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A life-course approach to assess psychosocial factors and periodontal disease

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Abstract

Background: Several models have been used to suggest the role of psychosocial factors in periodontal disease. None have adopted the life-course approach, which emphasizes the importance of exposures over time and at critical points of a person's life.

Objective: To investigate the relationship between psychosocial factors at two periods of life and periodontal diseases in Brazilian adult females.

Material and Methods: The study design was a cross-sectional survey of 330 women randomly selected from a larger sample of mothers whose children participated in a study on chronic oral disease using a life-course framework. Each woman was clinically assessed for the presence of periodontal disease. An interview collected information on socioeconomic, behavioural and family-related factors at two periods of the participant's life (childhood and adulthood). The main outcome variable was loss of periodontal attachment. Data analysis used logistic regression.

Results: High levels of periodontal disease were predicted by <4 years of education, past and present smoking, high levels of paternal discipline in childhood and low levels of emotional support in adulthood. The influence of childhood factors was not attenuated by adulthood circumstances.

Conclusion: Psychosocial factors in childhood and adulthood were associated with high levels of periodontal disease in adulthood.

Key words: early life; family relationships; life course; periodontal attachment; periodontal disease; psychosocial factors; social support

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Studies have shown that bacteria-induced inflammatory responses, in conjunction with the direct destructive effects of bacteria, can cause most of the tissue destruction seen in periodontal disease (Genco 1992). However, there is growing evidence to show that other factors, such as psychosocial variables (Sheiham & Nicolau 2005), can contribute to periodontal risk and the disease itself. Diseases involving different organ systems and tissues, and different aetiologies are directly linked to common psychosocial factors, which might explain the socially patterned distribution of periodontal and other chronic diseases (Sheiham & Nicolau 2005). Changes in the oral habitat and health behaviours mediate the influence of psychosocial factors on the host's physiological responses to environmental determinants such as stress. For example, adverse psychosocial circumstances, such as low socioeconomic status, depression, social isolation and low levels of social support, are associated with the systemic effect of an elevated level of inflammatory cytokines (interleukin-6, C-reactive protein and tumour necrosis factor-α) (Uchino et al. 1996, Koster et al. 2006, Loucks et al. 2006) and platelet activation (Nemeroff & Musselman 2000), which in turn influence periodontal health.

Two main pathways have been proposed to explain the association between psychosocial variables and periodontal disease. The first is the behavioural pathway, whereby poor health behaviours such as smoking, poor oral hygiene, and a decreased pattern of dental attendance are influenced by psychosocial factors, which in turn modify periodontal disease risk (Genco et al. 1998). For example, depressed people

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are more likely to smoke and have physically sedentary lifestyles than non-depressed individuals (Wardle et al. 1999). Likewise, low socioeconomic status is associated with smoking, poor oral hygiene and reduced visits to dentists (Sheiham & Nicolau 2005). The second pathway is psychophysiological, and involves a more direct contribution of biological dysfunctions relevant to periodontal disease (Genco et al. 1998). The strongest evidence supporting this psychophysiological mechanism comes from non-human primate studies. Social stress related to social hierarchies in monkeys lead to an array of endocrine, neural and immune changes (Sapolsky 1997), all known to influence periodontal disease. The effects on the hypothalamic–pituitary–adrenal- (HPA) axis may account for part of the degenerative effects of the psychophysiological mechanism in humans. The HPA-axis acts via the interaction of hormones and chemical mediators, leading to the production of more cortisol and other related glucocorticoids (Genco et al. 1998). These hormones further induce the production of pro-inflammatory cytokine secretions (interleukins, prostaglandins, and tumour necrosis factor), known contributors to the development of periodontal disease. Similarly, catecholamines (epinephrine and norepinephrine) stimulate the formation and activation of prostaglandins and proteolytic enzymes, which can indirectly cause periodontal tissue destruction (Genco et al. 1998).

