Associations between Socio-economic Circumstances at Two Stages of Life and Adolescents' Oral Health Status

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Abstract

There is a consistent association between unfavourable socio-economic circumstances and oral health. Although the effects of poor social circumstances in childhood are known to have lasting influences on general health, there is little information on their effects regarding chronic oral diseases. ***Objective****: To assess the relationship between oral health status and socio-economic circumstances at two different periods of adolescents' life.* ***Methods:*** *A two-phase cross sectional study was carried out in Brazil. In Phase I, 652 13-year-olds were clinically examined and interviewed. In the second phase, 311 families were randomly selected for in-depth interviews. Information was collected on several indicators of socio-economic circumstances, family related variables, school grade level, and oral health behaviour, at two different life stages, at birth and at 13 years of age. The outcome variable was oral health status at the age of 13. It was constructed by counting the worst scores of DMFT, gingival bleeding, calculus and dental plaque. The data analysis used stepwise logistic regression.* ***Results:*** *The response rates for phases I and II were 85% and 94%. Boys, those at a lower grade level at school for their age, and those who experienced high levels of material deprivation at birth and at the age of 13 were more likely to have high levels of oral diseases; the odds ratios were 4.12 (1.86-9.16), 2.41 (1.01-5.76) and 4.61 (1.30-16.3), respectively.* ***Conclusion:*** *Brazilian adolescents experiencing adverse socio-economic circumstances at birth and at the age of 13 had high levels of oral diseases.*

Key Words: oral health, socio-economic circumstances, dental caries, periodontal diseases, life course, adolescents.

Introduction

There is a strong and consistent association between unfavourable socio-economic circumstances and oral health; various socio-economic indicators are related to different chronic oral diseases (1-6). Although several studies have documented the association between measures of socio-economic circumstances at different stages of an individual's life and adult health and mortality (7-11), there is sparse evidence on the effects of adverse socio-economic conditions throughout the life course on chronic oral diseases (12). Chronic oral diseases such as caries and periodontal diseases are progressive and are initiated early in life. They manifest in infancy, childhood, adolescence and in adults of all ages. Structural changes in teeth, such as enamel defects, can be used as markers of early biological insults. For example, excessive fluoride exposure during the first 20-30 months of life may cause subsequent diffuse mottling of the enamel of central incisors (13).

The effects of social structure on the accumulation of advantages and disadvantages throughout life and their future health potential are well known (7-12,14,15). Power et al. (1999) (10) suggested that cumulative lifetime exposures, as represented by social class at birth, and at the ages of 16, 23 and 33 years, had a major effect on self-rated health at the age of 33 years. A prospective study of Scottish men found that the mortality rate over a 21-year period was related to social position at each stage of the life course. Those who remained in less favourable circumstances throughout life experienced the highest mortality risk, suggesting that the risks accumulated over time (9). Similarly, results from the 1946 British Birth Cohort showed that study members who were in manual social classes in childhood and adulthood were almost 3 times more likely to die compared with those from non-manual social classes at two stages of life (11). Early material and psychosocial disadvantages may have an adverse impact on cognitive and psychological development that may in turn affect health and labour market success later in life. Socio-economic disadvantage in childhood is associated with low educational attainment, risk of unemployment, job insecurity (16) and low adult earnings for both men (17) and women (18). Evidence from the 1946 British Birth Cohort suggests that a non-manual social class background can protect children with poor health from further disadvantage (19). While serious illness slowed down the growth of manual class children, making them significantly shorter than their healthy peers, the effect for non-manual children with serious illness was not significant (19). This phenomenon, which has been called social protection, (15) is also found during adulthood (20).

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There is a considerable body of evidence from cross–sectional studies showing the effects of socio-economic position on oral health (1-6). However, the association between socio-economic circumstances at different points in time and oral health has not been fully explored. Except for Poulton et al. (12), we are not aware of any other study that has investigated this association. Results from Poulton's New Zealand birth cohort showed that both childhood and adult socio-economic conditions had major effects on dental health at age 26 years (12).

