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Effect of life-course family income trajectories on periodontitis: Birth cohort study

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Abstract

Aims: To quantify the impact of life course income trajectories on periodontitis in adulthood.

Materials and Methods: Data from the 1982 Pelotas Birth Cohort Study, Brazil, were used. Information on family income was collected at birth and ages 15, 19, 23 and 30 years. Group-based trajectory modelling was used to identify income trajectories. Periodontal measures were assessed through clinical examination at age 31. Log-Poisson regression models were used to estimate prevalence ratios (PRs) of any and moderate/severe periodontitis, as outcomes.

Results: Prevalence of any periodontitis and moderate/severe periodontitis was 37.3% and 14.3% (n = 539). Income trajectories were associated with prevalence of moderate/severe periodontitis. Adjusted PR in participants in low and variable income trajectory was 2.1 times higher than in participants in stable high-income trajectory. The unadjusted association between income trajectories and prevalence of any periodontitis was explained by the inclusion of behavioural and clinical variables in the model.

Conclusions: Low and variable life course income increased the prevalence of moderate/severe periodontitis at age 31 years. The findings may inform programmes in identifying and targeting potentially at-risk groups during the life course to prevent periodontitis.

KEYWORDS

cohort studies, disparities, health status, periodontal disease, social mobility, socioeconomic factors

1 | INTRODUCTION

It is widely debated within social epidemiology that social conditions are more than distal causes of disease. Acting through several pathways, they have a fundamental role in disease causation (Link & Phelan, 1995). Socio-economic positions are changeable during the life course, and the effect of socio-economic position (SEP) on health outcomes differs according to the extent and period of exposure to relative social disadvantage. For example, it has been suggested that the experience of short and long periods of poverty is fundamentally different and, therefore, should be studied and categorized separately (McDonough, Sacker, & Wiggins, 2005; Walker, 1998). Within such a context, it is plausible to assume that the effect of life course SEP trajectories in shaping adult health conditions may be different of a single-time SEP information (Chen, Martin, & Matthews, 2007). It is important to note that a minimum of three assessments is required to form a trajectory.

There is a substantial gap of studies evaluating the effect of SEP trajectories on oral health. Chronic periodontitis, together with

untreated dental decay and severe tooth loss, was indicated as a key oral health condition in the 2010 Global Burden of Disease study (Marcenes et al., 2013), and it remains a relevant public health problem. Studies that demonstrate the association between earlier SEP and periodontitis later in life neglect the dynamic processes through which social factors may affect health during the life course (Link & Phelan, 1995). A literature review conducted on PubMed database in June, 2016, found only four papers evaluating the influence of socio-economic trajectories on oral health outcomes, and none of these evaluated periodontitis (Delgado-Angulo & Bernabe, 2015a,b; Peres, Peres, Demarco et al., 2011; Peres, Peres, Thomson et al., 2011). Additionally, it is critical to understand the simultaneous and individual roles of different SEP measures, such as income and education, and their trajectories when studying the effects of SEP on health status (Hallal et al., 2012).

Although there is evidence pointing towards the association of SEP and a series of health outcomes, the majority of these studies have a cross-sectional design. Studies with a longitudinal design allow for constructing SEP trajectories over the life span and estimating its effects on health outcomes later in life (Chen et al., 2007). A temporal relationship on the association between relative lower socio-economic position and periodontitis has been evidenced in a systematic review, with individuals exposed to relative lower socio-economic position earlier in life presenting worse periodontal outcomes in adulthood (Schuch, Peres, Singh, Peres, & Do, 2017). However, to the best of the authors' knowledge, there is only one population-based prospective cohort study to date that investigated the association between childhood SEP and periodontitis in adulthood (Poulton et al., 2002). This study, however, did not capture the perspective of income trajectories over the life course, and it only evaluated the influence of exposure to socio-economic disadvantage in early life with periodontal outcomes in adulthood. Additionally, this study was conducted in a high-income country (New Zealand).

Therefore, the aims of the study were as follows: (i) to construct income trajectories over the life course of a birth cohort sample; (ii) to quantify its impact on the occurrence of periodontitis in adulthood controlling for covariates; and (iii) to analyse the interaction between income trajectories and participant's education and maternal education at participants' birth on the occurrence of periodontitis.

