RESEARCH REPORT

The relation between family socioeconomic trajectories from childhood to adolescence and dental caries and associated oral behaviours

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Objectives: To investigate the influence of family socioeconomic trajectories from childhood to adolescence on dental caries and associated behaviours.
Design: Population-based birth cohort.
Setting: Representative sample of the population of subjects born in 1982 in Pelotas, Brazil.
Participants: Adolescents (n = 888) aged 15 years old were dentally examined and interviewed.
Main outcome measures: Dental caries index (DMFT), care index (F/DMFT), tooth brushing, flossing and pattern of dental services use.
Main results: Adolescents who were always poor showed, in general, a worse pattern of dental caries, whereas adolescents who never were poor had a better pattern of dental caries. Adolescents who had moved from poverty in childhood to non-poverty in adolescence and those who had moved from non-poverty in childhood to poverty in adolescence had similar dental pattern to those who were always poor except for the pattern of dental services use, which was higher in the first group. In all groups girls had fewer carious teeth, better oral hygiene habits and higher dental services use than boys.
Conclusion: Poverty in at least one stage of the lifespan has a harmful effect on dental caries, oral behaviours and dental services use. Belonging to upwardly mobile families between childhood and adolescence only contributed to improved dental care.

The relation between the socioeconomic position of individuals and their health has been well established. Those at the top of the socioeconomic ladder perform better in most health status measurements.[1] However, most studies on adults or adolescents reporting inequalities in health used measurements of current socioeconomic position, or relied on adults' retrospective reports about their childhood. The latter may have been affected by poor recall or measurement errors.[2]

Studies with data on socioeconomic position at a single point in life may fail to fully elucidate the contribution of socioeconomic factors to health.[3] There is an increasing body of evidence showing that health outcomes may be affected by socioeconomic position during different periods in the course of life.[4–7]

Early life socioeconomic circumstances may determine future health inequalities, for example in terms of chronic diseases in adulthood. Social and biological risks accumulated during the course of life, especially in critical periods during early life, are considered as the key determinants of health in later years.[8] Kuh and Ben-Shlomo highlighted the concepts of ''chain of risk'' to describe how early life experiences increase the likelihood of future events.[8] Moreover, childhood socioeconomic status may modify the effect of the individual's socioeconomic position in adult life.

Income levels in youth and childhood have been related to death from heart disease and from all other causes. In a study from Finland, men living in poverty in both childhood and adulthood had higher heart disease mortality rates than those who had moved from being poor in childhood to a more affluent adulthood. Being poor in early life only made a difference for those who were also poor as adults.[9] Children who had grown up poor had worse cardiovascular and oral health than those from affluent families, and upward socioeconomic mobility did not reverse the negative effects of childhood poverty.[2]

Although several studies have investigated the health effects of socioeconomic position at different stages of life, only three have explored oral health outcomes.[2 10 11] In addition, none of these had a prospective birth cohort design, nor were any of them carried out outside high-income countries. Poulton *et al*[2] and Thomsom *et al*[10] followed 1000 children born in New Zeland during 1972–3. At age 26 they assessed several oral outcomes such as dental caries, plaque scores, bleeding and periodontal diseases. They found that adults from low childhood socioeconomic status presented high levels of dental caries when compared to those from high childhood socioeconomic status.

Because common risk factors are involved in oral and other chronic diseases,[12] it is plausible that the life course theories put forward for general health also apply to oral health, especially to dental caries—a chronic, cumulative and highly prevalent disease. Bacterial infection, consumption of fermentable carbohydrates, especially sucrose, and individual susceptibility are the main proximate determinants of dental caries. However, these factors are influenced by socioeconomic circumstances, which may be considered the distal determinants.

The objective of this study was to investigate the influence of current and childhood socioeconomic status in dental caries among adolescents. In addition, we aimed to describe oral behaviours, sweet consumption, and pattern of dental services use according to family income trajectories from childhood to adolescence.

METHODS

In 1982 a population-based birth cohort study was initiated in Pelotas, a medium-sized city located in a relatively affluent area of Brazil near the Southern border with Uruguay and Argentina.

