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Skin colour is associated with periodontal disease in Brazilian adults: a population-based oral health survey

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Abstract

Aim: To estimate the prevalence of periodontal disease in Brazilian adults and to test its association with skin colour after controlling for socio-demographic variables.

Methods: The periodontal status of 11,342 Brazilian adults was informed by a nationwide oral health survey. Socio-demographic variables included skin colour, gender, schooling, per capita income, age and geographical region. The association between periodontal disease and skin colour was tested by a logistic regression model, adjusting for covariates. Interactions between skin colour and socio-demographic variables were tested.

Results: The prevalence of periodontal diseases was 9.0% [95% confidence interval (CI) 7.6–10.3]. Lighter-skinned black people (*pardos*) and dark-skinned black people (*pretos*) presented higher levels of periodontal disease when compared with white people [odds ratio (OR) = 1.5; 95% CI 1.2; 1.8; OR = 1.6; 95% CI 1.2; 2.1, respectively] even after controlling for age, gender, schooling, per capita income and geographic region. No interactions were statistically significant.

Conclusion: Skin colour was significantly associated with periodontal disease among Brazilian adults after adjustment for socio-economic and demographic covariates.

Key words: Brazil; epidemiology; inequalities in health; periodontitis; skin colour; socioeconomic factors

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Social inequalities in health are described as resulting from a complex inter-play of biological and social standings. Genetic constitution disposition, culture, environment and behaviour, as well as the provision, quality and effective use of health services interact to produce unequal experience of disease among social strata. Interest in and concern on health differentials related to income, prestige and education have continually increased both in developed and developing countries (Bartley 2004).

The association between skin colour and health outcomes is a core issue of investigation on inequalities in health. However, the focus of research exploring health differentials among ethnic/skin colour groups mostly refers to genetic and biological standards or cultural patterns. On account of underestimating the socio-economic insertion of skin colour or ethnic groups, many studies do not assess it on a broader social scale, thus re-inforcing the belief that ethnic or skin colour disparities in health are mainly determined by biological or individual characteristics of subjects (Lillie-Blanton & Laveist 1996).

The pathway leading to skin colour inequalities in health relies on the social structure. Brazilian figures of skin colour disparities certainly contribute to explain huge differences in the distribution of the burden of disease in the country. Brazil presents a large proportion of black people, with almost 80 million inhabitants of African descent among 180 million inhabitants of the whole Brazilian population (IPEA 2002). In addition, Brazil presents an extremely skewed income distribution, which consequently shows one of the highest Gini coefficients in the world (United Nations Development Programme 2003). This measurement gauges the concentration

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of different variables distribution as per capita income.

Black people suffer poorer working conditions in Brazil; the average salary of black males ranks approximately 30% lower than their white counterparts (IBGE 2002), and the likelihood of poverty is higher for black people (48%) than for white people (22%; IPEA 2002). With regard to educational attainment, illiteracy affects 7.7% of white people and 18.7% of black adults, while the average number of years of study ranks near 6 for white people and 3.5 for black people. Health research also reported avoidable mortality as being higher for black people than for white people (Chor & Lima 2005). Several authors attribute this problem to the unequal socio-economic status of skin colour groups, while others consider the contribution of racial-based prejudice to explain such differences (IPEA 2002).

Dark-skinned black people were shown to present significantly higher rates of hypertension and stroke mortality than lighter-skinned black cohorts. A sociological argument explains that hypertension is linked to stress, and dark-skinned black people may have higher rates of hypertension on account of their more stressful experience of racial discrimination than their lighter-skinned cohorts (Davey Smith et al. 1998, Davey Smith et al. 2000, Klonoff & Landrine 2002).

Periodontal diseases comprise infection, and many forms of the disease are associated with specific pathogenic bacteria, which colonize the subgingival area. Initiation and progression of periodontal infection are clearly modified by local and systemic risk factors. The local risk factors include pre-existing disease as evidenced by deep probing depths and plaque retention areas associated with defective restorations (Genco 1996). Well-established risk factors also include smoking and poorly controlled diabetes (Tonetti & Claffey 2005). Some other putative risk factors for periodontal disease were proposed, such as gene polymorphisms, age, socio-economic status, gender, psychosocial factors, obesity, osteoporosis/osteopenia and race/ethnicity (Tonetti & Claffey 2005). Stress and coping behaviours are also potentially important periodontal risk indicators (Genco 1996).

