Absence of Association between Body Size and Deciduous Tooth Size in American Black Children

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ABSTRACT Weak positive associations between tooth size and body size have been documented for the permanent dentition. Presumably, if the deciduous dentition were under the same genetic controls as the permanent, there would also be a discernible association for the deciduous teeth in young children. The deciduous dentition of 133 modern American Black children was examined to determine the correlation between body size and tooth size. The results, based on Spearman's rank-order correlations, disclosed no statistically significant association with body weight or stature, expressed as age - and sex- specific centiles, and crown diameters at the alpha level of 0.05. It is speculated that maternal influences - which modulate perinatal growth of the offspring - dissociate the tooth size-body size association in children, whereas the individuals' own genotypes are relatively more strongly expressed with increasing age.

INTRODUCTION

It is known that prenatal environmental factors can appreciably affect tooth crown diameters (e.g. Mellanby, 1941; Kreshover and Clough, 1953; Paynter and Grainger, 1956; Bailit and Sung, 1968; Garn, Osborne and McCabe, 1979; Heikkinen, 1996). What is not understood is the degree to which the maternal environment impacts tooth size in the deciduous dentition versus the later-forming permanent dentition of an individual.

In previous studies (e.g. Filipson and Goldson, 1963; Garn, Lewis and Kerewsky, 1968; Lavelle 1974; Henderson and Corruccini, 1976) weak positive associations were reported for the permanent dentition and adult stature. Garn's data yielded significant correlations on the order of 0.2 to 0.4, indicating that roughly five to ten percent of the variation in tooth size is accounted for in the statistical sense by stature. When permanent tooth size is tested against relatively more proximate biological structures, such as skull size (Lavelle, 1974), the correlations are again positive and of the similar magnitudes, 0.2 to 0.3.

Studies to date have analyzed sizes of the permanent dentition in relation to completed adult stature or skull size. None has tested for associations between the size of the deciduous teeth and corresponding body size in children. Researchers have assumed that the biological relationships between tooth size and body size are the same for the primary and permanent dentitions.

MATERIALS AND METHODS

Children who were routine dental patients at the graduate program of Pediatric Dentistry at the University of Tennessee, Memphis, were examined. Only American Blacks (n = 133) were used in the present study, where ancestry was based on parental assessment. Full-mouth dental study casts were made using rigid disposable trays, and the impressions were poured immediately using dental stone.

Not all children had complete complements of deciduous teeth. Mean age at examination was 5.5 years, with a range of two to nine years. Sample sizes were, as a result, larger for the late-exfoliating deciduous premolars and canines than the incisors.

Stature was measured to the nearest millimeter on all children by the same examiner using a stadiometer and procedures detailed by Weiner and Lourie (1969). Children were dressed in light school clothes, with socks but with their shoes removed. Body weight was obtained to the nearest 0.5 kg.

Maximum mesiodistal and buccolingual crown diameters of all sound deciduous teeth were measured by a single examiner using methods described by Moorrees (1957). Left and right homologous variables were averaged, when possible, yielding a total of 20 crown dimensions. Each tooth dimension was transformed to a sex-specific z-score (Garn and Shamir, 1958) so the data from males and females could be combined, and these standardized scores were used for statistical analysis.

Each individual's height and weight were converted to sex-specific centiles using charts from the National Center for Health Statistics (Hamill et al., 1977). Interpolations to the nearest centile were computer-generated.

Bivariate correlations between each tooth crown dimension and stature and then body weight were calculated using Spearman's rank-order correlation coefficient corrected for tied ranks (Siegel and Castellan, 1988). This nonparametric statistic was used to guard against non-normal distributions.

RESULTS

There were 20 correlation coefficients between deciduous crown diameters and stature and 20 between crown size and body weight (Table 1). None of the 40 correlations was statistically significant at the conventional alpha level of 0.05. Indeed, only four correlations were significant at a relaxed alpha of 0.10.

Most of the correlations between stature and crown size were negative (19/20), which exceeds expectations of a random split between positive and negative scores (X2 = 10.2; P = 0.001). In contrast, the majority of correlations between weight and crown size were positive (13/20; X2= 0.9; P = 0.34).

Of note, the four stature-tooth size correlations significant at alpha of 0.10 were negative, implying that the weak association is between tall-for-age children and smaller-than-average crown sizes and vice versa.

We also investigated whether partialing-out the effect of age would alter the results. There are two possibilities here, one is that tooth size was linked to age in this cohort of children and the other is that older children might have smaller tooth crown dimensions because of attrition. In fact, none of the 20 correlations between tooth size and age achieved statistical significance. All correlations were less than 0.10, which is consistent with the observation that tooth wear characteristically is trivial in contemporary, soft-diet populations. Consequently, since the tooth size-age associations were low and centered on zero, Kendall partial rank-order correlation coefficients (Siegel and Castellan, 1988) were not systematically or significantly different from those in Table 1.