The hypothesis tested in this study was that socio-economic circumstances at birth and at the present stage of life were the fundamental risk factors for oral diseases such as dental caries and periodontal disease. We suggest that the differences in oral health among adolescents emerge as the biological and behavioural correlates of the process of hazard accumulation throughout the course of adolescent life. Material conditions from birth are hypothesised to have biological and behavioural impacts on the child and on their oral health. Most importantly, material conditions may influence health- related behaviours.

The cumulative effect of socio-economic circumstances on oral health can be explained as follows: adolescents who are raised in more affluent families are more likely to live in good residential areas with good quality housing and adequate basic amenities that prevent infections and diseases. In addition, they are more likely to attend a better school and the benefit of an income that allows them more dietary and other behavioural choices. By contrast, adolescents who are raised in less affluent families are more likely to live in poor housing with no or inadequate basic amenities, to attend schools with few resources and to live with an income that restricts their choice of healthier diets and behaviours. Therefore, this paper aims to test whether or not socio-economic circumstances at two stages of life of adolescents explains variation in adolescents' oral health using a life course approach.

Methods

This study was carried out in Cianorte, a town in southern Brazil, which had 50,000 inhabitants from a wide range of socio-economic backgrounds. They share Western cultural values. Cianorte's economy is mainly based on manufacturing clothes and on farming.

In the first phase of this study, all 13-year-old adolescents (N=764) who attended private and public primary schools in 1999 in Cianorte were invited to participate. The Education Registry Office provided information on the number of students, their full names, date of birth and the periods at which they were attending school. A letter was sent to all parents explaining the aim and characteristics of the study and asking their consent in permitting their children to participate in the study. Negative consent was adopted, that is, the parents were asked to tell the school personnel if they did not want their children to take part in the study. In addition, all adolescents were verbally asked if they wanted to participate in the study. Both parents and children were assured that there was no prejudice to the child who wanted to opt out and that all recording forms would be numbered but not named. Ethical clearance was obtained from the Brazilian Coordination for the Improvement of Higher Education Personnel (CAPES).

A total of 652 adolescents returned the questionnaire and agreed to participate in the study. They were clinically examined and interviewed (Phase I). Due to time and resource constraints, the Phase II of the study selected only 330 adolescents' parents for an in-depth interview. For the same reason we only include urban areas in this part of the study. The other criteria for inclusion in the second phase of the study was that the subjects live with one of their biological parents.

The size of the sample to test the research question posed in this article was 250 adolescents. This would satisfy our requirements of having 80% power to demonstrate statistically significant odds ratios of those who experienced adverse and favourable environmental circumstances at the 5% level, if the magnitude of the odds ratios were not less than 2.5. The total number invited to take part in Phase II of the study was higher than the required number to attend this requirements (N=330). This was because the study tested the hypothesis in relation to several oral health outcomes, and the largest sample size required was adopted. The differences in the size of the sample were due to different prevalence among the oral diseases. Of the 652 adolescents in Phase I of the study, 541 fulfilled the criteria to participate in Phase II of the study. From those, 330 families were selected at random using numbered cards. Cards were numbered from 1-541 and then put in a box and drawn at random by one of the researchers.

Instruments and measures. Data were collected through two separate structured interviews (an adolescent interview - Phase I and a parent's interview - Phase II) and a clinical oral examination of the adolescents - Phase I. A trained dental epidemiologist conducted the dental examinations (B.N.). Children were examined at school for dental caries experience, presence of bleeding gums after probing, presence of dental calculus and presence of dental plaque. A headlamp was used to standardise the source of light.

The criteria and methods for the dental examination were based on the WHO criteria (21). Dental caries status was measured using the DMFT index, which is a cumulative measure of caries experience in permanent dentition. For an individual, the DMFT index is expressed by the sum of Decayed, Missing and Filled teeth and for a population by the arithmetic average of sums for each individual. Bleeding gums status was recorded as yes or no as evidence of bleeding from the gingival sulcus after gently probing. Calculus and dental plaque were recorded as present or absent.

Two trained researchers carried out the interviews with the adolescents in a private room during school hours. The data collected included socio-demographic factors, family-related factors, behavioural variables such as: oral health behaviours, gen-

eral habits, and present school grade level.

