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Comparing lifecourse models of social class and adult oral health using the 1958 National Child Development Study

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Objective: To identify the lifecourse model that best describes the association between social class and adult oral health. ***Methods:*** Data from 10,217 participants of the 1958 National Child Development Study were used. Social class at ages 7, 16 and 33 years were chosen to represent socioeconomic conditions during childhood, adolescence and adulthood, respectively. Two subjective oral health indicators (lifetime and past-year prevalence of persistent trouble with gums or mouth) were measured at age 33. The critical period, accumulation and social trajectories models were tested in logistic regression models and the most appropriate lifecourse model was identified using the structured modelling approach**.** ***Results:*** The critical period model showed that only adulthood social class was significantly associated with oral health. For the accumulation model, a monotonic gradient was found between the number of periods in manual social class and oral health; and four out of eight social trajectories were found to be distinctive. Finally, the social trajectories model was not significantly different from the saturated model indicating that it provided a good fit to the data. ***Conclusion:*** This study shows the social trajectories model was the most appropriate, in terms of model fit, to describe the association between social class and oral health.

Key words: *social class, oral health, cohort studies, United Kingdom, lifecourse models*

Introduction

Three conceptual models have been proposed to clarify the complex and dynamic lifecourse processes that influence adult morbidity and mortality: the *critical period model* maintains that an exposure at a certain period of development results in adverse effects later in life; the *accumulation model* considers that exposures gradually accumulate over life to increase the risk of disease; and the *social trajectories model* refers to chains of risk by which one negative exposure increases the subsequent risk of another negative exposure (Ben-Shlomo and Kuh, 2002; Blane *et al.*, 2007; Kuh *et al.*, 2003; Lynch *et al.*, 2005). Knowing which model best reflects the timing and duration of exposure to socioeconomic disadvantage may provide important clues to address social inequalities in health.

The dynamics of how socioeconomic circumstances over time affect adults' oral health remains unclear. A few studies have explored lifecourse socioeconomic effects on adult oral health, using prospective data from the Pelotas Birth Cohort (Peres *et al.*, 2011), Newcastle Thousand Families Study (Pearce *et al.*, 2004; Mason *et al.*, 2006; Pearce *et al.*, 2009) and Dunedin Multidisciplinary Health and Development Study (Poulton *et al.*, 2002; Thomson *et al.*, 2004), and retrospective data from Finland and Brazil (Bernabe *et al*., 2011; Nicolau *et al*., 2007). However, only two have explored the three lifecourse models simultaneously (Bernabe *et al.*, 2011; Peres *et al.*, 2011). Hence, support for a particular model has been largely dependent on the *a priori* hypothesis being tested. No study to date has attempted to distinguish among these three models in relation to oral health. In addition, all the above studies assessed socioeconomic conditions in two specific time points only (early childhood and adulthood). This is the simplest scenario, and as such, unlikely to represent the entire array of socioeconomic circumstances that individuals experience across their lifespan.

Using data from an ongoing birth cohort study in the United Kingdom, which has not been previously used in relation to oral health inequalities, this study set out to identify the lifecourse model that best describes the association between social class and adult oral health.

Methods

Data for this study came from the National Child Development Study (NCDS), a birth cohort study of all 17,638 individuals born in England, Scotland and Wales during a week in 1958 (Power and Elliott, 2006). Childhood data were obtained from the mother, teacher and participant at 7, 11 and 16 years. Adulthood data were gathered at 23, 33, 42 and 50 years. This study used information on the first six sweeps, with the last one being carried out in 1991, at age 33 years. At birth, 98.7% of the eligible sample participated; at 7 years 92.2%; at 11 years 91.5%; at 16 years 86.7%; at 23 years 76.1%; and at 33 years 70.7% (Atherton *et al.*, 2008). Systematic differences between respondents and non-respondents are negligible in the 1958 NCDS (Atherton *et al.*, 2008; Tabassum *et al.*, 2008).