Clinical Relevance

Scientific rationale for study: There is a lack of studies evaluating income trajectories over the life course and how it affects periodontitis onset and progression in adulthood.

Principal findings: Individuals from low and variable income trajectories have double the risk of presenting moderate-to-severe periodontitis in adulthood than those in relatively stable high-income trajectories.

Practical implications: Special attention should be given to those patients at lower socio-economic trajectory groups over the life course, as they may be at a higher risk of developing periodontitis in adulthood.

2 | METHODS

2.1 | Study population

This study used data from the 1982 Pelotas Birth Cohort Study and is reported according to the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) Statement. Pelotas is a medium-sized city, with around 300,000 inhabitants, located in the southernmost state of Brazil. The prospective population-based birth cohort study started in 1982, when all hospital births that occurred in the city of Pelotas, Brazil, were identified. 5,914 live births, whose families lived in the urban area of the city, were included on the cohort study. This population has been followed eleven times (waves) since 1982. Oral health substudies were conducted when participants were aged 15 (1997), 24 (2006) and 31 years (2013). The Ethics Committee of the Federal University of Pelotas approved all substudies, and written informed consent was obtained from participants. Methodological details of the cohort study and previous results of the oral health substudies have been published elsewhere (Horta et al., 2015; Peres, Peres, Demarco et al., 2011).

2.2 | Variables—main exposure

The main exposure variable was trajectories of relative family income over the life course. To estimate the income trajectories, family income data from participants at birth and at ages 15, 19, 23 and 30 years were used. Income at each assessment was collected through face-to-face interviews. Young adulthood is usually a phase where individuals may become financially more independent and constitute new families. Family income referred to the total amount of household earnings in the month before the interview. Income information at each time point was categorized into tertiles, and for analytical purposes, the 2nd and 3rd tertiles were combined. Thus, the dichotomized income at each age comprised the poorest group (1st tertile) versus middle and highest income groups (2nd and 3rd tertiles). This categorization was adopted based on the evidence that middle and upper income groups in Brazil were comparable, while the poor lagged well behind (Victora, Fenn, Bryce, & Kirkwood, 2005).

Group-based trajectory analysis (GBTM; Nagin, 2005; Nagin & Odgers, 2010) was the statistical technique adopted to construct the income trajectories. This is a statistical method derived from a finite mixture modelling for approximating unknown trajectories across population members. GBTM aims to identify clusters of individuals with similar trajectories, and the model itself forms the trajectories based on maximum-likelihood estimation. A plug-in in the Software Stata, version 14.0 (Stata Corporation, College Station, TX, USA), was used for forming the trajectories (Jones & Nagin, 2013). When fitting the data using GBTM, the number of groups, the model distribution and the polynomial type were chosen. To decide the number of groups that best represented the heterogeneity in developmental trajectories

in our sample, Bayesian information criteria (BIC; Raftery, 1995) was used as a parameter. The logit distribution was the model adopted in our analyses, considering the dichotomous distribution of the income at each time point. Finally, a cubic model was used, which represents the highest polynomial order allowed with the Stata procedure 'TRAJ'. Trajectories were formed from five points during the life course of 539 individuals, and the output from the software showed a mean of 4.8 information on income per individual, confirming the low rate of missing information on the income variables.

2.3 | Variables—outcomes

The outcome of this study was periodontitis assessed at age 31 years. The research team consisted of six dentists as oral epidemiological examiners and six interviewers. The oral health substudy at age 31 was conducted in 2013 and comprised the 888 individuals in the sample selected from the oral health substudy at age 15 (1997). In 1997, a systematic sample of 70 (27%) of 259 census tracks in the city was selected and dwellings within those limits were visited. A total of 1,076 adolescents were interviewed. From those, a random sample of 900 adolescents was selected to participate in the oral health substudy at age 15.