Prolonged negative events may disturb the optimal functioning of the host's defence. Consequently, individuals experiencing stress have the potential to develop chronic diseases. Periodontal diseases fit into the framework of such a disease where suboptimal host defence to microbiological insults results in the loss of periodontal attachment. Stress may activate several neuroendocrine systems, including the hypothalamic–pituitary–adrenal axis and the sympathetic nervous system. This leads to a reduced potential of host defence or an effect on the development of the disease through lifestyles such as smoking or poor oral hygiene (Aleksejuienè et al. 2002).

A relative small subset of population in the US, Central and South America, Europe, Africa, Asia and Oceania exhibit severe forms of periodontal diseases (Albandar & Rams 2002). Within Latin American countries, Argentina and Chile showed a higher prevalence of destructive periodontal disease in middle-aged individuals ($>30\%$), Uruguay and El Salvador showed an intermediate prevalence (between 10% and 29%) and Brazil presented a low prevalence ($<10\%$) in the same age group (Gjermo et al. 2002). When European countries are considered as a whole, the prevalence of severe periodontal diseases in adults aged 35–44 is low (14%), ranging from 2% in UK to 31% in Belarus (Sheiham & Netuveli 2002).

Large epidemiological studies addressing inequalities in periodontal health in individuals with differences in skin colour showed that black adults present a higher prevalence of periodontal disease than white adults (Albandar et al. 1999, Borrel et al. 2005). As periodontal disease shares common determinants with hypertension and chronic diseases, such as smoking and stress, skin colour is hypothesized to influence the experience of periodontitis, regardless of other socio-economic conditions.

The aim of the current study was to assess the prevalence of periodontal disease in Brazilian dentate adults according to skin colour groups after controlling for socio-economic and demographic variables.

Methods

The present study resulted from the assessment of data primarily gathered by a nationwide epidemiological survey performed by the Brazilian health authority. Further methodological information is available in the original report of the survey (SB 2000 2004).

From May 2002 to October 2003, official agencies of the Brazilian health authority performed a major epidemiological survey of oral health including examinations of individuals from different age ranges. The studied sample of the 2002–2003 Brazilian Oral Health Survey included pre-school children, children aged 12, adolescents aged 15–19, adults aged 35–44 and elderly people aged 65–74. The total number of individuals involved was 108,921.

When the survey data were made available for public consultation by sponsoring institutions, we reviewed all oral examination records, for a total of 13,431 male and female adults aged 35–44 years.

The multi-stage sampling design consisted of a random selection of 250 towns according to population size and their insertion in Brazilian states and regions, with census tracts and their households as the unit of analysis for adults. Brazil has five geographical regions namely the Southeast, the South, the North, the Northeast and the Centre-West. In each state of the Brazilian federation, instructors with previous experience in oral health surveys, following the World Health Organization diagnostic criteria (WHO 1997), directed the training and calibration of nearly 900 dentists and 1200 assistants and clerks. Oral examinations were performed at home under natural illumination, using periodontal community periodontal index (CPI) probes (Trinity®, Campo Mourão, Paraná, Brazil) and wooden spatulas for better visualization.

The original report (SB 2000 2004) of the survey presented comprehensive information on data reliability, i.e. the assessment of κ statistics for the inter- and intra-observer agreement of all dental conditions. κ statistics were calculated based on categories of periodontal pocket and clinical attachment loss (CAL). Each regional coordinator trained 25 calibrators with previous experience in epidemiological studies. Each calibrator, in turn, was responsible for the training of examiners for two towns. Approximately 5% of the exams were carried out in duplicate in order to measure intra-observer reliability; for the assessment of periodontal condition, the lowest κ value observed was 0.7, which indicates an adequate intra-observer agreement.