Parents' level of education was measured in number of years at school. Adolescents were categorized into low or high academic achievers based on the number of times they failed a final school examination. Those who had failed the final school examinations 3 or more times were regarded as low academic achievers.

The parents' interview (Phase II) collected information on the details of adolescents' birth and early infancy (e.g. adolescents' childhood infection, birth weight, mother's health during pregnancy, etc.). In addition, information on several indicators of socio-economic circumstances in two different stages of the child's life (at birth and at 13 years old) was obtained. These included presence of a toilet inside the house, type of material used to construct the house, car ownership, house tenure, overcrowding and availability of piped water. An indicator of socio-economic circumstances at an adolescents' birth and at 13 years of age was created using presence and absence of each socio-economic indicator. The most favourable score was 6 and the least favourable was 0. The two indicators were further categorized using the mean as a cut-off point for low and high levels of material deprivation.

Data analysis. Data analysis was carried out using the Statistical Package for Social Science (SPSS for Windows, version 10.0). A hierarchical approach to the variable selection modelling technique was used. The variables were grouped from distal to proximate determinants of oral health according to the theoretical framework of the study (fig.1). For each group of variables, stepwise logistic regression analysis was carried out to select the best predictors at that group. A probability of was 0.25 to enter and 0.10 for removal from the equation was used. The selected variables in each group were included in the final model following a temporal sequence. As such, the adolescents' birth and first year of life were analysed first, then childhood factors were analysed with those from adolescents' birth and so on. All two-way interactions were tested.

A variable representing the oral health status at 13 years of age was constructed counting the worse scores of DMFT (highest quartile scored 1 point, other 3 quartiles scored 0), gingival bleeding (highest quartile scored 1 point, other 3 quartiles scored 0), presence of calculus (highest quartile scored 1 point, other 3 quartiles scored 0) and presence of plaque (highest quartile scored 1 point, other 3 quartiles scored 0). Therefore the possible scores ranged from 0 through 4. The new variable was categorized into low (1st, 2nd, 3rd quartile) and high (last quartile) levels of oral diseases.

The rationale for adopting these cut-off points was that the variables bleeding after probing, dental plaque, calculus and dental caries had a high prevalence (99%, 98%, 44%, and 80% respectively). Therefore severity rather than prevalence, measured by number of teeth with gums bleeding on probing, presence of dental plaque, presence of calculus and dental caries was used to assess the adolescents' oral health status. The 75th percentile of the distribution was used to define high and low levels of gingival bleeding, dental plaque, calculus and dental caries. Thus, low levels of bleeding, dental plaque, calculus and dental caries experience was recorded if 22, 23, 4 and 6 or less teeth respectively had bleeding gums, dental plaque, calculus and dental caries, while high levels of bleeding gums, dental plaque, calculus and dental caries experience was recorded if more than 22, 23, 4 and 6 teeth respectively had bleeding gums, dental plaque, calculus and dental caries.

