Community Dent Oral Epidemiol 2005; 33: 93–8

COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

The life course approach: explaining the association between height and dental caries in Brazilian adolescents

Belinda Nicolau[1], Wagner Marcenes[2], Paul Allison[1] and Aubrey Sheiham[3]

[1]Division of Dental Public Health, Faculty of Dentistry, McGill University, Montreal, QC, Canada, [2]Barts and The London, Institute of Dentistry, QMUL, University of London, London, UK, [3]Department of Epidemiology and Public Health, University College London Medical School, University College London, London, UK

Nicolau B, Marcenes W, Allison P, Sheiham A. The life course approach: explaining the association between height and dental caries in Brazilian adolescents. Community Dent Oral Epidemiol 2005; 33: 93–8. © Blackwell Munksgaard, 2005

Abstract – *Aim:* To investigate the relationship between height and dental caries in Brazilian adolescents. *Methods:* A cross-sectional survey design was used to collect retrospective data. Of 764 eligible 13-year-old adolescents enrolled in urban private or public schools in a Brazilian town, 652 were clinically examined and interviewed. Data were collected on socioeconomic circumstances, family related variables, oral health behaviour and anthropometric measures (height and weight). Dental caries was measured by decayed, missing and filled teeth (DMFT) index. The DMFT was categorized according to two levels of severity (low DMFT ≤ *6;* high DMFT > 6) using the 75th percentile of the distribution as the cut-off point. Data analysis involved multiple logistic regression. *Results:* Adolescents who were the second or later child were 1.90 times more likely to have a high DMFT, whilst being a taller adolescent had a protective effect on caries experience (OR = 0.04; 95% CI = 0.00–0.79). In addition, adolescents from rural areas (OR = 2.74; 95% CI = 1.56–4.82), those whose mothers had less than 8 years of education (OR = 2.10; 95% CI = 1.03–4.27) and those who reported high levels of paternal punishment (OR = 1.60; 95% CI = 1.02–2.52) had an increased risk of having a high DMFT. *Conclusion:* There is a relationship between height and dental caries experience in this sample of Brazilian adolescents.

Key words: adolescents; dental caries; height; life course; socioeconomic circumstances

Belinda Nicolau, Division of Dental Public Health, Faculty of Dentistry, McGill University, 3640 University Street, Room 2/38G, Montreal, QC, Canada H3A 2B2
Tel: +1 514 398 7202 (ext. 09977)
Fax: +1 514 398 8242
e-mail: belinda.f.nicolau@mcgill.ca

Submitted 7 June 2004;
accepted 29 October 2004

There is increasing interest in conceptualizing chronic disease aetiology within a life course framework. This approach analyses the effects of physical and social exposures along the individual's life on chronic disease risk. It provides a more comprehensive approach than traditional risk factor epidemiology as it seeks to understand when and how particular exposures act on later health outcomes (1). One of the tenets of the life course theory is that the stock of biological resources inherited and acquired during earlier stages of life will determine current and future health potential including resilience to challenges (2). An individual's biological resources are influenced by their genetic endowment, their pre-natal and post-natal development and their social and physical environment in early life. Adversity in childhood becomes 'embodied' at an early age and its full impact manifests later in life (2).

Height is an important surrogate marker of early development and of social and physical environment exposures in early life and it is related to health and longevity (3). Socioeconomic circumstances influence foetal development and growth during childhood. Subsequently, poor foetal development and delayed linear growth, as indexed respectively by low birth weight (4) and shorter leg-length (5) are associated with increased

mortality, suggesting an important role for diet in early life on adult health (4, 5). Studies in populations with high levels of nutritional deficiency also have found that children with low height for their age had significantly greater caries experience in their primary dentition (6, 7).

In this study we investigate whether or not dental caries experience in permanent dentition is associated with height in adolescents. We use height as a potential indicator of individual biological resources gained in childhood as it has been used to explain variations on coronary heart disease and mortality.

Material and methods

This paper is part of a project investigating the relationship between the life course circumstances and oral health status in Brazilian adolescents. A full description of the methodology was presented elsewhere (8). In brief, all 13-year-old adolescents ($n = 764$) who attended private or public schools in a town in Brazil (Cianorte) in 1999 were eligible to participate in this study. Ethical clearance was obtained from the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES). A letter was sent to all parents explaining the aim and characteristics of the study and asked for consent for their child to participate in the study. Negative consent was adopted, that is, the parents were asked to communicate with the school personnel if they did not want their child to take part in the study. In addition, all adolescents were verbally asked if they wanted to participate in the study. Both parents and adolescents were assured that there would be no prejudice to the child who wanted to opt out and that all recording forms would be numbered but not named. Those who agreed to participate in the study were clinically examined and interviewed.