Clinical Examinations

The assessment of the CPI and the CAL used criteria standardized by the World Health Organization (WHO 1997).

Periodontal examinations were carried out by sextants according to the CPI index. Six sites per tooth were assessed (mesiobuccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mediolingual sites) by using the periodontal probe to measure CAL and pocket depth (PD). CAL was defined as the distance (in millimetres) from the cement–enamel junction to the base of the pocket sulcus. PD was defined as the distance from the free gingival margin to the base of the pocket/sulcus. Periodontal disease was defined as a combination between the occurrence of at least one site presenting a periodontal pocket equal to or deeper than 4 mm and at least one site with CAL of equal to or more than 4 mm. Although the definition of the outcome is essential in all epidemiologic studies, the international periodontal literature has been plagued by a plethora of case definitions of periodontal disease (Borrell & Papapanou 2005, Tonetti & Claffey 2005). In conformity with many researchers mentioned in a comprehensive literature review carried out by Borrell & Papapanou (2005), we used a combination of depth of periodontal pocket and CAL for the present periodontal disease definition.

Explanatory Variables

In addition to the oral examination, an interview allowed for the gathering of participants' socio-demographic information: gender, age, geographical region, monthly family income and schooling (referring to the number of years of study). For analytical purposes, covariates assessing socio-demographic characteristics were categorized. Schooling compared individuals according to their completed years of study as follows: $\geqslant$12 years, 9–11 years, 5–8 years and $\leqslant$4 years. Information on income and the number of inhabitants per household allowed for identification of the per capita household income, which was categorized according to quartiles of the frequency distribution in Reais (Brazilian currency). One US$ is worth 2.20 Reais (exchange rate for August 2006).

Adults also informed their skin colour according to the Brazilian census categories: dark-skinned black people (*Pretos*), lighter-skinned black people (*Pardos*), and white people. The sample also included 510 participants of yellow skin colour (Asian descent) and Amerindian descent, who were not appraised in the current study. The sample did not include any other ethnic groups. As Brazilian regions present socio-economic contrasts, this was used as a control variable.

Exclusion Criteria

For the purpose of this study, all edentulous adults (9.1%) were excluded.

Data entry and statistical analysis

Statistical analysis was performed with STATA 9.0. The socio-demographic characteristics and periodontal status of subjects were described in terms of their distribution in the previously defined strata or according to their measures of central tendency and dispersion. The prevalence of periodontal disease was compared among socio-demographic groups using 95% confidence intervals (CIs). To assess the role of confounding from socio-demographic covariates, we used unconditional logistic regression analysis to estimate adjusted odds ratios (OR), 95% CIs, and Wald' tests for statistical significance (p-values). Interactions between skin colour and gender, age, schooling, per capita income and geographical region were tested by the Wald tests for heterogeneity. All analyses were adjusted for the clustered sampling design.

Ethical issues

The project was submitted to and approved by the National Committee for Ethics in Research, approval document No. 581/2000, 21 July, 2000. A consent form was distributed to all individuals and only those who returned it properly signed participated in the study.

Results

We analysed complete data from 11,342 Brazilian adults. The sample consisted of 46.2% white people, with an average age of 39; 66.3% of the sample was females and 40.1% of the studied population had 4 or less years of study, with a mean per capita income of 317.83 Reais (US$ 144.5). The prevalence of periodontal disease was 9.0% (95% CI 7.6; 10.3; Table 1).

Periodontal disease was significantly more prevalent in lighter-skinned black people (*pardos*) and dark-skinned black people (*pretos*), males, older adults, those receiving a lower per capita income and those who had not completed fundamental schooling (Table 2).

Table 3 shows the crude and multivariable logistic regression analyses for the association between periodontal disease and socio-demographic covariates. In the crude analyses, all variables strongly associated with periodontal diseases. Lighter-skinned black people (*pardos*) and dark-skinned black people (*pretos*) showed a higher OR than white people (OR = 1.4 and 1.7, respectively). After adjustment for confounders, skin colour remained associated with periodontal disease. In comparison with white people, lighter-skinned black people (*pardos*) presented a 50% higher likelihood of presenting periodontal disease, while dark-skinned black people (*pretos*) had a 59% higher likelihood.