Figure 1
Hierarchical approach to variable selection and modeling of the data

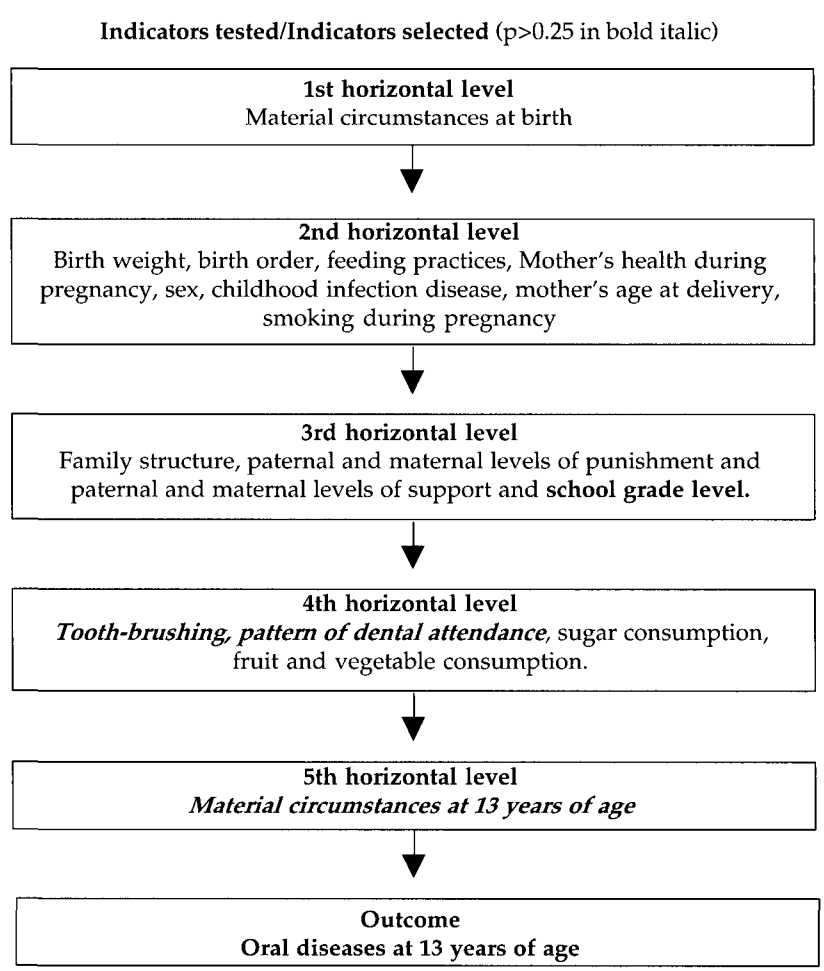

Table 1
Prevalence of high levels of oral diseases by socio-economic indicators, sex, school grade level and oral health behaviour in a sample of 13-year-old adolescents (N=307)

Variable	Total sample N (%)	High levels of oral diseases N (%)
Material deprivation at birth		
Low levels of material deprivation	145 (47.2)	10 (6.9)[1]
High levels of material deprivation	162 (52.8)	32 (19.8)
Material deprivationat 13 years of age		
Low levels of deprivation	101 (32.9)	9 (8.9)[2]
High levels of deprivation	206 (67.1)	33 (16.0)
Sex		
Female	151 (49.2)	9 (6.0)[1]
Male	156 (50.8)	33 (21.2)
School grade level		
Low academic achievers	36 (11.7)	11 (30.6)[1]
High academic achievers	271 (88.3)	31 (11.4)
Tooth-brushing frequency		
One to two times per day	133 (43.3)	25 (18.8)[2]
More than 3 times per day	174 (56.7)	17 (9.8)
Pattern of dental attendance		
Check up	76 (24.8)	5 (6.6)[2]
Emergency treatment	231 (75.2)	37 (16.0)
Total	307 (100.0)	55 (17.9)

X^2 test: [1] $p<0.01$; [2] $p<0.05$

Results

The response rate for the first and second phases of the study were 652 (85.3%) and 311 (94.2%) respectively. The intra-examiner agreement was very good as demonstrated by correlation coefficients above 0.92. In addition, we calculated Kappa values for the presence of dental caries on a tooth-by-tooth basis, and all values were greater than 0.90. Self-reported birth weight was validated by comparing with health records. Fifty-two of 311 adolescents had their birth cards, which contained information on birth weight, diseases and vaccination. Correlation scores and Kappa values above 0.90 validated the information obtained in the interview. Intra- and inter-interviewer reliability was satisfactory as demonstrated by correlation scores above 0.73.

The results reported in this paper are related to Phase II of the study since information on the adolescents' early life was not available for Phase I. We compared the socio-demographic characteristics available for both samples (Phase I and II) and no statistically significant difference was found ($P>0.05$).

Table 1 shows the frequency distribution of the predictors of poor oral health that were chosen by the stepwise procedure as illustrated in Figure 1. More than half of the adolescents had experienced high levels of deprivation at either period; birth (52.8%) and at 13 years of age (67.4%). In addition, the majority of adolescents were high academic achievers (88.3%) and visited a dentist only for emergency treatment (74.2%).

Results of the multiple logistic regression are shown in Table 2. Boys, those who were born to families which experienced high levels of material deprivation at their birth and those who were low academic achievers were more likely to have high levels of oral diseases. The odds ratio were 4.23 (1.91-9.37), 3.14 (1.44-6.86) and 2.32 (1.00-5.47), respectively.

