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Oral-health-related beliefs, behaviours, and outcomes through the life course.

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Abstract

Complex associations exist between socio-economic status (SES) in early life, beliefs about oral health care (held by both individuals and their parents) and oral-health-related behaviours. The pathways to poor adult oral health are difficult to model and describe, especially due to a lack of longitudinal data. The study aim was to explore possible pathways of oral health from birth to adulthood (age 38 years), We hypothesised that higher socio-economic position in childhood would predict favourable oral health beliefs in adolescence and early adulthood which, in turn, would predict favourable self-care and dental attendance behaviours; those would lead to lower dental caries experience and better self-reported oral health by age 38. A generalized structural equation modeling approach was used to investigate the relationship between oral-health-related beliefs, behaviours in early adulthood , and the dental health outcomes and QoL in adulthood (age 38), based on longitudinal data from a population-based birth cohort. The current investigation utilised prospectively-collected data on early (age 3-15 years) and adult SES (age 26 and 32 years), oral-health-related beliefs (ages 15, 26, and 32 years), self-care behaviours (ages 15, 28, and 32 years), and oral health outcomes such as the number of carious missing tooth surfaces, and oral-health-related quality of life (age 38 years). Early SES and parental oral health-related beliefs were associated with the Study members' oral health-related beliefs which, in turn, predicted toothbrushing and dental service use. Toothbrushing and dental service use were associated with the number of untreated carious and missing tooth surfaces in adulthood. The number of untreated carious and missing tooth surfaces were associated with oral health-related quality of life. Oral health towards the end of the fourth decade of life is associated with both intergenerational factors and various aspects of people's beliefs, SES, dental attendance and self-care operating since the childhood years.

Introduction

Oral conditions can affect quality of life, with consequences including dysfunction, pain, discomfort, and disability. They consistently rank among the most frequently reported illness episodes (Spencer, 2001), yet have been described as the "silent epidemic" (Satcher, 2000), in that dental health issues are often overlooked in the wider health discourse. Chronic oral conditions (such as dental caries and periodontitis) are largely irreversible and cumulative (Locker, 1988), and so lifecourse epidemiology readily lends itself to their investigation. During childhood, the onset and progression of these conditions are driven by both structural and behavioural factors (Fisher-Owens et al, 2007). Structural factors include socio-economic position (Delgado-Angulo and Bernabe, 2015), social capital (Rouxel et al, 2015), and social and economic policies (Thomson et al, 2002). Behavioural factors include diet (Moynihan and Petersen, 2004), self-care (Walsh et al, 2010; Broadbent et al, 2011), and the use of dental care (Thomson et al, 2010; Aldossary et al, 2015).

Exposures that affect risk for the occurrence of chronic oral conditions may occur at any point in life, but investigating the interplay between those is challenging, and the effects of prior exposures are invariably modified by current circumstances (Hertzman et al, 2001). A number of life course models have been proposed, including the critical period model, the critical period model with later-life effect modifiers, the accumulation of risk model, and the chains of risk model (Nicolau et al 2007; Mishra et al, 2010). Structural equation modelling (SEM) has been proposed as a valid approach to investigating these life course models, but its satisfactory deployment in oral health research has been hindered by a lack of suitable longitudinal data (Newton and Bower, 2005; Baker and Gibson, 2014). Application of SEM to life course data may provide support for these life course theories about how social factors may shape a person's beliefs and behaviours throughout life, and ultimately affect oral health and quality of life. There have been only three previous reports from oral health studies using an SEM approach with longitudinal data. One was of Singaporean preschoolers and used a one-year follow-up (Gao et al, 2010); another was of Malaysian 12-13-year-olds and used a six-month follow-up (Baker et al. 2010), and the third was of Thai 10-14-year-olds and used follow-ups at three, six and nine months (Gururatana et al, 2014). Such short follow-up times carry the risk of spurious associations because there may be insufficient variation in the observed disease incidence (or increment), and the true effects of putative determinants may remain obscure. Thus, our

understanding of how unfavourable oral health behaviours originate, persist, and affect health is limited by a lack of available longitudinal lifecourse data.

The aim of this study was to develop a model of oral health from birth to adulthood (age 38 years), using longitudinal data from a birth cohort study. Because most of our measures are categorical, we used generalised structural equation modelling (GSEM) to assess the associations between the variables instead of adopting a SEM approach. We hypothesised that higher socio-economic position in childhood would predict favourable oral health beliefs in adolescence and early adulthood which, in turn, would predict favourable self-care and dental attendance behaviours; those would lead to less untreated dental caries, fewer teeth lost due to caries, and better self-reported oral health by age 38 years.