Interactions between skin colour and gender ($p = 0.98$), skin colour and age

Table 1. Socio-demographic characteristics and periodontal status of 35–44-year-old Brazilians

Variables	*N*	%	Mean (SD)	Percentiles		
				25th	median	75th
Skin colour						
White	5245	46.2				
Lighter-skinned black people	4998	44.1				
Dark-skinned black people	1099	9.7				
Gender						
Females	7538	66.3				
Males	3834	33.7				
Periodontal disease						
Absent	10,354	91.0				
Prevalent	1018	9.0				
Age			39.0 (3.1)	36.0	39.0	42.0
Schooling level (years)			6.5 (4.28)	4.0	6.0	10.0
Per capita income (Reais)			317.8 (1719.7)	50.0	100.0	200.0

Brazil, 2002–2003 ($n = 11,342$).
Excluded missing values.
SD, standard deviation; Reais, Brazilian currency.

($p = 0.43$), skin colour and schooling ($p = 0.90$), skin colour and per capita income ($p = 0.92$) and skin colour and geographic region ($p = 0.97$) were tested and showed no statistical significance.

Table 2. Prevalence of periodontal disease according to socio-demographic characteristics of 35–44-year-old Brazilians

Variables	Prevalence (%)	95% confidence interval
Skin colour		
White	7.2	5.7;8.8
Lighter-skinned black people	10.1	8.4;11.9
Dark-skinned black people	11.8	8.8;14.9
Gender		
Female	7.9	6.6;9.2
Males	11.1	9.3;12.9
Age(years)		
35–39	7.8	6.5;9.1
40–44	10.5	8.9;12.1
Schooling level (years)		
⩾12	5.1	3.6;6.5
9–11	7.1	5.7;8.6
5–8	9.5	7.7;11.3
⩽4	10.5	8.8;12.2
Per capita income (Reais)		
⩾200	6.0	4.6;7.4
101–199	8.5	6.8;10.2
51–100	10.6	8.7;12.6
⩽50	10.8	8.8-12.8

Brazil, 2002–2003 ($n = 11,342$).
95% confidence intervals adjusted for the clustered sampling design.

Discussion

The current study assessed skin colour inequalities in the prevalence of periodontal disease in the Brazilian adult population. The overall prevalence of periodontal disease in Brazilian adults was 9.0% (Table 1), a lower figure than previously reported by Gjermo et al. (2002), in their review of epidemiological studies on periodontitis among middle-aged subjects carried out in Latin American countries during the 1990s. On the other hand, Borrell et al. (2004, 2005) found a much lower prevalence when examining US epidemiological data from the third National Health and Nutrition Examination Survey (NHANES III). The explanation for these discrepancies entails different diagnostic criteria and samples referring to different age and gender groups. Examinations were carried out observing the CPI methodological criteria, which is the tendency in most Latin American studies (Gjermo et al. 2002). This condition hinders comparisons because solely the worse situation found in each sextant is registered, and the presence of calculus masks signs of inflammation, such as the prevalence of bleeding. The presence of periodontal pockets also underestimates the register of calculus. As a result, as regards comparative studies, recordings of prevalence should be made and reported separately for later inclusion in the standards of the respective indices.

We defined periodontal disease as the presence of deep periodontal pockets and CAL in any sextant of the mouth. Measuring the loss of periodontal attachment is a valuable assessment for the severity of periodontal tissue loss and may be indicative of previous experience of destructive disease. On the other hand, probing periodontal pockets provides information about the current state of periodontal tissue, thus indicating the presence of local chronic inflammation (Susin et al. 2005).

The studied population presented a high mean DMFT (20.13), with the missing component representing 65.7% of the index (mean of 13.2). Black people (*pardos* and *pretos*) showed a 15% higher prevalence of 12 or more missing teeth than did white people (SB 2000 2004). The impact of tooth loss on our results is difficult to appraise. Adults with high levels of missing teeth may present a lower risk of developing periodontal disease. On the other hand, missing teeth may have been lost due to periodontal disease.