As this study included three outcomes, the size of the sample was calculated separately for each of them and the largest sample size required was adopted. The power of the test was 80% in order to demonstrate significant odds ratio of those who experienced adverse or favourable environmental circumstances at a 5% level, if the magnitude of the odds ratio was not less than 2 using an 80% prevalence of dental caries of among nonexposed.

Data were collected through a structured interview and a clinical oral examination. Adolescents were examined for dental caries, bleeding gums and traumatic dental injuries. The dental examination for dental caries included all surfaces and recorded each tooth according to the WHO criteria (9). Anthropometric measures included height and weight with the participant barefoot and wearing light clothes. Weight was assessed to the nearest 0.1 kg on a standard scale. Height was measured to the nearest 0.1 cm with the child erect against a wall-mounted measuring tape.

Participants were also face-to-face interviewed by two trained researchers. Sociodemographic and economic factors (sex, parents' levels of education, family income, area of residence), adolescent/parent related variables (family structure and family relationships) and oral health behaviour (dietary habits, use of fluoride, oral hygiene practices, dental attendance) were recorded. Family income was calculated by adding the monthly wages of all economically active members of the family and by dividing this sum by the current Brazilian Minimum Wage (1 BMW = \$75 per month). Parent's level of education was measured in number of years completed at school. Adolescent/parent relationships were measured using six questions derived from the Whitehall Study II (10). These questions are responses to four Likert-type items, each rated on a four-point scale ranging from 'very much' to 'none'. Adolescents answered the six questions for each parent and two dimensions of familial relationships were identified; mothers' and fathers' levels of support and punishment. Both mothers' and fathers' levels of support were calculated by summing up the scores for the questions on trust, love, attention and understanding. Levels of punishment by fathers and mothers were estimated by adding the scores for the questions on strictness and punishment. The variables were grouped using principal component analysis.

Data analysis

Data analysis was carried out using the Statistical Package for Social Sciences version 10.0. Following descriptive statistics (frequency and distribution and cross-tabulation) logistic regression was used to identify potential correlates of dental caries experience. Variables were forced into the model if they were significantly associated with the outcome variable dental caries ($P < 0.05$). Colinearity among the independent variables was assessed and, as expected, a highly significant correlation was found among socioeconomic indicators. As highly correlated variables added

to a model together may obscure each other's effect (11), the models were developed using only one of the socioeconomic indicators. Different models were tested using different socioeconomic indicators (family income, mothers' and fathers' level of education). Mothers' education level was chosen based on goodness-of-fit to the model and its importance as reported in the literature. Statistical significance was set at 5%. The variables were tested for two-way interactions. The outcome variable, dental caries, was measured by the decayed, missing and filled teeth (DMFT) index. The variable was categorized according to two levels of severity (low dental caries: DMFT ≤ 6; high dental caries: DMFT > 6) using the 75th percentile of the distribution as the cut-off point.

Results

A total of 652 of 764 eligible 13-year-olds (85%) agreed to participate. Due to missing data the final models were based on 586 subjects representing 77% of the total sample. Intra-examiner agreement was very good. Kappa values for the presence of dental caries were calculated on a tooth-by-tooth basis, and all values were greater than 0.90. Kappa values for anthropometric measures were also greater than 0.90. Intra- and inter-interviewer reliability was satisfactory as demonstrated by correlation scores above 0.73.

The frequency distribution of the variables studied is presented in Table 1. The mean height of adolescents and their levels of dental caries were 160 cm (SD = 0.08) and 4.00 (SD = 3.56)

Table 1. Prevalence of dental caries by sociodemographic and economic indicators, family related variables, oral health behaviours and height in a sample of 13-year-old adolescents (n = 586)