Both the psychophysiological and behavioural pathways described above are influenced by early life experiences (Coe 1999, Kuh & Ben-Shlomo 2004). The importance of the psychophysiological pathway can be illustrated by studies showing that stressful early life experiences may impact on the HPA-axis response and negatively influence health outcomes in later life. For example, women who experienced high levels of stress in infancy and childhood exhibited a more pronounced HPA-axis response evidenced by higher adrenocorticotropin and cortisol responses compared with those not experiencing such stressors early in life (Heim et al. 2000). In addition, exposures to stress hormones during sensitive periods of immune system maturation in early infancy can alter immune function, leading to increased susceptibility to infectious or inflammatory diseases later in life (Coe 1999).

The influence of the early psychosocial environment, such as family environment, on health behaviours has also been demonstrated (Glendinning et al. 1997, Chassin et al. 1998, Stansfeld 1999). Family conflict may lead to a pattern of anxious emotional attachment or dissociation from emotional attachment. This, in turn, may lead to unhealthy behaviours (e.g., excessive eating, smoking), which act partially as a substitute for a satisfactory emotional relationship (Stansfeld 1999). Indeed, there is strong evidence that people who experience family conflict or dissention in childhood and adolescence are more likely to smoke, use alcohol and to eat less fruits and vegetables in adulthood.

To date, most studies on the relationship between periodontal disease and psychosocial factors focus mainly on current risk factors and rely on a limited number of markers of social and psychological circumstances ignoring the effects of a poor psychosocial environment in early life. The latter have an important influence on both the behavioural and pathophysiological mechanisms of adult health. Therefore, a study was conducted to study the life-course influences on periodontal health outcomes. The hypothesis of this study is that adverse psychosocial environments in childhood and adulthood will modulate both the periodontal inflammatory response and health behaviours leading to increased severity of periodontal disease in adult women.

Material and Methods

Sample

This study uses data from the second part of a two-phase cross-sectional survey that was set up to investigate the aetiology of chronic oral disease using the life-course framework. The first phase involved all 13-year-old children who attended private and public primary schools in Cianorte, Brazil in 1999; 764 eligible children were invited to participate and 652 (85.3%) agreed. In the second phase, 330 of the 652 adolescents' families were randomly selected using numbered cards. The selection was restricted by two conditions: (1) at least one of the parents should be a biological parent and (2) for reasons of logistics and to avoid heterogeneity, families must be living in urban areas of Cianorte. Five-hundred and forty one families fulfilled these criteria and 330 mothers were selected from them. Three-hundred and five (94%) of the invited mothers participated in this study. The sample size calculations, performed in the first phase, were based on adolescent outcomes. For the present study, post hoc power calculations were carried out using the smallest of the significant unadjusted odds ratio (OR) (1.89 for childhood discipline) and found the power to be 0.72.

All participants gave personal consent. Ethical clearance was obtained from the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES). Confidentiality was assured in a letter to participants and all recording forms were anonymized.

Instruments and methods

Data included those from a structured interview and from clinical oral examination of the participants. All the dental examinations and interviews were carried out in the participants' houses by a trained dental epidemiologist (B. N.) assisted by a dental nurse.

Mothers were examined for the presence and absence of plaque, calculus, bleeding gums on probing, pocket depth and loss of attachment. Because the clinical examinations were conducted in the participants' residences, the exact arrangement of the clinical examination area was determined by the physical condition of the house. As much as possible, examinations were standardized as follows: (i) the dental examinations took place in a room next to a window; (ii) an adjustable chair was used so that all participants were examined seated in the same position; and (iii) a headlamp was used to standardize the source of light. Gauze squares, cotton buds, sterile sets of plane mouth mirrors, #23 explorers and community periodontal index (CPI) probes were packed in sufficient quantities for each working day. The criteria and methods for the dental examination were based on the WHO criteria (World Health Organization 1997). Dental plaque was recorded as present or absent while loss of attachment was measured in millimetres using a periodontal probe. All tooth surfaces were examined and recorded as a score per tooth.

The interview collected information on sociodemographic factors (participant's (adolescents' mother) education levels, family income, participant's

parents' education level), family-related factors (participant's relationship with parents during childhood, marital status, and social support in adulthood) and behavioural and attitudinal variables such as oral health behaviours (dietary habits, use of fluoride, oral hygiene practice, and pattern of dental attendance).