The study began as a perinatal health survey including all 6011 infants born at three maternity hospitals (accounting for 99.2% of all births in the city). The 5914 live-born infants and their mothers

Table 1 Dental caries indices of Brazilian adolescents (n = 875) according to family socioeconomic trajectories. Mean (standard deviation) and proportions

Variables	Always poor (n = 162)	Poor/non-poor (n = 99)	Non-poor/poor (n = 129)	Never poor (n = 485)	p Value
Decayed	4.18 (3.56)	3.27 (2.62)	3.74 (3.33)	2.39 (2.84)	<0.01
Missing	0.36 (0.73)	0.40 (0.75)	0.30 (0.74)	0.28 (0.76)	0.06
DMFT*	5.06 (3.85)	4.84 (2.99)	5.33 (3.71)	5.13 (3.81)	0.81
Caries free	9.90%	8.08%	4.65%	10.00%	0.29
High caries (D≥5)	34.57%	30.30%	33.33%	18.97%	<0.01
Care index	11.97%	23.00%	24.96%	48.24%	<0.01

*Traditional measurement assessing caries prevalence and severity, which refers to the average number of permanent teeth somehow affected by caries, that is, decayed (D), missing (M) or filled (F) teeth (T).

were weighed and measured and the mothers answered a questionnaire shortly after the infant's birth, including socioeconomic, demographic, and health-related variables.[13]

In 1997—when the cohort children were 15 years of age—we systematically selected 70 census tracts (27% of the total) and visited every household in these tracts. Census tracts include an average of 300 households and are numbered consecutively from the central area of the city to the suburbs. One in every four tracts was systematically selected. As socioeconomic status is strongly related to place of residence, this systematic procedure was expected to result in a sample that would be representative of the entire urban area. This led to the identification and to interview 1076 cohort members, corresponding to a follow up rate of 72%. Of these, 900 were randomly selected for the Oral Health Study. The dental research team consisted of eight previously trained dental students who visited the adolescents at home to perform oral examinations and an interview.[13]

The oral exams included the determination of data regarding dental caries, periodontal conditions, and malocclusion, collected according to the methods and definitions proposed by the World Health Organization (WHO).[14] WHO provides a clinical definition of dental caries in order to standardise the observation of different dental examiners in the survey. A tooth is considered to be decayed when "a lesion in a pit or fissure, or on a smooth tooth surface, has an unmistakable cavity, undermined enamel, or a detectably softened floor or wall". This category includes filled or sealed teeth that are also decayed. The index measuring caries prevalence also records teeth with previous experience of decay, even after receiving restorative treatment or being extracted because of caries. A tooth is considered to be filled when one or more restorations are present, and the caries have already been treated; a tooth that has been extracted because of caries is considered to be missing. These specifications allow for an estimate of the DMFT index, a traditional measurement assessing caries prevalence and severity, which refers to the average number of permanent teeth somehow affected by caries, that is, decayed (D), missing (M) or filled (F) teeth (T).

Additionally, DMFT information allowed for the identification of caries-free adolescents (DMFT = 0), and high-caries adolescents (D from DMFT≥5). The 75th percentile of the local distribution—5 caries (D)—was used to define high-caries adolescents. The third outcome was the care index, a measurement originally proposed by Walsh[15] for comparative studies addressing dental programs, which indicates dental services use by the group and refers to the ratio between the number of filled teeth and the overall index of caries—F/DMFT—for each group.

Eight dental students performed the oral examinations. Before the field work the observers were trained and calibrated to adopt the WHO criteria. Calibration was carried out in a population with the same age as the studied population and involved 25 adolescents. Inter- and intra-examiner reliability were calculated using kappa statistics on a tooth-by-tooth basis. The lowest value was 0.65.

The interview included information on oral hygiene practices and oral health behaviours such as possession of a toothbrush (Have you got a toothbrush?), tooth brushing (How many times do you brush your teeth?) flossing frequency (How many times do you floss your teeth?), chocolate and chewing gum consumption (How many times do you eat chocolate? How many times do you chew gum?), profile of dental services use throughout the subject's life collected from the cohort records and in the year prior to examination (Did you visit the dentist in the last 12 months? Where did you go?) and household water supply connection (yes/no). Pelotas has a water fluoridation scheme which covers more than 90% of households. Family socioeconomic trajectories from childhood to adolescence were analysed.