Variables	DMFT ≤ 6, n (%)	DMFT > 6, n (%)	OR (95% CI)	P-values
Mother's level of education				
More than 8 years of education	109 (91.6)	10 (8.4)	1	
Up to 8 years of education	370 (79.2)	97 (20.8)	2.85 (1.44–5.66)	0.003
Father's level of education				
More than 8 years of education	109 (90.1)	12 (9.9)	1	
Up to 8 years of education	344 (79.4)	89 (20.6)	2.35 (1.23–4.45)	0.009
Family income				
More than five BMWs	155 (89.6)	18 (10.4)	1	
Up to five BMWs	302 (77.8)	86 (22.2)	2.45 (1.42–4.22)	0.001
Area of residence				
Urban	436 (84.5)	80 (15.5)	1	
Rural	43 (61.4)	27 (38.6)	3.42 (2.00–5.85)	<0.001
Family structure				
Two-parent family	369 (81.5)	84 (18.5)	1	
Single-parent family	63 (81.8)	14 (18.2)	1.18 (0.56–2.52)	0.652
Reconstituted family	47 (83.9)	9 (16.1)	1.16 (0.46–2.90)	0.751
Paternal levels of punishment				
Low	327 (84.1)	62 (15.9)	1	
High	152 (77.2)	45 (22.8)	1.56 (1.01–2.39)	0.042
Birth order				
First	206 (86.9)	31 (13.1)	1	
Second or later child	273 (78.2)	76 (21.8)	1.85 (1.17–2.91)	0.008
Sex				
Male	244 (85.0)	43 (15.0)	1.54 (1.00–2.36)	0.045
Female	235 (78.6)	64 (21.4)	1	
Toothbrushing frequency				
Once or two times a day	212 (81.5)	48 (18.5)	1	
Three or more times a day	267 (81.9)	59 (18.1)	1.02 (0.67–1.56)	0.910
Sugar consumption				
Up to four times a day	246 (80.7)	59 (19.3)	1	
More than four times a day	230 (82.7)	48 (17.3)	0.87 (0.57–1.32)	0.538
Pattern of dental attendance				
Mainly for check up	122 (89.1)	15 (10.9)	1	
When in trouble	357 (79.5)	92 (20.5)	2.09 (1.17–3.75)	0.013
Use of fluoride mouth rinse				
Yes	467 (81.6)	105 (18.4)	1	
No	11 (84.6)	2 (15.4)	0.80 (0.17–3.70)	0.785
Height (cm)	X = 160	X = 158	0.02 (0.00–0.41)	0.009

Table 2. Logistic regression for the association between height and dental caries in a sample of 13-year-old school adolescents ($n = 586$)

Variable	Unadjusted OR (95% CI)	*P*-values	Adjusted OR (95% CI)	*P*-values
Mother's education level				
More than 8 years of education	1		1	
Up to 8 years of education	2.85 (1.44–5.66)	0.003	2.10 (1.03–4.27)	0.040
Area of residence				
Urban	1		1	
Rural	3.42 (2.00–5.85)	<0.000	2.74 (1.56–4.82)	<0.001
Sex				
Male	1		1	
Female	1.54 (1.00–2.36)	0.045	1.51 (0.96–2.37)	0.068
Paternal levels of punishment				
Low	1		1	
High	1.56 (1.01–2.39)	0.042	1.60 (1.02–2.52)	0.040
Birth order				
First child	1		1	
Second or older child	1.85 (1.17–2.91)	0.008	1.90 (1.18- 3.05)	0.008
Height (cm)	0.02 (0.00–0.41)	0.009	0.04 (0.00–0.79)	0.034
Pattern of dental attendance				
Mainly for check ups	1		1	
When in trouble	2.09 (1.17–3.75)	0.013	1.75 (0.95–3.22)	0.071

respectively. Most adolescents were from low-income families and their parents had low levels of education (Table 1). Results of univariate analysis showed that the prevalence of high levels of caries varied by socioeconomic status, area of residence, sex, dental attendance, birth order, family relationships and height. Those adolescents with a higher DMFT were girls (21.4% versus 15.0%, $P = 0.045$), those living in rural areas (38.6% versus 15.5%, $P < 0.000$), those in the lower income group (22.2% versus 10.4%, $P = 0.001$) and those whose fathers (20.6% versus 9.9%, $P = 0.009$) and mothers (20.8% versus 8.4%, $P = 0.003$) had less than 8 years of formal education. More adolescents with high levels of caries visited the dentist only when in trouble (20.5% versus 10.9%, $P = 0.013$) and were the second-born or later child in the family (21.8% versus 13.1%, $P = 0.008$). Adolescents who reported high levels of paternal punishment also experienced high levels of caries (22.8% versus 15.9%, $P = 0.042$). Finally, shorter adolescents had a higher DMFT ($P = 0.009$) (Table 1).