A further step tested a two-way interaction for all variables in the final model, in particular the interaction between levels of material deprivation at the child's birth and at 13 years of age. This interaction allowed us to assess the association between social mobility and levels of oral diseases. All other interactions tested were not statistically significant. To estimate the effect of the interaction between levels of material deprivation at the adolescents' birth and at 13 years of age on oral health status, a new variable was created. It included four categories; (i) adolescents who experienced low levels of material deprivation at both birth and at 13 years of age; (ii) adolescents who experienced high levels of material deprivation at birth and low levels of material deprivation at 13 years of age; (iii) adolescents who experienced low levels of material deprivation at birth and high levels of material deprivation at 13 years of age; and (iv) adolescents who experienced high levels of material deprivation in both periods of life. Adolescents who experienced high levels of material deprivation at birth and low levels of material deprivation at 13 years of age and those who experienced high levels of material deprivation at both periods of life were more likely to have high levels of oral diseases. The odds ratios were 7.20 (1.65-31.3) and 5.67 (1.65-19.4) respectively (Table 3).

We built a new model including the variable representing the interaction between levels of material deprivation at the adolescents' birth and at 13 years of age and all selected indicators from each horizontal level. Adolescents who experienced high levels of material deprivation at birth and low levels of material deprivation at 13 years of age and those who experienced high levels of material deprivation at both periods of life were more likely to have high levels of oral diseases than others, with odds ratios were 7.18 (1.58-32.4) and 4.61 (1.30-16.3), respectively. In addition, boys and low academic achievers had odds of experiencing high levels of oral diseases which were, respectively, 4.12 (1.86-9.16) and 2.41 (1.01-5.76) times greater than for other adolescents.

Discussion

This study addresses the hypothesis that there was an association between socio-economic circumstances at two stages of life and oral health in Brazilian adolescents. The results

Table 2
Stepwise logistic regression for the association between life course variables and levels of oral diseases in a sample of 13-year-old adolescents (N=307)

Variables	Low levels of oral diseases N(%)	High levels of oral diseases N(%)	Unadjusted OR 95% C.I.	Adjusted OR 95% C.I.
Material deprivation at birth				
Low levels of material deprivation	135 (93.1)	10 (6.9)	1	1
High levels of material deprivation	130 (80.2)	32 (19.8)	3.32 (1.57-7.03)	3.14 (1.44-6.86)
Material deprivation at 13 years of age				
Low levels of material deprivation	92 (91.0)	9 (8.9)	1	*
High levels of material deprivation	173 (84.0)	33 (16.0)	1.95 (0.89-4.25)	
Sex				
Female	142 (94.0)	9 (6.0)	1	1
Male	123 (78.8)	33 (21.2)	4.43 (1.94-9.18)	4.23 (1.91-9.37)
Tooth-brushing frequency				
One to two times per day	108 (81.2)	25 (18.8)	1	
More than 3 times per day	157 (90.2)	17 (9.8)	2.13 (1.10-4.14)	*
School grade level				
Low academic achievers	25 (69.4)	11 (30.6)	1	1
High academic achievers	240 (88.6)	31 (11.4)	3.40 (1.52-7.59)	2.32 (1.00-5.47)
Pattern of dental attendance				
Check up	71 (93.4)	5 (6.6)	1	
Emergency	194 (84.0)	37 (16.0)	2.70 (1.02-7.16)	*

*Not significant (P>0.05)

suggest that the socio-economic circumstances of the adolescents' families at birth and at 13 years of age influenced oral health status in adolescents. The association between poorer socio-economic circumstances at birth and oral health was particularly strong, and it was independent of socio-economic circumstances at 13 years of age. Moreover, our results suggest a cumulative effect of socio-economic circumstances along the life course. Adolescents who experienced poorer socio-economic circumstances at birth and at 13 years of age and those who were upwardly socio-economically mobile by 13 years of age were significantly more likely to have high levels of oral diseases than adolescents who experienced favourable socio-economic circumstances at both stages of life and than those who had more favourable conditions at birth but not at 13 years of age.