Social class at three points was chosen to represent exposure to socioeconomic disadvantage at different stages in the lifecourse. Childhood social class was based

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on the father's occupation when the cohort member was aged 7 years; adolescent social class was based on the father's occupation when the cohort member was 16 years old; and adulthood social class was based on the cohort member's own occupation at age 33 years. If there was no information on father's or own occupation, then the social class from the previous sweep was imputed (n=4,357 at age 7 from birth, n=2,570 at age 16 from 11 years, and n=636 at age 33 from age 23 years), in accordance with a number of previous studies (Mishra *et al.*, 2009; Murray *et al.*, 2011; Tabassum *et al.*, 2008). Social class was based on the Registrar General's six-group classification of occupations, namely professional (I); managerial and technical (II); skilled non-manual (IIINM); skilled manual (IIIM); partly skilled (IV); and unskilled (V) (Galobardes *et al.*, 2006). Binary indicators were created at each time point by collapsing the six classes into: 0, non-manual (classes I, II and IIINM); 1, manual (classes IIIM, IV and V).

At age 33 years, the interview questionnaire included sets of 3 questions about 15 common health problems/complaints, including persistent trouble with gums or mouth. The questions followed the same format across all the health problems, namely 'Have you ever suffered from or been told you had [complaint]?', 'Have you suffered from, or been told you had [complaint] in the last 12 months?' and 'Did you see a doctor (or dentist) in the past 12 months about your [complaint]? The response options were 'yes', 'only when pregnant' or 'no' for the first question and 'yes' or 'no' for the second and third. We chose the first two questions as measures of lifetime and past-year prevalence of persistent trouble with gums or mouth. To improve comparability across the two measures, the 'only when pregnant' responses (n=49) were merged with the 'yes' responses for analysis. Self-reported symptoms are valid and reliable indicators of individuals' oral health status and are positively correlated with disease measures (Blicher *et al.*, 2005; Thomson *et al.*, 2012; Eke *et al.*, 2013). For validity assessment, we explored the association of the two subjective indicators with a number of established determinants of oral health for which data were available at age 33 years. As expected, the two outcome measures were significantly related to demographic (gender), socioeconomic (education and employment) and behavioural factors (current smoking and consumption of sweets/chocolates). Furthermore, the two outcome measures were negatively correlated with self-rated general health.

All statistical analyses were performed using STATA v.12. The critical period, accumulation and social trajectories models were tested in logistic regression models treating the lifetime and past-year prevalence of persistent trouble with gums or mouth separately. As the critical period model assumes that one particular point in time has an effect on the outcome, there are as many scenarios as time points. Consequently, being in manual social class in childhood, adolescence or adulthood would increase the odds of reporting persistent trouble with gums or mouth. The independent effects of social class at childhood, adolescence and adulthood on each outcome were assessed in gender-adjusted and mutually adjusted models. The accumulation model assumes the longer the time spent in manual social class, the more chances of reporting persistent trouble with gums or mouth, irrespective of the time point at which the manual social class occurred. A summary score was created by summing the number of periods in manual social class, which ranged from 0 (reference group) to 3 (consistently manual). The association between this score and each outcome was assessed in gender-adjusted models. Linear trends were assessed fitting the accumulated number of periods in manual social class as a continuous variable. The social trajectories model assumes any downward mobility, in other words from non-manual (N) to manual (M) social class, would be harmful to oral health and lead to increasing odds of reporting persistent trouble with gums or mouth. Eight different social trajectories were evaluated: N-N-N (reference group); M-N-N, N-M-N and N-N-M; M-M-N, M-N-M and N-M-M, and M-M-M. The association between an indicator variable for social trajectories and each outcome was assessed in gender-adjusted models.

The most appropriate lifecourse model was selected using the structured modelling approach, which sets out three different hypothesised models using a counterfactual framework and contrasts them in a series of nested models (Mishra *et al.*, 2009). Briefly, given three binary measures of social class, the three lifecourse models can be formulated in terms of alternative specifications of regression models of the outcome on the time points S_1, S_2, S_3 and their two-way interactions. This means that alternative hypotheses can be tested by comparing each model specification to the fully saturated model (one including all main effects and possible interactions) using the partial likelihood ratio test, where large p-values indicate the nested model is as good as the saturated model, hence suggesting that particular hypothesis is supported by the data (Mishra *et al.*, 2009; Murray *et al.*, 2011).