Results of multiple logistic regression are displayed in Table 2. Adolescents who were the second born or later child were 1.90 times more likely to have a high DMFT ($P = 0.008$), whilst being a taller adolescent had a protective effect on caries (OR = 0.04; 95% CI = 0.00–0.79). Adolescents from rural areas (OR = 2.74; 95% CI = 1.56–4.82), those whose mothers had less than 8 years of education (OR = 2.10; 95% CI = 1.03–4.27) and those who reported high levels of paternal punishment (OR = 1.60; 95% CI = 1.02–2.52) had an increased risk of having higher levels of caries (Table 2).

Discussion

Height at 13 years of age was used as a marker of general health resources to test whether early childhood experiences affected adolescents' oral health as measured by dental caries status. Adolescents' DMFT was statistically significantly associated with height. In addition, those living in rural areas, those whose mother had less than 8 years of education, those who were the second or later child in the family and those who reported high levels of paternal punishment were more likely to have a DMFT score higher than 6.

The association found here between height and caries is not a cause–effect relationship. Several factors, indexed by shorter stature, could explain the association between shorter adolescents and high levels of dental caries experience. Height and dental caries has been related to foetal development and growth during pregnancy (4, 12). Factors that result in reduced birth weight, such as poor maternal nutrition and smoking during pregnancy may, therefore, influence individual health resources as they are reflected in height and caries experience. In addition, height and dental caries are related to socioeconomic circumstances along the life course (5, 12, 13). Health-related

behaviours, psychosocial influences, environmental factors and their physiological consequences could thus account for the observed associations. For example, nutritional deficiency during childhood, which is associated with adverse socioeconomic circumstances, delays linear growth as indexed by shorter leg length (5) as well as it affects tooth structure (14–19), saliva secretion rate, buffering capacity and immunological systems (20, 21). Indeed, studies in populations with high levels of nutritional deficiency found that children with low height for their age had significantly greater caries experience (6, 7).

In addition, slow growth and leg length is independently associated with family conflict (22). There is evidence that family life also affects oral health (23, 24). The association between height and dental caries may also reflect exposure to life events in early life, which, through psychosocial processes, affects biological resources (2), i.e. adverse family relationships in childhood may alter the subjects' hormonal and immune systems, which in turn diminish their biological resources (25, 26). The association between paternal levels of punishment and dental caries experience and between height and dental caries experience as demonstrated in this study provides further support to this argument.

The findings of the present study should be considered in relation to its methodological limitations. Although there was incomplete information on 66 subjects and 112 adolescents did not agree to be examined, the findings reported here relate to 77% of the total population of school adolescents in the town of Cianorte, Brazil, a good participation rate. Some measures used in this study may also cause some concern, namely, paternal levels of punishment. A number of studies have assessed the accuracy of recalled information against historical records and demonstrated good levels of agreement (27–29). Furthermore, reliability was assessed re-interviewing 10% of participants within a week interval and results were satisfactory. Finally, it is difficult to compare the results of this study with those of other populations. As the Brazilian growth curve is currently being developed, categorization of adolescents' height could not be done using this standard measure. However, our sample is representative of the adolescents living in Cianorte.

In conclusion, the findings of this study provide further evidence for supporting the hypothesis that early life events may be associated with dental caries experience in this sample of Brazilian adolescents. This suggests that the stock of biological resources that one acquires in childhood may affect dental caries experience in adolescence. This has relevance for policies, especially with respect to those pertaining to childhood development. Hence, it is important to acknowledge that interventions to promote oral health should start in early life rather than later in life.

Acknowledgements

This work was carried out while BN was in receipt of a scholarship from the CAPES (Brazilian Coordination for the Improvement of Higher Education Personnel). We also thank Dr Angela Martins and Ms Claudette Silva for their help in the data collection.