The clinical oral examinations were conducted at participants' houses, following biosafety procedures recommended by the World Health Organization. Examiners used headlight, dental mirror and PCP2 periodontal probe with 2-mm banding (Hu-Friedy PCP-2; Rotterdam, the Netherlands). Prior to the clinical examination, the research team was trained and calibrated and 30 volunteers were clinically examined. The lowest intra-examiner reliability measure for periodontal outcomes was 0.85 (intra-class correlation coefficient). Clinical oral examination assessed four periodontal health indicators: bleeding on probing, supragingival dental calculus, gingival recession and periodontal pocket depth. Gingival recession and pocket depth were measured at six sites (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual and distolingual) on all teeth present, except third molars, and were recorded in millimetres. Dental implants were excluded in the examination, as well as teeth when the measurement was not possible for reasons such as large amount of dental calculus, orthodontic band or non-cooperation of the participant. Attachment loss (AL) was estimated as sum in millimetres of gingival recession and pocket depth at each site.

The criteria to define periodontitis were that proposed in partnership by the Centers for Disease Control and Prevention (CDC) and the American Academy of Periodontology (AAP; Eke, Page, Wei, Thornton-Evans, & Genco, 2012; Page & Eke, 2007). Two combinations of the CDC-AAP criteria were adopted as outcomes of this study: prevalence of any periodontitis and prevalence of moderate-to-severe periodontitis. Cases of any periodontitis were defined as having 2+ interproximal sites with 3+ mm of AL and 2+ interproximal sites with 4+ mm of periodontal pocket depth. Moderate-to-severe periodontitis was defined as having 2+ interproximal sites (not on same tooth) with AL of 4+ mm, or 2+ interproximal sites (not on same tooth) with 5+ mm of pocket depth.

2.4 | Covariates

Covariates included sex and maternal education at participant's birth, smoking status at age 23, dental flossing, bleeding on probing, dental calculus and presence of periodontal pocket at age 24 and participant's level of education at age 30. Detailed description of time of collection and categories of each variable is displayed in Table 2.

2.5 | Statistical analyses

Analyses were conducted using Stata, version 14.0. Descriptive analyses evaluated the representativeness of the oral health substudy at age 31 compared to the original cohort and the baseline of the oral health study. We also computed the distribution of the variables on our sample and the prevalence of the outcomes according to each independent variable. Additionally, we cross-tabulated the income trajectories against the outcome and covariates. Multivariable log-Poisson regression analyses with robust variance estimation were conducted for the two definitions of the outcome to estimate the effect of income trajectories on periodontitis. Model 1 included only sociodemographic characteristics, specifically the income trajectories, sex, maternal education at participant's birth and participant's education at age 30. Model 2 included all sociodemographic variables, behavioural variables at ages 23 and 24 and clinical variables at age 24. All variables were retained in Model 2, regardless of their *p* value. Interactions between income trajectories with maternal education at participants' birth and participants' education on the occurrence of periodontitis at age 31 were also tested separately in Model 2 for the two outcomes.

3 | RESULTS

A total of 539 individuals participated in the oral health substudy at age 31. Socio-economic and demographic characteristics of the followed-up sample were similar to the original 1982 Pelotas Birth Cohort study and to the baseline of the oral health study (age 15; Table 1). The prevalence of any periodontitis and moderate-to-severe periodontal disease was 37.3% and 14.3%, respectively (Table 2).

The GBTM identified three distinct income trajectories: trajectory 1 (Stable high income) comprised of 31.6% of the sample; trajectory 2 (Stable middle income) accounted for 46.0%; and trajectory 3 (Low and variable income) comprising 22.4% of the total sample. The latter trajectory is characterized by a relatively low income from birth to age 15 after which a steady increase in income was observed (Figure 1). The BIC value associated with this analysis was −1,514.99. As a comparison, the BIC value associated with four trajectory groups was −1,526.56 and with five trajectory groups was −1,541.89.

