing are multifactorial. One factor with a significant effect on dental and skeletal development is a child's body mass index (BMI). It has been proven that overweight and obese children are skeletally and dentally more advanced than their peers with a normal BMI.[1-7]

Relatedly, Gaur and Kumar[8] and Gaur et al[9] in India have established the effect of undernutrition or low BMI on dental development. They reported that undernutrition leads to delayed emergence of deciduous and permanent teeth compared with their normal counterparts. These findings have been verified in malnourished Haitian adolescents.[10] Their deciduous teeth were slow to exfoliate, and permanent teeth were slow to erupt compared with their normal peers.

Delayed dental development and eruption are seen in underweight children and in many systemic conditions such as cleft lip and palate, hypothyroidism, Apert's syndrome, celiac disease, Down syndrome, cerebral palsy, childhood cancer, Ehlers-Danlos syndrome, fetal alcohol syndrome, Gorlin's syndrome, hemifacial microsomia, and hypodontia.[11-26]

Whereas delayed dental development has many contributing factors and consequences in orthodontic treatment timing, determining a child's BMI is a noninvasive way to help predict dental and skeletal maturation. In this study, we assessed whether there is a correlation between nonsyndromic children with low BMI and delayed skeletal and dental development.

MATERIAL AND METHODS

The protocol for this retrospective study was reviewed and approved by institutional review boards at Saint Louis University and Baylor College of Dentistry.

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The sample was obtained from Baylor University's orthodontic clinic in Dallas, Texas, and consisted of 197 patients (82 boys, 115 girls) between 7 and 14 years of age.

The subjects were randomly selected from a computer search of patients seen in the Baylor orthodontic clinic in 2011. They were then filtered for chronologic age (7-14 years).

Data were then collected using electronic charting (Axium, Portland, Ore) and software (Dolphin Imaging & Management Solutions, Chatsworth, Calif). The birthdates and initial examination dates were verified to ensure accurate ages of the patients. The height and weight data were collected by Baylor orthodontic residents at the initial examinations. Ethnicity was recorded for each subject: white, Hispanic, black, Asian, Middle Eastern, and other. Because there were few subjects in the Asian, Middle Eastern, and other categories, they were excluded from the study. The Hispanic and black subjects were grouped together based on similar body mass status.[27]

The exclusion criteria were congenital tooth anomalies, significant medical history that could affect normal growth, bilaterally missing mandibular permanent teeth (excluding third molars), and unreadable radiographs.

The BMI was calculated using height and weight data. The BMI formula used by the Centers for Disease Control and Prevention (CDC) is weight (pounds) divided by height (inches) squared multiplied by 703. This calculation is widely used to assess health status of infants, children, and adults. When calculating a BMI for a growing child in whom height is rapidly increasing, age must be taken into account. Therefore, after the BMI was calculated with the formula, it was assessed using age- and sex-specific BMI percentile charts from the CDC. The BMI percentile gives a more accurate weight status in growing children and adolescents than the BMI alone.

The CDC has specific guidelines for weight status according to the child's BMI percentile. A child with a BMI percentile less than 5 is considered underweight, a child with a percentile of 5 through 84 has a healthy weight, one with a percentile of 85 through 94 is overweight, and one at percentile 95 or greater is considered obese.[28]

The radiographs were assessed by 1 investigator (E.A.D.) independently from the subjects' BMI data. The index of Demirjian et al[29] was used to evaluate the panoramic radiographs and determine a dental maturity score and corresponding dental age. Using this protocol, 7 mandibular teeth (left central incisor to left second molar) were scored based on 8 stages of tooth maturation and eruption. Scoring was based on criteria from crown calcification, root development, and apex characteristics. The scores were added together to give a dental maturity reading and then converted to a dental age using sex-specific tables. The subjects' chronologic ages were then subtracted from their dental ages to produce a "dental age difference." Negative differences reflected a delay in dental development, and positive differences reflected acceleration.

The lateral cephalogram radiograph was used to analyze the cervical vertebral maturation with the method developed by Baccetti et al.[30] This method analyzes the cervical vertebrae C2 through C4 based on lower border concavity and vertebral body shape. The different vertebral body shapes are trapezoid, rectangular horizontal, square, and rectangular vertical. Stages 1 through 5 were assigned to each subject based on these criteria. The pubescent growth spurt occurs at stage 3.[30]

Statistical analysis

Data were collected and organized using Microsoft Office Excel 2010 (Microsoft, Redmond, Wash). Statistical analysis was performed with SPSS software (version 20; IBM, Armonk, NY). The means, medians, and standard deviations of BMI percentiles, chronologic ages, calculated dental ages, and dental age differences were calculated.

Pearson correlation coefficients (r) were calculated for the parametric variables with interval data (BMI percentile and dental age difference). The Spearman rank correlation coefficient (ρ) was used for the nonparametric variable (cervical vertebral stage) with ordinal data. The type 1 error was set at both $\alpha = 0.05$ (2-tailed) and $\alpha = 0.01$ (2-tailed).

Analyses were performed with unpaired t tests (BMI percentile vs sex, and BMI percentile vs ethnicity) and analysis of variance (ANOVA) (BMI percentile vs cervical vertebral stage). A multiple regression model was used to test the predictive value of BMI percentile. A Cronbach alpha correlation was performed on 10% of the sample for error analysis.

RESULTS

One hundred ninety-seven children, 82 boys (41.6%) and 115 girls (58.4%), met the inclusion criteria. The mean BMI percentiles were 61.7 ± 32.2 for the boys and 55.2 ± 29.3 for the girls. Approximately 60% of the sample was white (n = 118), and 40% was Hispanic or black (n = 79). The mean BMI percentiles were 53.6 ± 30.2 for the white group and 64.3 ± 30.2 for the Hispanic/black group. The sample distribution included 4.1% (n = 8) who were considered underweight (<5th percentile), 66% (n = 130) with a healthy weight (5th-84th percentile), 16.2% (n = 32) who were overweight (85th-94th percentile), and 13.7% (n = 27)