The inclusion criteria for the current assessment followed the adult age range indicated by the WHO's guidelines for oral health surveys (WHO 1997), i.e. from 35 to 44 years of age.

The adjusted regression model indicated that the odds of periodontal disease remained significantly higher for dark-skinned black people (*pretos*) and lighter-skinned black people (*pardos)* than for white people, even after controlling for age, gender, schooling, income and geographical region. One hypothetical reason for the persistence of skin colour differences that remained after adjustment for socio-economic status is that commonly used indicators do not fully capture differences of economic status between skin colour groups (Williams & Collins 2002). A residual confounding of socio-economic status on the likelihood of periodontal disease among skin colour groups may have persisted even after adjusting for covariates. Such residual confounding may be ascribed to insufficiently detailed information on socio-economic status, unsuitable categorization of covariates and misclassification of one or more confounding variables.

Table 3. Multivariable assessment of periodontal disease and socio-demographic characteristics of Brazilian adults

Variables	Crude OR (95% CI)	*p* value	Adjusted OR (95% CI)	*p* value
Skin colour				
White	1.0	<0.01	1.0	<0.01
Lighter-skinned black people	1.4 (1.1;1.9)		1.5 (1.2–1.8)	
Dark-skinned black people	1.7 (1.2;2.4)		1.6 (1.2–2.1)	
Gender				
Female	1.0	<0.01	1.0	<0.01
Males	1.5(1.3;1.7)		1.5 (1.2–1.7)	
Age (years)				
35–39	1.0	<0.01	1.0	<0.01
40–44	1.4 (1.2;1.6)		1.4 (1.2–1.6)	
Schooling level (years)				
⩾12	1.0		1.0	
9–11	1.4 (1.1;2.0)	<0.01	1.3 (1.0;1.8)	0.02
5–8	2.0 (1.5;2.6)		1.6 (1.2;2.1)	
⩽4	2.2 (1.6;3.0)		1.5 (1.1;2.1)	
Per capita income *(Reais)*				
⩾200	1.0	<0.01	1.0	<0.01
101–199	1.4 (1.1–1.8)		1.3 (1.1;1.7)	
51–100	1.9 (1.4–2.4)		1.7 (1.3;2.1)	
⩽50	1.9 (1.4–2.5)		1.7 (1.3;2.1)	

Crude and adjusted unconditional logistic regression models. Brazil, 2002–2003 ($n = 11,342$).
Results adjusted for Brazilian regions.
OR, odds ratio; *p* value, Wald's test; 95%CI, 95% confidence intervals adjusted for the clustered sampling design.

However, if a residual association between skin colour and health outcomes persists after controlling for other risk factors, then additional aspects of discrimination should be appraised for further explanation of skin colour disparities in health (Krieger 2000). This consideration motivated the current assessment, whose strategy was to determine whether adjusting for many dimensions of socio-economic conditions would remove the observed excess of periodontal disease in Brazilian dark-skinned black and lighter-skinned black adults.

Dark-skinned black and lighter-skinned black adults presented a higher prevalence of periodontal disease when compared with white people, and this association is unlikely to be due to insufficient control for confounding. No effect modification of skin colour on income, gender, age, schooling and region was identified. This observation emphasizes the importance of systematically testing for interaction (Williams & Collins 2002), as different and unexpected results have been reported by Borrell et al. (2004) in the United States. In the paper mentioned, the relationship between income level and periodontal disease was modified by skin colour; i.e. high-income black people presented a higher prevalence of periodontal disease than low-income black people and high-income white people.

Individuals subjected to skin colour prejudice may develop physiological, psychological and behavioural stress responses (Clark et al. 2002), which may participate in the causal framework of periodontal disease (Genco 1996). This perception allows for the hypothesis that hypertension, diabetes, depression, smoking, drinking and poor oral hygiene may present different prevalences among social strata, as well as among ethnic or skin colour groups in particular (Davey Smith et al. 1998). This hypothetically contributes to explain the associations reported in the current study. Therefore, the current study may constitute a former indication of the prejudicial effect of skin colour discrimination for an outcome in periodontal health, despite the absence of information on the skin colour distribution of the major risk factors (smoking, drinking and poor oral hygiene) for the disease in the Brazilian context.