Distribution of the sample characteristics by income trajectories is presented in Table 3. A clear gradient was observed in distribution of the outcomes by income trajectories. Individuals in the low and variable income trajectory had higher prevalence of periodontitis

TABLE 1 Comparison of demographic and socio-economic characteristics at birth between the original sample and those located in the follow-up study at age 31. 1982 Pelotas Birth Cohort Study, Brazil

	Pelotas birth cohort, age 0, 1982	Baseline of oral health study, age 15, 1997	Follow-up study, age 31, 2013
Variables	***n* (%)**	***n* (%)**	***n* (%)**
Sex			
Male	3,037 (51.4)	480 (54.1)	273 (50.6)
Female	2,876 (48.6)	408 (45.9)	266 (49.3)
Total	5,913 (100.0)	888 (100.0)	539 (100.0)
Maternal skin colour			
White	4,851 (82.1)	743 (83.8)	454 (84.2)
Black	1,060 (17.9)	144 (16.2)	85 (15.8)
Total	5,911 (100.0)	887 (100.0)	539 (100.0)
Family income at birth			
≤1 MW	1,288 (21.9)	161 (18.2)	93 (17.3)
1.1–3 MW	2,789 (47.4)	457 (51.7)	282 (52.4)
>3 MW	1,808 (30.7)	266 (30.1)	163 (30.3)
Total	5,885 (100.0)	884 (100.0)	538 (100.0)
Maternal education at birth (years)			
0–4	1,960 (33.2)	285 (32.2)	162 (30.1)
5–8	2,454 (41.5)	393 (44.4)	254 (47.2)
9+	1,493 (25.3)	208 (23.5)	122 (22.7)
Total	5,907 (100.0)	886 (100.0)	538 (100.0)

defined by the two case definitions. Women were about 53% of the sample in stable high-income and stable middle-income trajectories, while almost 58% in low and variable income trajectory. Presence of periodontal pocketing at age 24 also showed a gradient, with 8.8% of individuals from trajectory 3 having 1+ teeth with 4 mm+ periodontal pocket, compared to 1.5% in trajectory 1. Table 3 also presents distribution of income tertiles at each age on income trajectories over the life course.

Unadjusted estimates showed that participants in income trajectory 3 had 1.5 (95% CI: 1.0; 1.9) times higher prevalence of any periodontitis than those in income trajectory 1 (Table 4). The inclusion of sociodemographic characteristics in Model 1 slightly attenuated the difference in the prevalence ratio between the two extreme trajectories, but it remained significant (trajectory 3 PR 1.4 [95% CI: 1.0; 2.0]). The unadjusted association between income trajectories and prevalence of any periodontitis lost its statistical significance after the inclusion of health behaviours and clinical oral variables in Model 2 (trajectory 3 PR 1.4 [95% CI: 1.0; 2.0]). Sex, dental calculus and presence of periodontal pocketing at age 24 were associated with prevalence of any periodontitis in the final model, with being male and those with higher number of teeth with calculus and periodontal pocket presenting higher adjusted PRs.

Table 5 displays log-Poisson regression models of the association of moderate-to-severe periodontitis by income trajectory during the life course. After adjustment for covariates, income trajectories were significantly associated with moderate-to-severe periodontitis, with participants in trajectory 3 having 2.1 (95% CI: 1.1; 4.1) times higher prevalence than participants in trajectory 1. Sex and presence of periodontal pocketing at age 24 were also associated with moderate-to-severe periodontitis at age 31.

The final models for both outcomes do not include interaction terms, as interactions between trajectories and participants' education at age 30 and trajectories and maternal education at birth were not statistically significant in any model.

4 | DISCUSSION

Income trajectories from birth to age 30 influenced the occurrence of any periodontitis and of moderate-to-severe periodontitis at age 31 in a middle-income country. This association remained significant even after adjustment for sociodemographic, behavioural and clinical variables. To the best of the authors' knowledge, this is the first paper in the health literature evaluating the influence of income trajectories on periodontal health outcomes.

Some strengths of the present study are noteworthy. Firstly, the 1982 Pelotas Birth Cohort Study is one of the longest and largest running birth cohorts and the only with clinical oral health data in low- and middle-income countries (Horta et al., 2015). Secondly, trained and calibrated dentists conducted the data collection, and the inter- and intra-examiner's reliability was considerably high. Thirdly, appropriate analytical techniques were applied to model income trajectories. With the use of the GBTM, the researchers were able to capture and combine changes of income levels during the life course from birth to the age of 30 years. Additionally, the participants followed up in the OH-13 presented sociodemographic characteristics comparable