Family income in adult life was calculated by adding up the monthly wages of all economically active members of the family and dividing the sum by the current Brazilian minimum wage (1BMW = US$75/month). Participants' level of education was measured by number of years of formal education. This variable was categorized as ''low'' or ''high'', depending on whether they had less than or more than 4 years of formal education, respectively. Participant–parent relationships were measured using six questions derived from the Whitehall Study II (Marmot et al. 1991). These questions were characterized responses to four Likert-type items, which are rated on a four-point scale ranging from ''very much'' to ''none''. Two dimensions of family relationships were identified: mothers' and fathers' level of support and mothers' and fathers' levels of discipline reported by the participants. Both mothers' and fathers' levels of support were calculated by summing the scores on questions for trust, love, attention, and understanding. Level of discipline by fathers and mothers was estimated by adding the scores of questions on strictness and punishment. The variables were grouped using the principal component analysis. Social support in adulthood was measured using the question ''Is there someone in particular in your life that you think would listen to you and give you emotional support if you needed it?'' The question is derived from the 1946 British birth cohort.

A pilot study was carried out on 20 families to test the feasibility of the study, dental examination and the interview procedures. The questionnaire was also piloted and proven to be applicable to a Brazilian population. Ten per cent of the sample ($N = 25$) was re-examined and re-interviewed to test for reliability during the fieldwork.

Data analysis

Data analysis was carried out using the Statistical Package for Social Science version 13.0. The outcome, periodontal disease, was measured by the proportion of the number of teeth present with loss of attachment. The variable was further categorized into two levels of severity (low $\leqslant 0.419$; high > 0.420) using the mean as a cut-off point. Initial data analysis explored univariate relationships between periodontal disease (low $\leqslant 0.419$; high > 0.420) and social and psychological factors in childhood and adulthood. Multiple logistic regression analysis was used to identify potential correlates of periodontal health. The models were built following a conceptual and temporal sequence of variables, that is, variables were entered in groups representing socioeconomic and psychological variables in childhood, followed by behavioural variables and then by socioeconomic and psychological variables in adulthood. Although we had more than one socioeconomic indicator in adulthood, we used only participants' education level. Similarly, although we have questions addressing oral hygiene practices, we used the presence or absence of plaque assessed clinically as an indicator of oral hygiene practices. The choice of levels of plaque as a proxy measure of oral hygiene practice was based on the fitness of the models. Plaque levels were measured by the proportion of the number of teeth with plaque. The variable was further categorized into low and high levels of plaque using the mean as a cut-off point. Statistical significance was set at 5%. The variables were tested for two-way interaction. The fit of the final model was assessed using the Hosmer and Lemeshow test (Hosmer & Lemeshow 1989). The best value for this test is 1.

Results

Three-hundred and eleven of 330 eligible mothers (94%) agreed to participate and 305 mothers were available for the study. Because 54 of these participants were edentulous, the sample was based on 251 subjects. However, due to missing information, 27 additional subjects had to be excluded from the final data analysis. The final sample size represented 68% of the total population of mothers of 13-year-old school adolescents living in urban areas of Cianorte. Intra-examiner agreement for periodontal health indicators was good. κ values were > 0.67. Intra-interviewer reliability was also satisfactory as demonstrated by intra-class correlation scores ranging from 0.73 to 1.

Most participants were from low-income families and had low levels of education (Table 1). The results of univariate analysis showed that the prevalence of high levels of loss of attachment varied by socioeconomic status, family relationships in childhood, oral hygiene practices, smoking habits, and social support in adulthood. Those participants with higher levels of loss of attachment were those whose fathers had 4 or less years of formal education, those who reported high levels of paternal discipline in childhood and those who had high levels of dental plaque. In addition, older participants who were smokers or had smoked in the past and those who reported lack of emotional support in adulthood had higher levels of periodontal attachment loss (Table 1). Socioeconomic variables in adulthood were not significantly related to periodontal attachment loss.