References

1. Kuh D, Ben Shlomo Y. Introduction: a life course approach to the aetiology of adult chronic disease. In: Diana K, Ben-Shlomo Y, editors. The life course approach to chronic disease epidemiology. Oxford: Oxford University Press; 1997. p. 3–14.
2. Kuh D, Power C, Blane D, Bartley M. Social pathways between childhood and adult health. In: Diana K, Ben-Shlomo Y, editors. The life course approach to chronic disease epidemiology. Oxford: Oxford University Press; 1997. p. 169–98.
3. Song YM, Smith GD, Sung J. Adult height and cause-specific mortality: a large prospective study of South Korean men. Am J Epidemiol 2003;158:479–85.
4. Barker DJP. Mother, babies and health in later life. 2nd rev. edn. Edinburgh: Churchill Livingstone; 1998.
5. Gunnell DJ, Davey Smith G, Frankel S, Nanchahal K, Braddon FE, Pemberton J et al. Childhood leg length and adult mortality: follow up of the Carnegie (Boyd Orr) Survey of Diet and Health in Pre-war Britain. J Epidemiol Community Health 1998;52:142–52.
6. Alvarez JO, Caceda J, Woolley TW, Carley KW, Baiocchi N, Caravedo L et al. A longitudinal study of dental caries in the primary teeth of children who suffered from infant malnutrition. J Dent Res 1993;72:1573–76.
7. Li Y, Navia JM, Bian JY. Prevalence and distribution of developmental enamel defects in primary dentition of Chinese children 3–5 years old. Community Dent Oral Epidemiol 1995;2:72–9.
8. Nicolau B, Marcenes W, Sheiham A. The relationship between traumatic dental injuries and adolescents' development along the life course. Community Dent Oral Epidemiol 2003;31:306–13.
9. World Health Organization (WHO). Oral health surveys: basic methods. Geneva: World Health Organization; 1997.
10. Marmot MG, Smith GD, Stansfeld S, Patel C, North F, Head J et al. Health inequalities among British civil

servants: the Whitehall II study. Lancet 1991;337:1387–93.
11. Altman DG. Practical statistics for medical research. 1st edn. London: Chapman and Hall; 1996.
12. Nicolau B, Marcenes W, Bartley M, Sheiham A. A life course approach to assessing causes of dental caries experience: the relationship between biological, behavioural, socio-economic and psychological conditions and caries in adolescents. Caries Res 2003; 37:319–26.
13. Poulton R, Caspi A, Milne BJ, Thomson WM, Taylor A, Sears MR et al. Association between children's experience of socioeconomic disadvantage and adult health: a life-course study. Lancet 2002;360:1640–5.
14. Enwonwu CO. Influence of socio-economic conditions on dental development in Nigerian children. Arch Oral Biol 1973;18:95–107.
15. Sweeney EA, Saffir AJ, De Leon R. Linear hypoplasia of deciduous incisor teeth in malnourished children. Am J Clin Nutr 1971;24:29–31.
16. Sweeney EA, Guzman M. Oral conditions in children from three highland villages in Guatemala. Arch Oral Biol 1966;11:687–98.
17. Seow WK, Brown JP, Tudehope DA, O'Callaghan M. Dental defects in the deciduous dentition of premature infants with low birth weight and neonatal rickets. Pediatr Dent 1984;6:88–92.
18. Seow WK, Humphrys C, Tudehope DI. Increased prevalence of developmental dental defects in low birth-weight prematurely born children: a controlled study. Pediatr Dent 1987;9:221–25.
19. Seow WK. A study of the development of the permanent dentition in very low birth-weight children. Pediatr Dent 1996;18:379–84.
20. Johansson I, Saellstrom AK, Rajan BP, Parameswaran A. Salivary flow and dental caries in Indian children suffering from chronic malnutrition. Caries Res 1992;26:38–43.
21. Johansson I, Lenander-Lumikar M, Saellstrom AK. Saliva composition in Indian children with chronic protein-energy malnutrition. J Dent Res 1994; 73:11–9.
22. Montgomery SM, Bartley MJ, Wilkinson RG. Family conflict and slow growth. Arch Dis Child 1997;77:326–30.
23. Mattila ML, Rautava P, Sillanpaa M, Paunio P. Caries in five-year-old children and associations with family-related factors. J Dent Res 2000;79:875–81.
24. Marcenes WS, Sheiham A. The relationship between marital quality and oral health status. Psychol Health 1996;11:357–69.
25. Sapolsky R. The importance of a well-groomed child. Science 1997;277:1620–21.
26. Heim C, Newport DJ, Heit S, Graham YP, Wilcox M, Bonsall R et al. Pituitary-adrenal and autonomic responses to stress in women after sexual and physical abuse in childhood. JAMA 2000;284: 592–97.
27. Baumgarten M, Siemiatycki J, Gibbs GWB. Validity of work histories obtained by interview for epidemiologic purposes. Am J Epidemiol 1983;118:583–91.
28. Krieger N, Okamoto A, Selby JV. Adult female twins' recall of childhood social class and father's education: a validation study for public health research. Am J Epidemiol 1998;147:704–8.
29. Blaxter M, Paterson E. Mother and daughters: a three generational study of health attitudes and behaviour. London: Heinemann; 1982.