Method

Participants were members of the Dunedin Multidisciplinary Health and Development Study, a longitudinal investigation of health and behaviour in a complete birth cohort. Study members were born in Dunedin, New Zealand, between April, 1972, and March, 1973, and 1037 (91% of eligible births; 52% male) participated in the first follow-up at age 3 years; these constituted the base sample for the remainder of the study. Cohort families represented the full range of socioeconomic status in New Zealand's South Island. Over 90% of cohort members identified as New Zealand European or "white", while 7.5 % self-identify as being Māori. This matches the ethnic distribution of the South Island of New Zealand. Follow-ups were done at ages 5, 7, 9, 11, 13, 15, 18, 21, 26, 32, and 38 years, when we assessed 961 (95.4%) of the surviving 1007 study members. The Otago Research Ethics Committee, Dunedin, New Zealand, granted ethics approval for each assessment phase. Study members gave informed consent before participating (Poulton et al., 2015).

The indicator of socio-economic status (SES) used in this analysis was occupation. 'Childhood SES' was calculated as the average of the highest SES level of either parent of each study member, assessed repeatedly from birth to 15 yrs. This method was used because measurement of SES at a single point early in life does not describe cumulative exposure to low SES during childhood. SES during adulthood was based on individually assessed occupation during the age-26 and age-32 interviews. Standard New Zealand occupationally based indices were used to classify SES (Elley and Irving, 1985; Irving and Elley, 1977). These classifications use a six-interval scoring system (where, for example, a

doctor scores '1' and a laborer scores '6'). The resulting scores were used to assign each individual to one of three SES groups using predetermined thresholds: scores of 1 and 2 were allocated to the 'high SES' group; those scoring 3 or 4 were allocated to the 'medium SES' group; and the remainder (scores 5 or 6) were categorized as 'low SES'.

Data on parental oral-health-related beliefs were collected when Study members were aged 5 years. Parents were asked whether they believed diet has a significant influence on tooth decay, and whether they believed that certain foods and drinks (specifically: milk, honey, fluoridated water, apples, sweet biscuits, peanuts, potato crisps, and dried raisins) help to "build strong teeth or keep them healthy". A score was derived as the percentage of questions answered correctly.

Data on Study members' oral-health-related beliefs were collected at ages 15, 18, and 26. The beliefs referred to the benefit for oral health of (1) avoiding a lot of sweet foods, (2) using fluoride toothpaste, (3) visiting the dentist regularly, (4) keeping the teeth and gums very clean, (5) drinking fluoridated water, and (6) using dental floss. They were asked to rate each item on a four point scale as 'extremely important', 'fairly important', 'doesn't matter much/not very important', or 'not at all important'. These were coded such that the higher the score, the more positive the oral health beliefs.

Study members were asked about their usual reason for visiting the dentist at age 26 and age 32 years. Dental attendance was reported on the basis as 'regular' (usually attends for dental check-ups) or 'non-regular' (attends the dentist only when a problem occurs). Study members were asked about their frequency of tooth brushing at ages 15, 26, and 32 years with the question 'when do you brush your teeth?' Response options included 'more than once a day', 'once a day', 'not every day', 'less than once a week', and 'never'. For the current analyses, response options were recoded to 'at least once a day' and 'less than once a day'.

Dental caries experience by age 38 years was assessed by three calibrated examiners, and the methodology used has been reported previously (Broadbent, 2013). Untreated dental caries and tooth loss are reported as counts of decayed and missing tooth surfaces (DS and MS respectively). The number of filled tooth surfaces is not included in the model because

a majority of dental restorations were placed prior to adulthood and do not affect oral health-related quality of life in the same way as missing teeth and untreated caries.

The short-form Oral Health Impact Profile (OHIP-14; Slade, 1997) was used to assess Study members' oral-health-related quality of life (OHRQoL) at age 38 years. The OHIP-14 questionnaire has 14 items corresponding to the seven domains of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Study members' experience of OHRQoL impacts during the 4 weeks prior to their age 38 interview were coded as 'very often' (scoring 4), 'fairly often' (3), 'occasionally' (2), 'hardly ever' (1) or 'never' (0). A total OHIP-14 score was calculated by summing responses over all 14 items, with possible scores ranging from 0 to 56. Item weights were not used.