Before offering an explanation for the association between socio-economic circumstances at two different stages of adolescents' life and oral health it is important to recognize the study's limitations. First, the study used a cross-sectional design. Therefore a causal relationship cannot be established. Second, most of the data are based on retrospective information. We acknowledge this may have introduced some level of recall bias. However, it is unlikely that it actually affected the validity of the data. Objectives measures previously recorded in a number of participants medical birth card such as birth weight were available, and this data was compared to the data collected showing very good agreement. This is not surprising as the type of data collected has a significant effect on the level of recall bias (22,23). Also, the type of retrospective information collected in this study was related to adolescents' health in the first years of life and family socio-economic circumstances at adolescents' birth, which are less susceptible to recall bias than behavioral factors (22,23). Furthermore, the scale of measurement used in this study is less subject to bias. The reliability of testing a hypothesis is better when the variables are related to the relative standing of individuals in the distribution than those which demand precision in estimating event frequencies and event dates (23). Moreover, a number of studies that have assessed accuracy of recalled information against historical records have found good levels of agreement (24-26). Finally, in-depth interviews were carried out in a randomly selected subsample of 330 adolescents' families. Comparison between the two samples (Phases I and II) showed no statistically significant difference in socio-demographic variables. Therefore it was assumed that this approach did not affect the validity of the study.

Some may also argue that there is no theoretical basis for the use of a composite measure of oral health. The rationale for using a composite measure of oral health in this study is based on the finding that many chronic diseases, such as oral chronic diseases, have common causes (27). Second, it has been suggested that these common risk factors are general rather than disease specific (28,29).

The results of our study are in line with other studies that have suggested that the accumulation of environmental insults or the cumulative effects of unfavourable behavioural or psychological factors throughout the life course progressively increase sus-

ceptibility to adult chronic diseases, including oral diseases (9-12). In a New Zealand birth Cohort study, subjects who had grown up in a low socio-economic household had more tooth decay, gingivitis, plaque and periodontal diseases (12). The findings on oral health mimic the findings for general health. In a prospective study of Scottish men the mortality risk was graded by cumulative social class, comprised of class of origin, at labour market entry and later adulthood (9). Cumulative effects have also been shown in the 1958 British Birth Cohort where socio-economic conditions from birth to the age of 33 years had a cumulative effect on self-rated health and on level of education achieved (10).

Several associations observed at different levels of the model used here suggest possible pathways about how socio-economic environments may determine risk behaviours and thus, oral health status at 13 years of age. Adverse material circumstances at the beginning of life, such as limited access to housing amenities, may have influenced the development of key positive oral health behaviours. In this study, behavioural variables such as the adolescents' low levels of fruit consumption, low daily tooth-brushing frequency and irregular dental attendance at 13 years of age were associated with high levels of material deprivation at both stages of adolescents' life (birth and at 13 years of age) and with parents' low levels of education (data not shown). The latter are stable measures of socio-economic conditions throughout life. Thus, it is plausible that an adverse socio-economic environment at birth and throughout the upbringing of a child with reduced biological resources reduced the chances of consuming a healthy diet and gaining access to dental services, and reduced the likelihood of adopting behaviours such as frequent tooth-brushing with fluoride toothpaste, which in turn increased the risk of having high levels of oral diseases in adolescence.

Another possibility is that adverse socio-economic conditions in the beginning of life may have also compromised the development of individual social resources. For example, the adolescents' educational progress was statistically significant correlated with levels of material deprivation at both periods of the adolescents' life and with parent's level of education. Educationally low achievers were significantly more likely to have worse oral health behaviours and were 2.32 times more likely to have high levels of oral diseases.