Family income was collected in 1982 according to five categories of Brazilian minimum wages (<1, 1–3, 3–6, 6–10 and >10) with respective frequencies of 21.9, 47.4, 18.5, 6.5 and 5.7% for the whole cohort. One minimum wage at that time was equivalent to US$50 a month, a very low salary that is not sufficient to keep a minimally adequate living standard. Unfortunately information on the continuous level of income was not available, because the variable was already collected in the five categories above. In order to classify families into

Table 2 Dental caries indices of Brazilian boys aged 15 (n = 472) according to family socioeconomic trajectories. Mean (standard error) and proportions

Variables	Always poor, n = 84 (17.8%)	Poor/non-poor, n = 47 (10.0%)	Non-poor/poor, n = 70 (14.8%)	Never poor, n = 271 (57.4%)	p Value
Decayed	4.37 (0.40)	3.66 (0.41)	4.10 (0.42)	2.55 (0.18)	<0.01
Missing	0.32 (0.07)	0.51 (0.12)	0.29 (0.08)	0.24 (0.04)	0.02
DMFT*	5.08 (0.42)	4.98 (0.41)	5.44 (0.44)	4.82 (0.22)	0.48
Caries free	10.7%	8.5%	5.7%	11.1%	0.58
High caries (D≥5)	38.1%	38.3%	40.0%	19.6%	<0.01
Care index	9.2 %	19.0%	19.8%	31.8%	<0.01

*See table 1 footnote.

Table 3 Dental caries indices of Brazilian girls aged 15 (n = 403) according to family socioeconomic trajectories. Mean (standard error) and proportions

Variables	Always poor, n = 78 (19.4%)	Poor/non-poor, n = 52 (12.9%)	Non-poor/poor, n = 59 (14.6%)	Never poor, n = 214 (53.1%	p Value
Decayed	3.97 (0.39)	2.92 (0.33)	3.31 (0.41)	2.19 (0.18)	<0.01
Missing	0.40 (0.09)	0.31 (0.09)	0.32 (0.11)	0.33 (0.06)	0.73
DMFT*	5.03 (0.44)	4.71 (0.44)	5.20 (0.49)	5.53 (1.27)	0.50
Caries free	9.0%	7.7%	3.4%	8.4%	0.60
High caries (D≥5)	30.8%	23.1%	25.4%	18.2%	0.03
Care index	14.8%	26.6%	30.9%	38.9%	<0.01

*See table 1 footnote.

tertiles for the data analyses, it was necessary to regroup the five categories. A principal components analysis was carried out using four variables strongly related to wealth in our sample—delivery care payment mode (out-of-pocket, public free or private health insurance) and the schooling, height and skin colour of the mother. The first factor score from the principal component analysis was used to sort individuals within family income groups. Cut-off points were then determined within each category so that three nearly equal-sized groups were formed. To form the poorest tertile the 1288 individuals in the first family income category were pooled with the poorest 675 individuals in the second category, as predicted from the factor score. The next 1979 individuals in this second category formed the second tertile, while all the remaining individuals formed the last tertile (the richest ones from the second original group and all subjects in the three higher income groups). The groups did not have exactly the same number of individuals due to ties in the derived score.

''Current'' family income was determined in 1997 and tertiles were then generated from this variable. The middle and higher tertiles of family income were merged into a group referred to as ''non-poor'', while the lower tertile was referred to as ''poor''. The choice of comparing the poorest tertile with the other two tertiles is due to the fact that health inequalities in Brazil follow a ''bottom inequity'' pattern,[16] that is, the middle and upper classes are reasonably similar while the poor lag well behind. For example, in our cohort the prevalence of height deficits (stunting, a condition that is highly determined by socio-environmental conditions) at age 4 years was 19% in the poorest tertile, 5% in the intermediate tertile and 2% in the richest tertile. The combination of this classification resulted in four different family income trajectories: (1) those who were always poor; (2) those who were never poor; (3) those who were poor at birth and non-poor later on, and (4) those who were non-poor at birth and then became poor. This classification was performed following the proposal of Barros *et al*.[17]

Data analyses included descriptive statistics of DMFT index and its components. Dental caries indices were compared among the four family income trajectory groups using the Kruskal-Wallis test, for males and females separately. This test was used because these variables presented a clearly asymmetric distribution. Finally, oral behaviour, sweet consumption and pattern of dental services use by gender and according to family income trajectories were compared using the χ^2 test. In addition, the differences between variables from always poor, non-poor/poor and, poor/non-poor groups and always poor and never poor separately, were tested using the Mann–Whitney U test and χ^2 test when appropriate.

RESULTS

A total of 888 adolescents were dentally examined, a response rate of 97.8% relative to those traced in 1997. Mean DMFT ranged from 0 to 23, with a mean of 5.10 (SD 3.1) (table 1). The percentages of adolescents with at least one decayed, missing and filled tooth were 59%, 6.1% and 34.9%, respectively. Only 8% of adolescents were caries-free. Almost 100% of the sample had a household connection to the public piped water network.

Of 875 adolescents with complete socioeconomic information, 162 (18.5%) were always poor, 99 (11.3%) were poor in early childhood and moved up to the non-poor group in adolescence, 129 (14.7%) were non-poor in early childhood and had moved down to the poor group in adolescence, whilst 485 (55.5%) were never poor. For 13 individuals (1.5%), no information was available about family income trajectories.