Health status assessments may reflect the impact of a complex inter-play between socio-economic status and skin colour.

There are large differences in the quality of elementary and high school education, so that dark-skinned black and lighter-skinned black adults may bring fewer skills to the labour market than their white counterparts. In addition, poorer access to health units in general, and to high-quality services in particular, may affect dark-skinned and lighter-skinned black Brazilians to a higher extent than white people (Antunes et al. 2003). Finally, racial discrimination may induce stress and adverse physical and mental health status, such as tobacco and alcohol addiction (Williams & Collins 2002).

In spite of periodontal diseases being mainly affected by behaviours determined by social and psychological factors (Sheiham & Nicolau 2005), the hypothesis that we present is an unusual explanation linking skin colour and periodontal disease. The predominant aetiological paradigm mostly focuses on biological factors related to the host and microbial aspects rather than on population, social science and demography (Baelum & Lopez 2004), thus limiting our understanding of social determinants of periodontal health. The finding of a higher prevalence of periodontal disease in dark-skinned black Brazilians and lighter-skinned black Brazilians when compared with white people as a consequence of genetic differences among these groups should be viewed with caution, as a study demonstrated that skin colour is a poor predictor of genomic ancestry in Brazil, as estimated by molecular markers (Parra et al. 2003).

The main limitation of this study is the lack of information on oral cleaning, brushing, flossing and smoking at the individual level, which are all mediating factors in periodontal disease aetiology. Gjermo et al. (2002) highlighted this limitation, and reported that patterns of oral hygiene have scarcely been studied in the Latin American context.

The strength of this study comprises the assessment of a large population-based data, representative of all Brazilian regions, including towns of different sizes, in addition to presenting satisfactory examiner reliability. Similarities between per capita income from our study (317.83 Reais) and those from the Brazilian Census (297.23 Reais) carried out in 2000 (PNUD 2003) reinforce the external validity of the study.

The current study assessed the excessive likelihood of lighter-skinned and dark-skinned black adults manifesting periodontal disease. Two main hypotheses emerge from this finding. The first one refers to the possibility of residual confounding of the differential socio-economic status of skin colour groups in the Brazilian context. The second one includes the role of stress response due to racial prejudice in the aetiology of periodontal disease. Our data were originally produced in a survey context instead of a planned study to test a theoretical hypothesis linking skin colour and periodontal disease. Consequently, we did not collect any physiological and/or psychological indicators of perceived racism.

On the other hand, Klonoff & Landrine (2002), in the US context, assessed the relationship between skin colour and experience of racial discrimination, and found that dark-skinned black people reported significantly more frequent racial prejudice in the past year and in the course of their lifetime, than did lighter-skinned black people. Dark-skinned black people also reported a more stressful subjective experience than lighter-skinned black people.

Evidence of racial discrimination and dental and general health outcomes has been documented in Brazil. Cabral et al. (2005), in a study on a large city in Northeast Brazil, reported that dentists tend to extract teeth more frequently in black people than in white people in spite of similar clinical conditions. Leal et al. (2005), in a population-based cross-sectional study of 9633 postpartum women, related that black women were reported to be less satisfied than white women regarding pre-natal, labour and newborn care. In addition, black women received fewer anaesthesias in vaginal deliveries. These associations were found even when schooling was controlled for.

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Clinical Relevance

Scientific rationale for the study: Acknowledging skin colour disparities on the experience of disease may contribute to a deeper understanding of the complex framework involved in the aetiology and progression of periodontal diseases.

Principal findings: The association between skin colour and periodontal disease remains the subject of some dispute. We present a hypothesis that skin colour, as a marker of racial discrimination, is persistently associated with the prevalence of periodontal disease, but further research is needed to confirm or refute it.

Practical implications: Preventive actions and treatment may be more effective when social factors are taken into account. Promoting periodontal health and reducing inequalities in the experience of disease demand effective knowledge of their determinants.