Causal factors in each stage of life include physical hazards and behaviours with known biological pathways, but may also include stressful life conditions, which affect biological resources through psychosocial processes that are only beginning to be understood. The results of this study suggest that the association between socio-economic circumstances and oral health status remained statistically significant after adjusting for sugar consumption, daily tooth-brushing, fluoride exposures and dental attendance. It may be hypothesised that emotional deprivation and psycho-social stress in

Table 3
Stepwise logistic regression for the association between life course variables and levels of oral diseases in a sample of 13-year-old adolescents with and without interaction between early life and present life socio-economic circumstances (N=307)

Variables	Low levels of oral diseases N(%)	High levels of oral diseases N(%)	Unadjusted OR 95% C.I.	Adjusted OR 95% C.I.
Material deprivation at birth and 13 years of age				
LLMD at both periods of life	71 (94.7)	4 (5.3)	1	1
HLMD at birth LLMD at 13 yrs	19 (73.1)	7 (26.9)	7.20 (1.65-31.3)	7.18 (1.58-32.4)
LLMD at birth HLMD at 13 yrs	62 (88.6)	8 (11.4)	2.66 (0.66-10.7)	2.14 (0.52-8.84)
HLMD at both periods of life	108 (79.4)	28 (20.6)	5.67 (1.65-19.4)	4.61 (1.30-16.3)
Sex				
Female	142 (94.0)	9 (6.0)	1	1
Male	123 (78.8)	33 (21.2)	4.43 (1.94-9.18)	4.12 (1.86-9.16)
Tooth-brushing frequency				
One to two times per day	108 (81.2)	25 (18.8)	1	
More than 3 times per day	157 (90.2)	17 (9.8)	2.13 (1.10-4.14)	*
School grade level				
Low academic achievers	25 (69.4)	11 (30.6)	1	1
High school grade achievers	240 (88.6)	31 (11.4)	3.40 (1.52-7.59)	2.41(1.01-5.76)
Pattern of dental attendance				
Check up	71 (93.4)	5 (6.6)	1	
Emergency	194 (84.0)	37 (16.0)	2.70 (1.02-7.16)	*

* Not significant (P>0.05)
LLMD: low levels of material deprivation; HLMD: high levels of material deprivation

childhood might lead to imbalances in the stress-response systems, which in turn affects immunological responses (30). Deficient defense mechanisms affect the subject's response to bacterial plaque leading to more oral diseases (31). Another possible mechanism is that adolescents who experienced deprivation throughout their life were malnourished. Malnourished children have a reduced rate of saliva secretion and buffering capacity, lower calcium and protein secretion and impaired immunological and agglutinating defense factors (32,33), which in turn would make them more prone to oral diseases.

In summary, this study showed that there is an association between socio-economic circumstances at two periods of life and adolescents' levels of oral disease. This has implications for public health policy, especially with respect to policies affecting child development. It is important to acknowledge that interventions to promote oral health should start in early life, rather than in later life. Further research should elucidate to what extent socio-economic circumstances in different stages of life affects oral health and oral health related behaviours in adolescence using a prospective epidemiological design and a larger sample size.