The final models of the relationship between life-course variables and loss of attachment are displayed in Table 2. Participants who were from low socioeconomic backgrounds in childhood (measured by father's education) [OR = 3.74 (1.28–10.8)] and those who reported high levels of paternal discipline in childhood [OR = 2.15 (1.10–4.19)] were more likely to have loss of periodontal attachment. In addition, those who were past smokers [OR = 2.60 (1.16–5.85)], current smokers [OR = 2.17 (0.96–4.88)] and those who had high levels of dental plaque [OR = 4.13 (2.04–8.33)] were more likely to experience high levels of periodontal attachment loss and so did those who reported no emotional support in adulthood [OR = 3.74 (1.16–12.0)]. The final model showed a good fit (Hosmer & Lemeshow test, $p = 0.89$).

Discussion

Social and psychological environments, in both childhood and adulthood, were related to the severity of periodontal disease. Fathers' levels of education and self-reported paternal levels of discipline in childhood were statistically significantly associated with high levels of loss of periodontal attachment. In addition, those who reported lack of emotional support in adulthood, those who were past smokers and those who had high levels of dental plaque had

Table 1. Prevalence of periodontal disease, by socio-demographic and economic indicators, family-related variables oral health behaviours, in a sample of Brazilian females ($N = 311$)

Variables	Loss of attachment level	
	low *N* (%)	high *N* (%)
Childhood variables		
Father's education level		
Up to 4 years	134 (83)	83 (93)
More than 4 years	27 (17)	6 (7)
Paternal levels of discipline in childhood		
Low	59 (41)	23 (27)
High	84 (59)	62 (73)
Paternal levels of support in childhood		
Low	65 (47)	39 (46)
High	74 (53)	45 (54)
Maternal levels of discipline in childhood		
Low	47 (31)	29 (33)
High	103 (69)	59 (67)
Maternal levels of support in childhood		
High	64 (43)	37 (42)
Low	83 (57)	51 (58)
Behaviour variables		
Plaque levels*		
Low	87 (54)	18 (20)
High	74 (46)	72 (80)
Smoking		
Never	116 (72)	44 (49)
Past	23 (14)	22 (24)
Current	22 (14)	24 (27)
Adulthood variables		
Participants' level education		
More than 4 years of education	92 (58)	47 (52)
Up to 4 years of education	68 (42)	43 (48)
Family income		
Low	92 (58)	60 (67)
High	67 (42)	29 (33)
Emotional support in adulthood		
Yes	151 (94)	74 (82)
No	9 (6)	16 (18)
Age	$X = 39.01$	$X = 40.51$
	SD = 4.7	SD = 5.3

*Proxy measure of oral hygiene practices.
SD, standard deviation.

an increased risk of experiencing high levels of periodontal attachment loss. The influence of childhood factors was independent of adulthood circumstances.

Although there is no comparable dental research, the results from this study are compatible with the general life-course epidemiological findings and can be interpreted in terms of both critical periods and accumulation of adverse factors over the life-course. Studies using the critical period model claim that psychological stress during critical periods of development, that is, periods in the life span when the immune system is undergoing developmental change, may alter the set point of the stress response system (Coe & Lubach 2003). This, in turn, will make people more vulnerable to the effects of stress, increasing their risk for stress-related diseases later in life. The vulnerability to stress may be mediated through persistent hyperactivity and/or sensitization of central nervous corticotropin-releasing factor neuronal systems (Coe & Lubach 2003). The argument is that the immune system, when disrupted at a very early and malleable point, affects the maturational processes. Because hormone and immune changes persist over time, and also alter reactivity, there is a shift in physiological set points (Coe & Lubach 2003). Our findings that social and psychosocial adversities in childhood, represented here by paternal levels of discipline and paternal levels of education, support such a mechanism. In this study, women reporting high levels of paternal discipline when young and those whose father had <4 years of education had more periodontal diseases. The similarity of our results to findings from studies that examined the effects of childhood stress and altered physiological response later in life suggests that the mechanism outlined above is of importance. For example, Heim et al. (2000) demonstrated a marked increase in pituitary–adrenal and autonomic reactivity to psychosocial laboratory stress in adult women with a personal history of childhood sexual or physical abuse.