DISCUSSION

Intuitively, one might expect that size-controlling genes would influence body size and tooth size in parallel fashions in childhood, leading to positive body size-tooth size correlations. However, there was no statistically significant association in the present study with percentile weight or stature and any of the 20 crown diameters at the conventional alpha level of 0.05. This suggests that the size-promoting genes responsible for deciduous crown size have little or no overlap with the phenotypic expression of height and weight during childhood. The literature suggests that, in contrast, by the time growth is effectively complete in early adulthood, weak but measurable size communalities have developed between tooth and body size (e.g., Garn, Lewis and Kerewsky, 1968; Henderson and Corruccini, 1976; Garn, Smith and Cole, 1980).

One conjectural explanation for the lack of association in the present study is that body size in childhood is a poor predictor of size at maturity because the tempos of growth vary considerably among children. Perhaps a measure of body size as a function of biological age (e.g., so-called bone age or dental age) would better control body size variation in children, thus disclosing stronger associations. Alternatively, the low but obvious correlations attained by the completion of growth in adults may simply not be present early in life when most growth remains potential and the degrees of maturity vary by tissue system (Scammon, 1930; Tanner, 1962).

Another, more likely consideration is that maternal influences and/or other environmental factors play a larger role in childhood growth than generally appreciated. It is documented that the intrauterine environment has a greater impact on size variation of the deciduous dentition than it does on the permanent dentition (e.g., Ayers et al., 1974; Brown, Margetts and Townsend, 1980). All of the deciduous tooth crowns achieve final size either in utero or in infancy, where - just as for body size and other dimensions (Ounsted and Ounsted, 1973; Penrose, 1973) - maternal size and health modulate growth substantially more than at later ages when the offspring's own genotype is manifested.

Previous studies have found that maternal influence ranges from 15% for human tooth size (Townsend, 1980) to 16 - 25% for tooth size in mice (Bader, 1965). Maternal influences on later-developing permanent teeth are only about 6% (Townsend, 1980). In turn, while the correlations between deciduous and permanent crown sizes within individuals are positive and statistically significant, they are not particularly high (ca. $r^2 = 0.25$), suggesting that different factors are influencing the two dentitions (Mootrees and Reed, 1964).

Finally, from an evolutionary standpoint, there is no reason to expect a correlation similar to the permanent dentition and body size. If tooth size is related to diet consistency, then the deciduous dentition will not have the same selective pressures as the permanent dentition. Deciduous teeth are present for a limited time of an individual's lifespan, and selection has a short time period to impact the underlying genetics. This lack of selective pressure may also explain the thinner, less dense enamel of the deciduous teeth (Sumikawa et al., 1999).

Still, the preponderance of negative associations between stature and deciduous tooth size (Table 1) is striking. Most (19/20) correlations were negative, though the correlations are not independent of one another because tooth dimensions are all positively intercorrelated (Moorrees and Reed, 1964; Harris and Bailit, 1988). Children with lower centiles for stature tended to have larger teeth, whereas tall-for-age children had smaller crowns.

This contrasts with prior results based on permanent teeth in adults and awaits further data for confirmation. There was no trend among the associations for weight-for-age and tooth size, and the ponderal index (i.e., weight/stature3) was also tested (results not shown) to see whether body-build was reflective of tooth size, but no statistically significant correlation was found.

On the basis of these data, then, the weak but discernible correlations between body size and permanent tooth crown size, on the order of 0.2 to 0.3, do not have any corresponding correlations in children with regard to the deciduous dentition and stature. Indeed, the weak trends between stature and crown size exhibit negative relationships. This lack of significant findings provides a further cautionary note against inferring body size from tooth size or vice versa, just as forewarned by Garn and coworkers (1979) and Henderson and Corruccini (1976) based on analyses of the permanent dentition.

TABLE 1. Rank correlation coeficients btween body size and deciduous tooth crown diameters.

	Tooth Crown Dimensions						
Body Size	Ui1	Ui2	Uc	Um1	Um2	Li1	Li2
	Lc	Lm1	Lm2				
	Mesiodistal Crown Diameters						
Height	-0.09	-0.19†	-0.08	-0.06	-0.03	-0.18	
Centile	0.02	-0.10	-0.09	-0.03			
Weight							
Centile	0.07	0.03	-0.05	-0.08	0.11	-0.09	-
0.10	-0.02	0.03	0.08				
	Buccolingual Crown Diameters						
Height							
Centile	-0.09	-0.12	-0.07	-0.13	-0.17†	-0.05	-
0.15	0.18†	-0.06	-0.14				
Height							
Centile	-0.09	0.02	-0.08	0.03	-0.02	-0.04.	-
0.17†	0.02	-0.02	0.10				

†$0.10 > P \geq 0.05$

*$P < 0.05$

CONCLUSION

This study supports the idea that the maternal environmen not only impacts the size of the deciduous dentition but may degrade the correlations between biological systems ofthe mother and her offspring. Alternatively, the discernible synchrony between body size and tooth size seen by late adolescence may be weaker at earlier ages.

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