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References

1. Chen MS. Oral health of disadvantaged populations. 1st ed. In: Cohen LK, Gift HC, editors. Disease prevention and oral health promotion: socio-dental science in action. Copenhagen: Munksgaard; 1995.
2. Freire MC, de Melo RB, Almeida e Silva. Dental caries prevalence in relation to socio-economic status of nursery school children in Goiania-GO, Brazil. Community Dent Oral Epidemiol. 1996; 24:357-61.
3. Hobdell MH, Oliveira ER, Bautista R, Myburgh NG, Lalloo R, Narendran S, et al. Oral diseases and socio-economic status (SES). Br Dent J. 2003; 194:91-6.
4. Oliver RC, Brown LJ, Loe H. Variations in the prevalence and extent of periodontitis. J Am Dent Assoc. 1991; 122:43-8.
5. Weissenbach M, Chau N, Benamghar L, Lion C, Schwartz F, Vadot J. Oral health in adolescents from a small French town. Community Dent Oral Epidemiol. 1995; 23:147-54.
6. Petridou E, Athanassouli T, Panagopoulos H, Revinthi K. Sociodemographic and dietary factors in relation to dental health among Greek adolescents. Community Dent Oral Epidemiol. 1996; 24:307-11.
7. Lynch JW, Kaplan GA, Cohen RD, Kauhanen J, Wilson TW, Smith NL, et al. Childhood and adult socioeconomic status as predictors of mortality in Finland. Lancet. 1994; 343:524-27.
8. Gliksman MD, Kawachi I, Hunter D, Colditz GA, Manson JE, Stampfer MJ, et al. Childhood socioeconomic status and risk of cardiovascular disease in middle aged US women: a prospective study. J Epidemiol Community Health. 1995; 49:10-15.
9. Davey Smith G, Hart C, Blane D, Gillis C, Hawthorne V. Lifetime socioeconomic position and mortality: Prospective observational study. Br Med J. 1997; 314:547-52.
10. Power C, Manor O, Matthews S. The duration and timing of exposure: effects of socioeconomic environment on adult health. Am J Public Health. 1999; 89:1059-65.
11. Kuh D, Hardy R, Langenberg C, Richards M, Wadsworth ME. Mortality in adults aged 26-54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study. Br Med J. 2002; 325:1076-80.
12. 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; 360:1640-45.
13. Billings RJ, Berkowitz RJ, Watson G. Teeth. Pediatrics. 2004; 113:1120-7.
14. Wadsworth ME. Health inequalities in the life course perspective. Soc Sci Med. 1997; 44:859-69.
15. Blane D. The life course, the social gradient, and health. In: Marmot M, Wilkinson RG, editors. Social determinants of health. Oxford: Oxford University Press; 1999. p.64-80.
16. Power C, Matthews S. Origins of health inequalities in a national population sample. Lancet. 1997; 350:1584-89.
17. Kuh D, Wadsworth ME. Childhood influences on adult male earnings in a longitudinal study. Br J Sociol. 1991; 42:537.
18. Kuh D, Head J, Hardy R, Wadsworth M. The influence of education and family background on women's earnings in midlife: Evidence from a British National Birth Cohort Study. Br J Sociol Educ. 1997; 18:385-405.
19. Wadsworth MEJ. Family and education as determinants of health. 1st ed. In: Blane D, Brunner E, Wilkinson R, editors. Health and social organization; towards a health policy for the twenty-first century. London: Routledge; 1996. p.153-70.
20. Bartley M. Owen C. Relation between socioeconomic status, employment, and health during economic change, 1973-93. Br Med J. 1996; 313:445-49.
21. WHO. Oral health surveys: basic methods. World Health Organization, Geneva, 1997.
22. Blane DB. Collecting retrospective data: development of a reliable method and a pilot study of its use. Soc Sci Med. 1996; 42:751-7.
23. Henty B, Moffitt T, Caspi A, Langley J, Silva P. On the "remembrance of things past". A longitudinal evaluation of the retrospective method. Psychol Assess 1994; 6:92-101.
24. Baumgarten M, Siemiatycki J, Gibbs GW. Validity of work histories obtained by interview for epidemiologic purposes. Am J Epidemiol. 1983; 118:583-91.
25. Blaxter M, Paterson E. Mothers and daughters: a three generational study of health attitudes and behaviour.1st ed. London: Heinemann; 1982.
26. Krieger N, Okamoto A, Selby J. Adult female twins' recall of childhood social class and father's education: a validation study for public health research. Am J Epidemiol. 1998; 147:704-08.
27. Sheiham A, Watt RG. The common risk factor approach: a rational approach for promoting oral health. Community Dent Oral Epidemiol. 2000; 28:399-406.
28. Cassel, J. The Contribution of the Social Environment to Host Resistance. American J Epidemiol 1976; 104:107–23.
29. Evans RG, Stoddart GL. Consuming research, producing policy? Am J Public Health. 2003; 93:371-9.
30. Brunner E, Marmot M. Social organization, stress, and health. 1st ed. In: Marmot M, Wilkinson R, editors. Social determinants of health. Oxford: Oxford University Press; 1999. p.17-43.
31. Genco RJ. Pathogenesis and Host Responses in Periodontal Disease. 1st ed. Genco RJ, Goldman HM, Cohen DW, editors. Contemporary periodontics. ST. Louis: The C.V. Mosby Company; 1990.
32. 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.
33. Johansson I, Lenander-Lumikar M, Saellstrom AK. Saliva composition in Indian children with chronic protein-energy malnutrition. J Dent Res. 1994;73:11-19.