TABLE 2 Description of the sample. 1982 Pelotas Birth Cohort Study, Brazil

Variables	The 2013 follow-up *n* (%)	Any periodontitis[a] *n* (%)	Moderate or severe periodontitis[b] *n* (%)
Income trajectory	*n* = 539	*n* = 201	*n* = 77
1 (Stable high income)	38.4	31.4	11.1
2 (Stable middle income)	40.4	38.5	14.7
3 (Low and variable income)	21.2	45.6	19.3
Sex	*n* = 539	*n* = 201	*n* = 77
Male	50.6	42.9	18.3
Female	49.3	31.6	10.1
Education (years of study—age 30)	*n* = 492	*n* = 185	*n* = 73
12+	45.5	34.8	12.1
9–11	31.5	37.4	13.5
0–8	23.0	43.4	22.1
Maternal education at birth (years)	*n* = 538	*n* = 200	*n* = 77
9+	22.7	36.9	13.9
5–8	47.2	35.4	13.4
0–4	30.1	40.1	16.1
Smoking status	*n* = 511	*n* = 189	*n* = 72
Never	70.8	37.3	13.8
Former	9.8	24.0	8.0
Current	19.4	42.4	18.2
Dental flossing (age 24)	*n* = 477	*n* = 177	*n* = 65
Yes or sometimes	51.6	83 (33.7)	12.2
Never	48.4	94 (40.7)	15.1
Bleeding on probing (age 24)	*n* = 539	*n* = 201	*n* = 77
0 or 1 tooth	79.4	149 (34.8)	13.1
2 or more teeth	20.6	52 (46.8)	18.9
Dental calculus (age 24)	*n* = 539	*n* = 201	*n* = 77
0 or 1 tooth	25.6	34.1	15.9
2 or more teeth	74.4	38.4	13.7
Presence of 4 mm+ periodontal pocket (age 24)	*n* = 539	*n* = 201	*n* = 77
0 tooth	96.5	36.2	13.8
1 or more teeth	3.5	68.4	26.3
Periodontitis (CDC-AAP) age 31	*n* = 539		
Health	62.7	—	—
Mild	23.0	—	—
Moderate/severe	14.3	—	—

[a]Any periodontitis according to the CDC-AAP case definition (Eke et al., 2012).
[b]Health/mild versus moderate/severe periodontitis, according to the CDC-AAP case definition (Eke et al., 2012).

to those in the overall cohort study. The young age of our sample might also be a strength, allowing for early investigation of periodontitis. Finally, a comprehensive periodontal clinical examination was performed, allowing the researchers to use internationally recommended periodontitis case definitions (CDC-AAP case definitions).

A possible limitation of the study was that the covariates included in the models represented the situation in a specific time point; that is, they were not time-varying covariates. It might have limited the capacity of capturing all potential covariates, changes in covariates and their potential interactions. For example, smoking at different periods of life and changes in smoking status could affect periodontitis differently (Thomson, Broadbent, Welch, Beck, & Poulton, 2007). However, we were not able to capture such peculiarities.

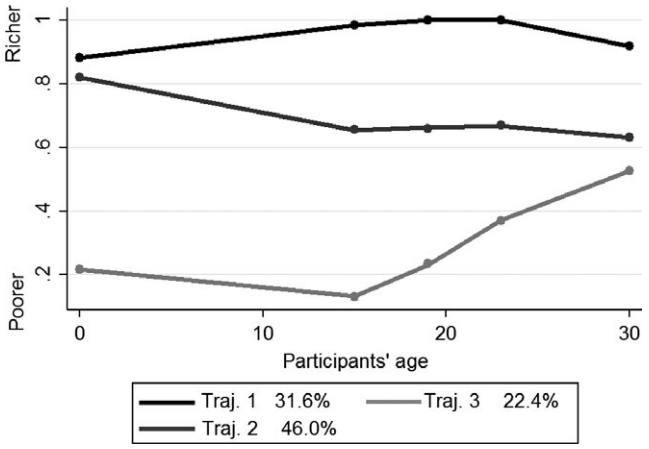

FIGURE 1 Income trajectories from birth to age 30. 1982 Pelotas Birth Cohort Study, Brazil