Along the same lines, it can be suggested that exposures to low socioeconomic status and stressful family relationships along the life-course – represented here by father's levels of education, paternal levels of discipline in childhood and lack of social support in adulthood – led to a cumulative damage to the biological systems leading to more periodontal disease. This hypothesis is based on the concept of allostatic load developed by McEwen (2001). Allostasis has been defined as ''the ability of the body to achieve stability through change, such that the autonomic nervous system, the hypothalamic-pituitary-adrenal axis, and cardiovascular, metabolic, and immune systems protect the body by responding to internal and external stress'' (McEwen 2001). The long-term consequences of the chronic accommodation to stress can be an ''allostastic load'', which is ''the wear and tear from chronic overactivity and underactivity of the allotastic system'' (McEwen 2001). In other words, concomitant to the increase of the number and/or duration of stressful exposures, there is a cumulative damage to biological systems (Ben-Shlomo & Kuh 2002).

Another hypothesis that also needs to be examined is the behavioural/lifestyle hypothesis. Adjusted results from this study showed that smoking and oral hygiene habits were significantly associated with loss of periodontal attachment. These results are in accordance with a plethora of evidence showing that cigarette smoking and oral hygiene habits are associated with periodontal disease (Bergstrom et al. 2000, Pihlstrom et al. 2005). Our results confirm these findings. From a life-course perspective, it may be hypothesized that adverse social and psychosocial environments throughout the life span may compromise individual behavioural capital, in turn influencing health-related

Table 2. Logistic regression of the association between life-course variables and loss of periodontal attachment in a sample of Brazilian females ($N = 224$)

Variables	Unadjusted OR 95.0% CI	Adjusted OR 95.0% CI*	Adjusted OR 95.0% CI†	Adjusted OR 95.0% CI‡
Participants' fathers' level of education				
More than 4 years of education	1	1	1	1
Up to 4 years of education	2.78 (1.10–7.03)	1.89 (1.05–3.41)	1.90 (1.01–3.60)	3.74 (1.28–10.8)
Paternal levels of discipline in childhood				
Low	1	1	1	1
High	1.89 (1.05–3.39)	2.56 (0.99–6.62)	3.12 (1.14–8.49)	2.15 (1.10–4.19)
Smoking				
Never	1		1	1
Past	2.52 (1.27–4.97)		2.49 (1.16–5.36)	2.60 (1.16–5.85)
Current	2.87 (1.46–5.64)		2.31 (1.07–5.01)	2.17 (0.96–4.88)
Plaque levels				
Low	1		1	1
High	4.70 (2.57–8.58)		4.12 (2.14–7.93)	4.13 (2.04–8.33)
Emotional support adulthood				
Yes	1			1
No	3.62 (1.53–8.59)			3.74 (1.16–12.0)
Participants' level of education				
More than 4 years of education	1			1
Up to 4 years of education	1.23 (0.73–2.08)			1.20 (0.63–2.27)
Age	1.06 (1.00–1.11)			1.09 (1.02–1.16)

Model fitness: Hosmer & Lemeshow test, $p = 0.89$.
*First group of variables representing social and psychological circumstances in childhood.
†Second group of variables representing behaviour.
‡Third group of variables representing social and psychological circumstances in adulthood.
CI, confidence interval; OR, odds ratio.

Table 3. Association between participants' levels of education and fathers' level of education

	Fathers' levels of education	
	up to 4 years of education *N* (%)	more than 4 years of education *N* (%)
Participants' level education		
Up to 4 years of education	117 (46)	16 (46)
More than 4 years of education	140 (54)	19 (54)

behaviours and periodontal health. Behavioural capital has been defined by Schooling & Kuh (2002) as ''the accumulation of positive individual attributes'' that could affect educational aspirations as well as the development of health behaviours such as smoking). Indeed, there is evidence showing a relationship between social and psychological environments at different periods of life and health-related behaviours.

The similarity of our findings to those on other chronic diseases that tested the life-course approach suggests that the pathways outlined above are also important for periodontal disease. Studies have shown that family dissension and conflict is associated with low school achievement and poor health behaviours and poor health (Lundberg 1993, Sweeting & West 1995, Sweeting et al. 1998, Nicolau et al. 2003). Moreover, risky health behaviours, such as smoking and heavy drinking, tend to aggregate in non-nuclear families, those who reported conflict and those from low socioeconomic backgrounds (Sheiham & Nicolau 2005). Periodontal disease is more common in subjects from low socioeconomic backgrounds, those with low levels of education and those adolescents whose parents reported low levels of marital quality (Marcenes & Sheiham 1992, Sheiham & Nicolau 2005). In this study, however, we did not find a statistically significant association between socioeconomic circumstances in adulthood and periodontal disease. This may be due to social mobility. There was a large proportion of the sample that moved up the social scale (Table 3). Thus, it is reasonable to assume that adverse family and socioeconomic environments reduces the chances of having good individual social resources, which in turn may lead to the development of poor health behaviours and may consequently increase the chances of having high levels of periodontal disease.