Results

Data from 10,217 individuals (51% women) out of the 11,648 who participated in the 1991 survey were analysed for this study because they had information on all the variables selected for analysis. No major socio-demographic differences were found between the full sample of participants in the 1991 survey and those included in the present analysis. Persistent trouble with gums or mouth was uncommon, with a lifetime and past-year prevalence of 5.2% and 4.3%, respectively. In addition, 67%, 57% and 40% of participants were in the manual social class at ages 7, 16 and 33 years, respectively.

When examining the critical period model, adulthood social class but not childhood or adolescent social class was significantly related to both outcomes (Table 1). Those in manual social class at age 33 years, when compared with their non-manual counterparts, had odds ratios in relation to experiencing persistent trouble with gums or mouth of 1.31 when considering *ever* having experiencing this and 1.33 if considering the *last 12 months*, even after adjustment for childhood and adolescent social class.

For the accumulation model (Table 2), a significant monotonic gradient was found between the number of periods in manual social class and the two outcomes. More specifically, participants with three periods in manual social class had 1.32 times the odds of ever having persistent trouble with gums or mouth while participants with two

Table 1. Models for the association between social class at different lifecourse stages (critical period model) and persistent trouble with gums or mouth

Social class		*Ever had persistent trouble with gums or mouth*		*Persistent trouble with gums or mouth in last 12 months*	
		Model 1A	*Model 1B*	*Model 2A*	*Model 2B*
	n	*% OR [a] [95% CI]*	*OR [95% CI]*	*% OR [95% CI]*	*OR [95% CI]*
At age 7					
Non-manual	3,355	5.0 1.00 [reference]	1.00 [reference]	4.0 1.00 [reference]	1.00 [reference]
Manual	6,862	5.3 1.04 [0.86-1.26]	0.88 [0.69-1.12]	4.4 1.08 [0.88-1.33]	0.89 [0.68-1.16]
At age 16					
Non-manual	4,406	4.8 1.00 [reference]	1.00 [reference]	3.8 1.00 [reference]	1.00 [reference]
Manual	5,811	5.5 1.15 [0.97-1.38]	1.17 [0.93-1.46]	4.6 1.21 [0.99-1.47]	1.21 [0.95-1.56]
At age 33					
Non-manual	6,139	4.8 1.00 [reference]	1.00 [reference]	3.9 1.00 [reference]	1.00 [reference]
Manual	4,078	5.8 1.32 [1.10-1.58]**	1.31 [1.09-1.58]**	4.8 1.35 [1.11-1.64]**	1.33 [1.08-1.63]**

[a] Logistic regression models were fitted and odds ratios (OR) reported. Model A adjusted for gender only. Model B adjusted for gender and the other two social class periods.
* p<0.05; ** p<0.01; *** p<0.001

Table 2. Models for the association between the number of periods in manual social class (accumulation model) and persistent trouble with gums or mouth at age 33 years (n=10,217)

Number of periods		*Ever had persistent trouble with gums or mouth*		*Persistent trouble with gums or mouth in last 12 months*	
	n	*%*	*OR [a] [95% CI]*	*%*	*OR [95% CI]*
None	2,305	4.4	1.00 [Reference]	3.4	1.00 [Reference]
One	1,773	5.0	1.12 [0.84-1.50]	4.1	1.20 [0.87-1.66]
Two	3,439	5.5	1.24 [0.97-1.59]	4.6	1.33 [1.01-1.75]*
Three	2,700	5.6	1.32 [1.02-1.71]*	4.6	1.42 [1.07-1.90]*
p value for trend			*0.026*		*0.013*

[a] Logistic regression models were fitted and odds ratios (OR) reported. All models were adjusted for gender.
* p<0.05; ** p<0.01; *** p<0.001

Table 3. Models for the association between social class trajectories (social trajectories model) and persistent trouble with gums or mouth at age 33 years (n=10,217)