There are different pathways that can explain the association between income trajectories and periodontitis (Schuch, Peres, Do, & Peres, 2015). The most commonly discussed one is through behavioural variables, with smoking status being the most theoretically and empirically recognized predecessor condition of periodontitis (Thomson et al., 2007). In fact, it is well known that smoking status follows a socio-economic gradient in the population, with individuals standing lower in the socio-economic hierarchy presenting higher prevalence of smoking habits that their richer counterparts (Hiscock, Bauld, Amos, Fidler, & Munafo, 2012) and this is true also for individuals living in Brazil (Barros, Cascaes, Wehrmeister, Martinez-Mesa, & Menezes, 2011). Additionally, as aforementioned, smoking status is a risk factor for periodontitis, and it is plausible to assume it is in the causal pathway between income trajectories and periodontitis. Having said that, after accounting for smoking status, our results remained significant, suggesting that a direct effect of income trajectories on periodontal outcomes may exist. Other important conditions, such as bleeding on probing and presence of dental calculus, as indicators of oral hygiene, and dental pattern flossing, were also accounted for in our analysis. Our results showed that income trajectories during the first 30 years of life influenced the occurrence of moderate-to-severe periodontitis at age 31, regardless of these behavioural factors.

Another potential link between income trajectories and periodontitis is a stress pathway. According to such a pathway, psychosocial stressors over the life course may affect the immune response of the individual, leading to an increased susceptibility of periodontitis (Schuch et al., 2015). It has been argued that such an exposure may have an exacerbated effect if happening in early childhood, as it is the period of the immune system maturation (Nicolau, Netuveli, Kim, Sheiham, & Marcenes, 2007). This reinforces the need of considering the physical and emotional environment of the population when promoting health, as these circumstances potentially impact many health outcomes, including periodontitis. It is also paramount to understand the potential impact children's life circumstances can have for their future periodontal health, as well as triggered factors form childhood that have lifelong effects.

TABLE 3 Description of the sample according to socio-economic trajectories. 1982 Pelotas Birth Cohort Study, Brazil

	Trajectory 1 Stable high income		Trajectory 2 Stable middle income		Trajectory 3 Low and variable income	
Variables	***n***	**%**	***n***	**%**	***n***	**%**
Periodontitis (CDC-AAP; *n* = 539)						
No periodontitis	142	42.0	134	39.6	62	18.3
Mild	42	20.3	52	23.8	30	26.3
Moderate/severe	23	11.1	32	14.7	22	19.3
Sex (*n* = 539)						
Male	111	53.6	114	52.3	48	42.1
Female	96	46.4	104	47.7	66	57.9
Education (years of study—age 30; *n* = 492)						
12+	126	70.0	83	39.9	15	14.4
9–11	38	21.1	78	37.5	39	37.5
0–8	16	8.9	47	22.6	50	48.1
Maternal education at birth (years; *n* = 538)						
9+	78	37.7	36	16.5	8	7.1
5–8	96	46.4	120	55.1	38	33.6
0–4	33	15.9	62	28.4	67	59.3
Smoking status (*n* = 511)						
Never	160	80.8	131	64.5	71	64.5
Former	17	8.6	20	9.9	13	11.8
Current	21	10.6	52	25.6	26	23.6
Dental flossing (age 24; *n* = 477)						
Yes or sometimes	113	61.4	99	51.8	34	33.3
Never	71	38.6	92	48.2	68	66.7
Bleeding on probing (age 24; *n* = 539)						
0 Tooth	171	82.6	174	79.8	83	72.8
1 or more teeth	36	17.4	44	20.2	31	27.2
Dental calculus (age 24; *n* = 539)						
0 Tooth	63	30.4	47	21.6	28	24.6
1 or more teeth	144	69.6	171	78.4	86	74.4
Presence of 4 mm+ periodontal pocket (age 24; *n* = 539)						
0 Tooth	204	8.5	212	97.2	104	91.2
1 or more teeth	3	1.5	6	2.8	10	8.8
Income birth (*n* = 539)						
1st tertile	27	13.0	34	15.6	98	86.0
2nd and 3rd tertiles	180	87.0	184	84.4	16	14.0
Income age 15 (*n* = 534)						
1st tertile	0	—	86	39.8	105	92.9
2nd and 3rd tertiles	205	100.0	130	60.2	8	7.1
Income age 19 (*n* = 530)						
1st tertile	0	—	84	39.3	89	80.2
2nd and 3rd tertiles	205	100.0	130	60.7	22	19.8