Adolescents who were always poor had the worst levels of untreated dental caries (decay), high caries and low care indices when compared with those who were never poor ($p<0.01$). Adolescents from the poor/non-poor and non-poor/poor groups showed intermediate levels of the indicators. However, most dental indicators of the poor/non poor and non-poor/poor groups were not significantly different when compared to those of always poor group except for the dental care index which was significantly lower in the always poor group than in the poor/non-poor and non-poor/poor groups in both genders (table 1).

Table 4 Oral behaviours, sugar consumption and pattern of dental attendance according to family socioeconomic trajectories of Brazilian boys aged 15 (n = 472)

Variables	Always poor (%)	Poor/non-poor (%)	Non-poor/poor (%)	Never poor (%)	p Value
Ever consulted with a dentist	66.7	87.5	76.9	89.3	<0.01
Consulted in the last year	28.6	48.9	44.3	58.7	<0.01
Used public dental care upon last visit	38.8	32.6	34.4	10.0	<0.01
Used private dental care upon last visit	20.3	37.2	36.1	73.7	<0.01
Toothbrush possession	96.2	100.0	97.0	99.3	0.14
Tooth brushing ≥2 times per day	49.4	66.0	53.7	62.2	0.09
Flossing	39.1	37.5	41.2	50.6	<0.01
Chocolate ≥2 times per day	24.6	25.0	21.3	17.7	0.53
Chewing gum ≥2 times per day	12.1	9.7	17.4	14.1	0.78

Table 5 Oral behaviours, sugar consumption and pattern of dental attendance according to family socioeconomic trajectories of Brazilian girls aged 15 (n = 403)

Variables	Always poor (%)	Poor/ non poor (%)	Non-poor/ poor(%)	Never poor (%)	p Value
Ever consulted with a dentist	66.0	82.8	84.4	94.6	<0.01
Consulted during the last year	32.1	44.2	45.8	73.8	<0.01
Used public dental care upon last visit	28.3	29.8	35.2	10.9	<0.01
Used private dental care upon last visit	20.0	40.4	27.8	74.4	<0.01
Toothbrush possession	94.8	100.0	100.0	100.0	0.21
Tooth brushing ⩾2 times per day	72.7	76.9	78.9	83.6	0.03
Flossing	51.2	59.5	56.8	78.1	<0.01
Chocolate ⩾2 times per day	10.3	23.4	22.6	22.9	0.97
Chewing gum ⩾2 times per day	17.2	31.8	33.3	25.1	0.20

No statistically significant difference was observed in the DMFT among socioeconomic trajectory groups in spite of slightly higher values being observed in the never poor and always poor groups in girls and boys, respectively. In general boys tended to show a worse decay component and care index in all family income trajectory groups (tables 2 and 3).

It was observed that untreated dental caries in the teeth of females was significantly higher in always poor than in poor/non-poor and non-poor/poor groups (table 3).

In all socioeconomic groups girls had, in general, a lower DMFT and a higher care index than boys. For example, the care index in the less privileged group—always poor—was only 9.2% in boys and 14.8% in girls, while in the never poor group it was 31.8% and 38.9%, respectively (tables 2 and 3).

Tables 4 and 5 summarise the results regarding oral health behaviour, sweet consumption, and pattern of dental services use. No statistically significant differences between groups were found in sweet consumption, such as chocolate and chewing gum. On the other hand, the pattern of dental services use, namely whether the adolescent had ever consulted a dentist, had consulted a dentist in the year before examination and used public dental care in the year before examination was associated with socioeconomic trajectories for both boys and girls. A higher proportion of girls from the never poor group brushed their teeth twice or more a day.

The proportion of adolescents who had consulted a dentist were, in general, higher among girls than boys in all four different family income trajectory groups, ranging from 94.6% among girls in the never poor group to 66.0% in boys from the always poor group. Use of private dental care upon the last visit varied significantly with socioeconomic trajectory groups for boys and girls (tables 4 and 5). The poor/non-poor group and the non-poor/poor group showed intermediate values between the extremes of the scale and did not differ significantly from one another, except in the use of private dental care upon the last visit, which was higher in poor/non-poor groups than in always poor groups for males and females. The always poor group had 3.9 and 2.6 times higher use of public dental care than the never poor group by boys and girls, respectively.