Social class trajectories			*Ever had persistent trouble with gums or mouth*	*Persistent trouble with gums or mouth in last 12 months*
		n	*% OR [a] [95% CI]*	*% OR [95% CI]*
——	N-N-N[b]	2,305	4.4 1.00 [reference]	3.4 1.00 [reference]
/—	M-N-N	905	4.0 0.87 [0.59-1.28]	3.4 0.97 [0.63-1.48]
\/	N-M-N	299	8.0 1.85 [1.17-2.94]**	7.0 2.09 [1.27-3.44]**
—\	N-N-M	569	4.9 1.15 [0.75-1.77]	3.7 1.11 [0.68-1.82]
_/	M-M-N	2,630	4.9 1.08 [0.83-1.41]	4.0 1.14 [0.84-1.53]
/\	M-N-M	627	7.2 1.74 [1.21-2.51]**	5.9 1.85 [1.24-2.77]**
_	N-M-M	182	8.2 2.05 [1.16-3.60]*	7.7 2.49 [1.68-4.49]**
_	M-M-M	2,700	5.6 1.33 [1.02-1.72]*	4.6 1.43 [1.07-1.91]*

[a] Logistic regression models were fitted and odds ratios (OR) reported. Models were adjusted for gender.
[b] M: Manual social class; N: Non-manual social class.
* p<0.05; ** p<0.01; *** p<0.001

Table 4. Comparison of the fit of alternative lifecourse models for the association between social class and mouth/gum trouble (n=10,217)

Lifecourse model	*Statistical equation tested* [a]	*Partial Likelihood Ratio (LR) test against saturated model* [b]		
		LR	*df* [c]	*p value*
Persistent mouth/gum trouble				
Critical period	$\alpha+\beta_1S_1+\beta_2S_2+\beta_3S_3$	10.99	4	0.027
Accumulation	$\alpha+\beta_1(S_1+S_2+S_3)$	16.92	4	0.002
Social trajectories	$\alpha+\beta_1S_1+\beta_2S_2+\beta_3S_3+\theta_{12}S_1S_2+\theta_{23}S_2S_3$	3.22	2	0.200
Mouth/gum trouble in the last 12 months				
Critical period	$\alpha+\beta_1S_1+\beta_2S_2+\beta_3S_3$	12.22	4	0.016
Accumulation	$\alpha+\beta_1(S_1+S_2+S_3)$	16.85	4	0.002
Social trajectories	$\alpha+\beta_1S_1+\beta_2S_2+\beta_3S_3+\theta_{12}S_1S_2+\theta_{23}S_2S_3$	2.41	2	0.300

[a] S_1, S_2 and S_3 refer to the three time points (6, 16 and 33 years, respectively). β_j and θ_{ij} refer to the regression coefficient for main and interactive effects

[b] The saturated model was $\alpha+\beta_1S_1+\beta_2S_2+\beta_3S_3+\theta_{12}S_1S_2+\theta_{23}S_2S_3+\theta_{13}S_1S_3+\theta_{123}S_1S_2S_3$

[c] df: degrees of freedom for the comparison against the saturated model
at age 33 years (n=10,217)

and three periods in manual social class had, respectively, 1.33 and 1.42 times the odds of having persistent trouble with gums or mouth in the last 12 months than those with no periods in manual social class.

For the social trajectories model (Table 3), four social class trajectories were significantly different from the stable non-manual group (N-N-N). Participants in trajectories N-M-N, M-N-M, N-M-M and M-M-M had, respectively, 1.85, 1.74, 2.05 and 1.33 times the odds of ever having persistent trouble with gums or mouth, and 2.09, 1.85, 2.49 and 1.43 times the odds of having persistent trouble with gums or mouth in the last 12 months than those in trajectory N-N-N (reference group).

Finally, the lifecourse model specifications and results from the structured modelling approach used for comparison are presented in Table 4. The social trajectories model was not significantly different from the saturated model, neither for lifetime (p=0.200) nor past-year prevalence of persistent trouble with gums or mouth (p=0.300), indicating that it provided good fit to the data. The specifications for the critical period and accumulation models showed poorer fit to data than the saturated model.