Generalized Structural equation modeling was used to assess the relationships between early oral health influences, oral-health-related beliefs, oral-health-related behaviours, clinical health outcomes and OHRQoL. The hypothesized model of the relationships is presented in Figure 1. All statistical analyses were performed in Mplus version 5.12. Probit regression was used for categorical dependent variables. Both unstandardized and standardized effects are given, along with the bias-corrected bootstrap confidence intervals for the unstandardized results. A standardized effect can be interpreted as the proportion of a standard deviation increase in one variable due to a one standard deviation increase in another one. Latent variables were constructed for oral-health-related beliefs based on the participants' oral-health-related beliefs at ages 15, 18 and 26 years, and for overall adulthood SES using the adult SES status at ages 26 and 32. Similarly, the latent variables for describing adult dental health-related behaviours were based on dental attendance and tooth-brushing frequency at ages 26 and 32 years.

Results

The generalized structural equation model was undertaken based on data for 878 of the original 1037 Study members. Mplus uses all the available data in the analysis, but excluded 139 participants with missing data on either childhood or parental oral health-related beliefs and a further 20 participants who had either childhood or parental oral health-related beliefs information but were missing data for other variables. The model fit was good (RMSEA< 0.01). At age 38 years, OHIP-14 data were available for 848

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participants, among whom the mean OHIP-14 score was 8.0 (sd 8.2); one or more impacts were experienced frequently or always by 189 (22.3%).

The participants who were excluded from the analysis did not differ from those included in respect of childhood SES (χ^2=4.66, P=0.10). Of those included, 20.6% were in the low-SES group, 64.1% were in the medium-SES group, and 15.3% were in the high-SES group. These proportions were 22.2%, 56.2% and 21.6% (respectively) for the participants who were excluded.

The measurement part of the model is presented in Table 1, where the loadings of the observed variables on the latent variables are provided. Standardized loadings provide the size of the correlation between the observed variables and the latent variable. All the loadings for adult SES, dental attendance and tooth brushing frequency were statistically significant and substantially high, indicating that the constructed latent variables successfully summarized the information on the observed variables. Although the loadings for early oral-health-related beliefs were relatively lower than the loadings for the other latent variables, they were still reasonable.

In accordance with the study hypothesis, childhood SES was associated with participants' early adulthood oral beliefs at age 15, 18 and 26, as were parental oral-health-related beliefs. Positive dental beliefs at early adulthood then predicted better dental self-care behaviours at ages 26 and 32, such as attending for routine dental check-ups and brushing the teeth frequently. Furthermore, the model suggested that adult SES (at ages 26 and 32) is also a strong predictor of the dental self-care behaviours at ages 26 and 32.

Favourable dental self-care behaviours were more frequently observed among participants of higher adult SES. In terms of dental outcomes by age 38, the number of missing tooth surfaces was negatively associated with adult SES and dental attendance at ages 26 and 32. The number of decayed surfaces was negatively associated with all three variables: fewer decayed tooth surfaces were observed among participants with higher SES and among those with better self-care behaviours at ages 26 and 32. Finally, more decayed and missing tooth surfaces led to worse OHRQoL (Table 2; Figure 1).

Discussion

This study set out to identify important antecedents—from childhood through adolescence and early adulthood—in oral-health-related quality of life at the age of 38, using GSEM applied to a longitudinal data-set from a life course study. It found important roles for oral beliefs, socio-economic status in childhood and adulthood, dental attendance, self-care and accumulated dental caries experience.

A major strength of the current study is that it is the first SEM analysis to use oral health information collected prospectively over almost four decades; previous such investigations with SEM have used shorter follow-up periods of one year or less (Gao et al, 2010; Baker et al, 2010; Gururatana et al, 2014). Moreover, the current study used no exposure variables which were nearer than six years previously to the measurement of the dependent variables. The long period over which the exposure data were collected means that there can be few doubts about either the directionality of the observed associations or the variation in the dependent variables. The findings of the study are likely to be generalizable to populations developed nations similar to New Zealand. The study has some weaknesses; for example, the aggregated form of the Oral Health Impact Profile (OHIP-14) was used to represent oral health-related quality of life. Some have suggested that the GOHAI may be a more appropriate measure (Locker et al, 2001); nevertheless, the OHIP-14 is a validated and valuable epidemiological tool which correlates strongly with the GOHAI (Locker et al, 2001; Rodakowska et al, 2014). Difficulties may also arise with the use of occupation as an indicator of SES, since it is a proxy for educational attainment and income, and an individual may be well-educated or have a high income but be unemployed, or be unemployed and share a household with an employed person. Finally, a drawback of the GSEM approach used in this study is that it does not allow us to calculate indirect effects in the same way as using SEM, because the models are non-linear; however, this approach was necessary because of the categorical nature of many of the variables used in the model.