DISCUSSION

This study from birth to age 15 years identified three different profiles in terms of dental caries index, oral behaviours and pattern of dental services use linked to family income trajectories. The first group included adolescents who were always poor, who in general showed the worst profile of dental caries, while adolescents who never were poor presented a better profile of dental caries and represented the second grouping. Adolescents who had moved from poverty in childhood to non-poverty in adolescence and those who had moved from non-poverty in childhood to poverty in adolescence represented a third, intermediate pattern of dental caries when compared with those at the extremes of the scale, although most of the differences between these two groups and the always poor group were not statistically significant.

Upward mobility did not reverse the adverse effects of low childhood socioeconomic status, corroborating the findings by Poulton *et al* in New Zealand.[2] On the other hand, dental outcomes were very similar in groups who were from upwardly and downwardly mobile families, showing that those who experienced poverty in at least one stage of life showed compromised dental health status. These findings are in agreement with the models of risk accumulation that focus on the importance of exposure over time and the sequence of exposures.[18]

The results of the present work also support the social-origin hypothesis. Adolescents who were born and grew up in poverty, namely those from the always poor group, had on average poorer dental health and presented with a worse profile of tooth brushing habits than their better-off counterparts. The most important difference, when behavioural factors were compared between the four groups, was that the always poor group had a lower frequency of tooth brushing, especially among girls. This implies lower exposure to topical fluoride in toothpaste and a worse profile of dental cleaning, which may explain their higher levels of dental caries. In addition, they attended dental services less frequently than their better-off counterparts, which may explain the large number of untreated dental cavities in this group.

On the other hand, we were unable to confirm the upward mobility hypothesis. On the contrary, the non-poor/poor and poor/non-poor groups were very similar in most measurements of dental caries and oral behaviours. Adolescents who experienced upward mobility did not overcome the consequences of a previous period of poverty.

According to Grytten and Holst,[19] several US studies reported a positive and strong relation between income and demand for dental care when treatment need is high, and less pronounced associations when need is low. However, dental attendances have little effect on reducing dental caries[20 21] although access to dental care may improve the quality of life of affected individuals.

Pelotas has a fluoridated water supply system benefiting almost the entire population.[22] Thus, differences in water fluoridation consumption cannot explain our findings.

In general, boys had fewer treated dental caries than girls in all groups. Oral behaviour is known to be better among girls.[23] Girls tended to have better dental care than boys, probably reflecting their increased concern about health and aesthetics. Paradoxically, girls in the never poor groups had a higher mean DMFT which could be explained by higher dental care services use. Higher access to dental care may lead to an increase in DMFT index, especially regarding the number of filled teeth, as a result of overtreatment.

Comprehensive studies of oral health inequalities throughout life must satisfy certain criteria, such as the use of a cohort study design and examination of population-based samples, and should commence early during the participants' lives.[10] In the present investigation, family income data were collected throughout the life course in a longitudinal study; a representative sample of all adolescents of the city was studied, and the

observers who dentally examined the sample did not know to which group each adolescent had been assigned. Consequently, selection, recall or classification bias is unlikely to have occurred, strengthening the internal validity of the study. On the other hand, the results cannot be extrapolated to Brazil as a whole since the population studied had better social and health indicators than those living in the North and Northeast regions.

These findings highlight the role of deprivation in dental caries and in related oral behaviours and dental services use, confirming findings that have been reported for most chronic diseases. The dental indicator differences between groups can be explained mainly on the basis of dental health care. Although an universal coverage health system was implemented in Brazil, the present findings indicate that public health policy needs to target socioeconomic groups located at the bottom of the social ladder. The need for a common risk approach to both oral and general disease is also supported by these results.

Poverty in early life has an effect on dental caries, oral behaviours and dental services use later on, which is only partially mitigated by upward social mobility between childhood and adolescence.

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What is already known

- Health outcomes may be affected by socioeconomic position during different periods throughout the life course. Findings from several studies have emphasised the influence of socioeconomic childhood conditions on diseases later on.

What this paper adds

- This paper has explored oral health outcomes using a life course approach. Few studies have explored oral health outcomes adopting this approach; none of them was performed outside high-income countries, nor did they adopt a prospective birth cohort design.

Policy implications

- It is important to develop a nationwide oral health surveillance system in order to monitor inequalities in the distribution of oral diseases.
- This system may also instruct health programmes aimed at targeting resources to areas with higher levels of need, thus contributing to socially appropriate interventions in oral health.
- The present findings indicate that public health policy needs to target socioeconomic groups at the bottom of the social ladder.
- Because common risk factors are involved in dental caries and other chronic diseases, strategies for health care should include intersectoral approaches to health promotion based upon a population strategy.

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