Discussion

We found a negative association between social class and having persistent trouble with gums or mouth in adulthood using each of the three lifecourse models. There was a critical period at age 33 years, suggesting that proximal experiences better account for the association between social class and oral health; a dose-response relationship between accumulation of socioeconomic disadvantage and oral health, with greater risk among those with three periods in manual social class; and four distinctive trajectories leading to differential oral health outcomes in adult life. However, we found that in terms of model fit the social trajectories model seemed to be the most appropriate.

Some limitations need to be borne in mind when interpreting the present findings. First, we used occupation-based social class to measure socioeconomic circumstances at different stages in life, ignoring other socioeconomic indicators relevant to oral health. A key strength of the Registrar's General Social Class system is its past official status in the UK, and hence, its widespread use in vital statistics and censuses over a long period of time. More importantly, it has been widely used to describe the socioeconomic gradient in health (Krieger *et al.*, 1997; Galobardes *et al.*, 2006). In addition, classifying social class into a binary variable of manual versus non-manual is a highly simplified approach, and prevented us from examining any potential gradient effects across the social spectrum. However, including more levels would have markedly increased the number of possible trajectories through life, with corresponding decline in the number of participants in each. Second, we used two unorthodox subjective oral health indicators, which may raise some concerns about their validity. However, following some standard methods for validity assessment of perceived measures (Locker and Miller, 1994; Gandek and Ware, 1998; Singh-Manoux *et al.*, 2006), we found that the two measures were sensitive to well-known socio-demographic and behavioural influences on oral health, on one hand, and were correlated with self-rated general health, on the other, thereby suggesting they might be acceptable indicators of how people view their oral health. A related point refers to the relatively low lifetime and past-year prevalence of persistent trouble with gums or mouth (around 5%). The questions aimed to identify individuals with regular rather than occasional complaints, and as such, they are indicative of severe or recurrent oral health problems only. Therefore, our findings require replication in other cohorts in the UK and elsewhere, using alternative socioeconomic as well as perceived and clinical oral health measures.

Four of the eight trajectories were found to be distinctive. They were manual only in adolescence (N-M-N), manual in childhood and adulthood (M-N-M), manual in adolescence and adulthood (N-M-M) and stable manual (M-M-M). We noted two distinctive patterns. First, aside from the two stable trajectories the other three shared a common experience of downward mobility, either from childhood to adolescence or from adolescence to adulthood. Hence, our findings indicate that any downward mobility may have a detrimental effect on adult oral health, which is unlikely to vanish. However, social class at age 33 years might not reflect the final social destination, and adult achievement later in life might increasingly undo earlier influences (Poulton *et al.*, 2002; Thomson *et al.*, 2004). Second, experiences of manual social class in later stages of life appeared to have a stronger impact on oral health than experiences at early life. This is particularly important as the relevance of the social trajectories model lies in the possibility of tracking individuals' trajectories over time. In other words, if there are social mobility effects then the effect on oral health in any given period would depend on what the individual was before and on what he or she will be in the future (Hallqvist *et al.*, 2004; Blane *et al.*, 2007). It is worth noticing that our analysis, based on data from birth to age 33 years, reflects inter-generational (from parents' to individuals' own social class) rather than intra-generational mobility (movement within a generation). However, most social mobility is likely to occur at younger age groups (Blane *et al.*, 1993).

It has been suggested that these lifecourse models are not mutually exclusive and may operate simultaneously (Hallqvist *et al.*, 2004; Rosvall *et al.*, 2006). However, a systematic review of models of lifecourse socioeconomic factors recommended that multiple lifecourse models should be tested in the same study (Pollitt *et al.*, 2005). By using a new structured modelling approach, we were able to distinguish among the three hypothesised lifecourse models and choose the most parsimonious. This approach is preferable to simply interpreting the results from a single pre-specified model without considering the relative merits of alternative models (Murray *et al.*, 2011; Mishra *et al.*, 2013). There is some literature supporting the idea that different models may operate for different outcomes and exposures (Kakinami *et al.*, 2013; Mishra *et al.*, 2013). Therefore, it is both possible and plausible that different lifecourse models are relevant for specific health outcomes.

In conclusion, this study shows that the social trajectories model was the most appropriate, in terms of model fit, to describe the association between social class experience from age 6 to 33 years and adult oral health in the 1958 National Child Development Study.

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