The findings help validate inferences drawn from recent applications of SEM in cross-sectional samples (e.g., Donaldson et al, 2008; Polk et al, 2010; Tolvanen et a, 2012; Duijster et al, 2014), as well as those from recent longitudinal research (e.g., Baker et al, 2010; Gao et al, 2010; Gururatana et al, 2014). As with those earlier studies, SES was of central importance: childhood SES shaped beliefs and directly influenced subsequent adult

SES. Oral-health-related beliefs were shown to be crucial in determining dental service utilisation and self-care (supporting earlier observations of the same birth cohort (Broadbent et al, 2006), and were substantially influenced by parental oral-health-related beliefs. The latter finding suggests a continuity in oral health beliefs about a range of preventive behaviours and (by extension) oral health which has also been highlighted earlier in findings from the same cohort (Shearer et al, 2011). Our data offer support for the central importance of the "accumulation of risk" model (Mishra et al, 2010) in the occurrence of oral disease and ill-health. That is, there is no strong evidence for a critical or sensitive period; rather, it is a balance of the ongoing adverse and beneficial exposures— along with contemporary influences (Hertzman et al, 2001)—which determine overall oral health and oral health-related quality of life in midlife.

Dental self-care (tooth brushing) in adulthood influenced all three aspects of dental caries experience by age 38, consistent with earlier observations relating to caries experience by age 32 (Broadbent et al, 2011). In turn, the number of tooth surfaces which were either decayed or missing due to dental caries was associated with oral-health-related quality of life at age 38. The model we present demonstrates a path of associations, linking factors acting in childhood, adolescence, and early adulthood with their effects on dental health and oral-health-related quality of life in mid-life. This path of associations illustrates how factors acting in childhood can affect an individual's oral health-related quality of life in adulthood.

In conclusion, the findings from this investigation of the determinants of dental caries experience and self-reported oral health by the age of 38 show that what we become towards the end of our fourth decade of life is influenced by both intergenerational factors and various aspects of our beliefs, socio-economic position, dental attendance and self-care which operate over the years since childhood.

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Table 1: Latent variable loadings for the observed variables in the model.

Latent variable	Std Estimate	Estimate	95% CI
Early oral health-related beliefs			
Oral health-related beliefs at age 15	0.568	--	--
Oral health-related beliefs at age 18	0.463	0.855	(0.616, 1.152)
Oral health-related beliefs at age 26	0.750	1.278	(0.969, 1.798)
Adult SES			
SES at age 26	0.741	--	--
SES at age 32	0.614	0.817	(0.572, 1.131)
Dental attendance			
Dental attendance at age 26	0.868	--	--
Dental attendance at age 32	0.889	1.025	(0.783 1.364)
Tooth brushing frequency			
Tooth brushing frequency at age 26	0.980	--	--
Tooth brushing frequency at age 32	0.871	0.883	(0.715, 1.049)

Table 2: Direct effects among the variables

Pathways	Std Estimate	Estimate	95% C.I.
Early oral health-related beliefs (from ages 15 to 26) on			
Childhood SES (from ages 3 to 15)	0.119	0.311	(0.083, 0.577)
Parental oral health-related beliefs	0.147	1.817	(0.725, 3.100)
Adult SES (at ages 26 and 32) on			
Childhood SES (from ages 3 to 15)	0.389	0.504	(0.385, 0.647)
Dental attendance (at ages 26 and 32) on			
Adult SES (at ages 26 and 32)	0.236	0.267	(0.129, 0.443)
Early oral health-related beliefs (from age 15 to 26)	0.362	0.203	(0.138, 0.288)
Tooth brushing frequency (at ages 26 and 32) on			
Adult SES (at ages 26 and 32)	0.421	0.549	(0.328, 0.849)
Early oral health-related beliefs (from age 15 to 26)	0.486	0.314	(0.228, 0.415)
Missing tooth surfaces (at ages 26 and 32) on			
Adult SES (at ages 26 and 32)	-0.203	-4.036	(-9.231, -0.175)
Dental attendance (at ages 26 and 32)	-0.334	-5.883	(-10.330, -2.811)
Tooth brushing frequency (at ages 26 and 32)	-0.034	-0.517	(-2.390, 2.205)
Decayed tooth surfaces (at ages 26 and 32) on			
Adult SES (at ages 26 and 32)	-0.189	-1.186	(-2.143, -0.367)
Dental attendance (at ages 26 and 32)	-0.214	-1.184	(-2.286, -0.395)
Tooth brushing frequency (at ages 26 and 32)	-0.225	-1.082	(-2.013, -0.427)
OHRQoL (age 38) on			
Missing tooth surfaces (at ages 26 and 32)	0.303	0.157	(0.091, 0.225)
Decayed tooth surfaces (at ages 26 and 32)	0.284	0.467	(0.297, 0.674)

Figure 1. Life course model of ==oral health-related== beliefs, behaviours, and health outcomes