(Continues)

TABLE 3 (Continued)

Variables	Trajectory 1 Stable high income n	%	Trajectory 2 Stable middle income n	%	Trajectory 3 Low and variable income n	%
Income age 23 (*n* = 511)						
1st tertile	0	—	69	34.0	80	72.7
2nd and 3rd tertiles	198	100.0	134	66.0	30	27.3
Income age 30 (*n* = 470)						
1st tertile	0	—	96	47.1	47	48.5
2nd and 3rd tertiles	169	100.0	108	52.9	50	51.5

A third potential pathway for the association between income trajectories and periodontitis may be related to a neo-materialist explanation. Additionally to individual exposures related to lack of resources, the neo-material interpretation considers the impact of societal factors on health outcomes. Under this explanation, contextual conditions related to the place where people live, such as a how resources are invested on human, physical, health and social infrastructure, are expected to have an effect on health outcomes, with individuals from more unequal societies presenting a higher burden of disease (Lynch, Smith, Kaplan, & House, 2000).

The evidence of the present study is in line with previous research in social epidemiology, showing that long-term and persistent exposure to relative socio-economic disadvantage earlier in life is associated with periodontitis later on (Poulton et al., 2002; Schuch et al.,

TABLE 4 Multivariable analyses between any periodontitis (CDC-AAP case definitions) and demographic, socio-economic, behavioural and clinical characteristics. Log-Poisson regression analysis. 1982 Pelotas Birth Cohort Study, Brazil

Variables	Crude analysis (*n* = 539) PR (95% CI)	*p*	Model 1 (*n* = 491) PR (95% CI)	*p*	Model 2 (*n* = 433) PR (95% CI)	*p*
SEP trajectory						
1 (Stable high income)	1.0	<.01	1.0	.05	1.0	.11
2 (Stable middle income)	1.2 (0.9;1.6)		1.2 (0.9;1.5)		1.1 (0.8;1.4)	
3 (Low and variable income)	1.5 (1.0;1.9)		1.4 (1.0;2.0)		1.4 (1.0;2.0)	
Sex						
Male	1.0	<.01	1.0	.01	1.0	.03
Female	0.7 (0.6;0.9)		0.8 (0.6;0.9)		0.8 (0.6;1.0)	
Education (years—age 30)						
12+	1.0	.13	1.0	.56	1.0	.67
9–11	1.1 (0.8;1.4)		1.0 (0.8;1.3)		1.0 (0.7;1.3)	
0–8	1.2 (0.9;1.6)		1.1 (0.8;1.5)		1.1 (0.8;1.6)	
Maternal education at birth						
9+	1.0	.53	1.0	.45	1.0	.43
5–8	1.0 (0.7;1.3)		0.8 (0.6;1.0)		0.8 (0.6;1.1)	
0–4	1.1 (0.8;1.5)		0.9 (0.6;1.2)		0.8 (0.6;1.2)	
Smoking status (age 23)						
Never	1.0	.62	—	—	1.0	.83
Former	0.6 (0.4;1.1)		—		0.7 (0.4;1.1)	
Current	1.1 (0.9;1.5)		—		1.0 (0.8;1.4)	
Dental flossing (age 24)						
Yes or sometimes	1.0	.12	—	—	1.0	.55
Never	1.2 (0.9;1.5)		—		0.9 (0.7;1.2)	
Bleeding on probing (age 24)	1.0 (1.0;1.1)	<.01	—	—	1.0 (1.0;1.1)	.09
Dental calculus (age 24)	1.0 (1.0;1.0)	<.01	—	—	1.0 (1.0;1.0)	.04
Periodontal pocket (age 24)	1.2 (1.1;1.3)	<.01	—	—	1.1 (1.1;1.2)	<.01
Number of teeth (age 24)	1.0 (0.8;1.1)	.73			1.0 (0.8;1.1)	.79
SEP traj × Education age 30[a]		.06				
SEP traj × Maternal education[a]		.25				

Model 1: Sociodemographic variables. Model 2: Full model.
[a]Interactions were included separately in Model 2 and not statistically significant in the final model.