The findings of the present study should be considered in relation to some methodological limitations. Although 17% of the sample was edentulous, there was incomplete information on 27 subjects and 6 mothers were not available for the study, the findings reported here relate to 68% of the total population of mothers of adolescents living in urban areas of a city. In addition, we did not ask why the mothers had their teeth extracted. It may be argued that mothers who were edentulous may be those who had already experienced the greatest accumulation of risk factors across their life-course. That is, periodontal disease in this group would already manifest itself in tooth loss. In order to test this hypothesis, we repeated our analyses including edentulous mothers in the same category as those presenting high levels of periodontal diseases. There were negligible changes in the results by performing this analysis. However, because we did not have the information on the reasons for the tooth loss, it was decided to present the results only for mothers who were dentate.

A second point of concern when analysing the results is the study design. This is a cross-sectional study and thus a

temporal relationship between the variables cannot be established. Retrospective studies have a potential for recall bias and misclassification of exposure. For example, even with events of considerably high impact such as those during 9/11, subjects interviewed 7 weeks later tended to recall and reconstruct the event incorrectly (Pezdek 2003). Although an accurate memory would be of great help to life-course research, for people memory helps them to live their lives and that they often reconstruct to suit specific contexts (Ross & Beuhler 2004). They may give a less accurate time sequence of exposure and outcome events, and be subject to recall bias. Therefore, they are prone to measurement errors as well as being limited in their ability to test accumulation models and interactions between early-and later-life exposures.

These concerns about recall bias led to the development of the life-grid method to collect more accurate retrospective data (Blane 1996). This technique was being tested when data for the current research were collected. Despite these deficiencies, cross-sectional studies are able to generate important hypotheses that can be confirmed by longitudinal studies. There are a few cohort studies in which dental data are being collected prospectively (Poulton et al. 2002, Thomson et al. 2004, Peres et al. 2007). Our study was based on self-reported data collected retrospectively, thus the information collected cannot be validated. However, the reliability of the questionnaire was satisfactory as demonstrated by correlation scores above 0.73. In addition, a number of studies have assessed the accuracy of recalled information against historical records and demonstrated good levels of agreement (Baumgarten et al. 1983, Krieger et al. 1998).

In conclusion, the findings support the hypothesis that events early in life may be associated with periodontal disease in Brazilian women. While the effects of life-course experiences on periodontal disease risk require further elucidation, our findings suggest that policies to redress social and psychological adversity in childhood may have the potential to improve periodontal disease risk in adult life.

Further studies, particularly longitudinal studies, are necessary to confirm our findings. In addition, studies in populations with different social conditions and different levels of access to preventive measures are required to elucidate whether the same pattern occurs in other countries. The results of this study may be used as a guide to decide on important measurements to include in longitudinal studies collecting dental data.

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Clinical Relevance

Scientific rationale for the study: There is a growing body of evidence suggesting that social and psychological exposures along an individual's life course influence the aetiology of chronic diseases. Although several models have suggested the role of psychosocial factors in periodontal disease, none have adopted the life-course approach, which incorporates the important concepts of risk accumulation over time, and the critical period of exposures.

Principal findings: Positive associations between periodontal loss of attachment and psychosocial factors in two periods of life – childhood and adulthood.

Practical implications: Our findings support the hypothesis that events early in life are associated with periodontal disease risk in adulthood. While the effects of life-course experiences on periodontal disease risk require further elucidation, our findings suggest that policies to redress social and psychological adversity in childhood may have the potential to improve periodontal disease risk in adult life. In addition, the results of this study may be used as a guide to which important measurements to include in longitudinal studies in which dental data are being collected.