TABLE 5 Multivariable analyses between moderate or severe periodontitis (CDC-AAP case definitions) and demographic, socio-economic, behavioural and clinical characteristics. Log-Poisson regression analysis. 1982 Pelotas Birth Cohort Study, Brazil

	Crude analysis (n = 539)		Model 1 (n = 491)		Model 2 (n = 433)	
Variables	**PR (95% CI)**	***p***	**PR (95% CI)**	***p***	**PR (95% CI)**	***p***
SEP trajectory						
1	1.0	.04	1.0	.058	1.0	<.05
2	1.3 (0.8;2.2)		1.2 (0.7;1.9)		1.1 (0.6;2.1)	
3	1.7 (1.0;3.0)		1.8 (1.0;3.2)		2.1 (1.1;4.1)	
Sex						
Male	1.0	<.01	1.0	.01	1.0	.02
Female	0.6 (0.4;0.9)		0.6 (0.4;0.9)		0.6 (0.4;0.9)	
Education (years—age 30)						
12+	1.0	.02	1.0	.17	1.0	.60
9–11	1.1 (0.7;1.9)		1.0 (0.6;1.7)		0.9 (0.5;1.6)	
0–8	1.8 (1.1;3.0)		1.5 (0.9;2.4)		1.2 (0.6;2.2)	
Maternal education (years)						
9+	1.0	.59	1.0	.51	1.0	.55
5–8	1.0 (0.6;1.7)		0.7 (0.4;1.3)		0.8 (0.4;1.6)	
0–4	1.2 (0.7;2.0)		0.8 (0.4;1.4)		0.8 (0.4;1.6)	
Smoking status (age 23)						
Never	1.0	.43	—	—	1.0	.93
Former	0.6 (0.2;1.5)		—		0.7 (0.3;1.9)	
Current	1.3 (0.8;2.2)		—		1.1 (0.6;1.9)	
Dental flossing (age 24)						
Yes or sometimes	1.0	.35	—	—	1.0	.52
Never	1.2 (0.8;2.0)		—		0.8 (0.5;1.4)	
Bleeding on probing (age 24)		.25		—		.34
Continuous	1.0 (1.0;1.1)		—		1.0 (1.0;1.1)	
Dental calculus (age 24)						
Continuous	1.0 (1.0;1.1)	.23	—	—	1.0 (1.0;1.1)	.44
Presence of periodontal pocket (age 24)						
Continuous	1.2 (1.1;1.4)	<.01	—	—	1.2 (1.0;1.3)	<.05
Number of teeth (age 24)						
Continuous	1.1 (0.8;1.4)	.73			1.1 (0.9;1.5)	.40
SEP traj × Education age 30[a]		<.01				
SEP traj × Maternal education[a]		.06				

Model 1: Sociodemographic variables. Model 2: Full model.

[a]Interactions were included separately in Model 2 and not statistically significant in the final model.

2017). Although there have been studies evaluating the effect of early childhood exposures and social mobility in oral health, few studies analysed an association using a life course approach. The current study is the first one using the perspective of income trajectories over the lifespan.

Some questions on the association between socio-economic position during the life course and periodontitis in adulthood remained unclear. As it has been suggested, the fact that cumulative family income is clearly important for the occurrence of disease does not preclude the idea that income at a specific point may have a stronger effect than in other moments of life (Chen et al., 2007). It is important to know exactly what is most critical period of life, that is when the socio-economic disadvantage will have a greater impact on occurrence of disease later on. Such evidence would inform a timely appropriate

intervention in the group of risk. It is theoretically plausible to assume that some behavioural characteristics over the life course, such as smoking status and flossing pattern, would mediate such an association. This role, however, is still not clear in the literature, and further studies are needed to deeply understand this question.

In conclusion, income trajectories from birth to age 30 years affected moderate-to-severe periodontitis measured in the fourth decade of life, even after controlling for demographic, behavioural and clinical variables. The findings contribute to identifying income as a structural determinant of this chronic oral condition and inform population-based measures to prevent periodontitis.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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