Community Dental Health (2011) **28,** 216–221
Received 17 June 2009; Accepted 24 February 2010
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doi:10.1922/CDH_2573Brennan06

Dental self-care and visiting behaviour in relation to social inequality in caries experience

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Objectives: To investigate associations of dental behaviour with social inequality in oral health. ***Methods:*** A random sample of 45-54 year-olds from Adelaide, South Australia was surveyed by self-complete questionnaire in 2004-05 (n=879, response rate 43.8%). Oral examinations were performed by calibrated dentists on 709 persons (80.7% of participants). ***Results:*** The mean (SE) number of decayed teeth (D) was 0.4 (0.04), with 5.3 (0.2) missing teeth (M), 11.0 (0.2) filled teeth (F) and 16.6 (0.2) DMFT. The majority brushed their teeth 8 or more times per week (78.8%) and had made a dental visit within the last 12 months (63.7%). Nearly a quarter had a household income of under $30,000 (24.0%). Multivariate analysis showed a three-way interaction ($p<0.05$, GLM) between income and brushing and visiting for decayed teeth, showing that the relationship between decayed teeth and dental behaviour varied across levels of income. Among those who had not made a dental visit in the last 12 months, those who brushed their teeth 8 or more times per week in the low income group had D=0.7 (0.2) while those who brushed less often had D=2.2 (0.5) compared to D=0.3 (0.08) and D=0.3 (0.2) respectively in the high income group. ***Conclusion:*** Dental behaviour in terms of brushing and visiting was associated with social gradients in oral health for decayed teeth across income groups, with less favourable dental behaviour having a stronger negative association with oral health among lower income groups.

Key words*: caries experience, dental behaviour, SES*

Introduction

Poorer health has often been observed among poorer people (Davey Smith *et al*., 1990), including oral health. Social inequality in health is reflected in social gradients, whereby health of lower socio-economic groups (SES) is worse than that of their higher SES counterparts (Watt, 2007). Four types of explanations of health inequalities have been identified: artefact; selection; cultural or behavioural; and materialist (Sisson, 2007). The cultural or behavioural explanation contends that people in lower SES positions are more likely to engage in risk-taking behaviour that results in a social gradient in health.

Dentistry has been accused of being narrowly focussed on changing behaviour of high-risk individuals (Watt, 2007). The lifestyle approach has been criticised for being ineffective and costly, for blaming the victim by assuming that individual behaviours are freely chosen and not socially conditioned, for a lack of a theoretical basis, and for diverting resources away from upstream factors (Watt, 2007). However, dental behaviour has been shown to vary by SES, for example social inequality in dental visiting (Roberts-Thomson *et a*l., 1995) and dental behaviour has been associated with oral health (Brennan *et al*., 2007), but it has been reported that dental behaviour accounted for little, if any, of the socioeconomic gradient in oral health (Sanders and Slade, 2006).

In this study we examine whether dental behaviour has a differential association with oral health at different SES levels. Hence, the aims of the present study were to investigate associations of dental behaviour with social inequality in caries experience by examining social gradients in oral health in different strata of dental behaviour.

Methods

A total of 2,248 persons aged 45-54 years were randomly sampled from metropolitan Adelaide, South Australia, using the electoral roll as a sampling frame. The age range of 45-54 years was chosen as it is increasingly becoming a focus of oral health research as this age group continues to retain more natural teeth than previous generations. Sampled persons were surveyed by mailed self-complete questionnaire during 2004-2005. A primary approach letter was mailed, followed a week later by the questionnaire and then by a reminder card and up to four follow-up mailings of the questionnaire to non-respondents in order to achieve a higher response rate (Dillman, 1978). Respondents to the questionnaire were then telephoned and asked to participate in an oral examination where clinical measures of tooth status, caries experience, periodontal disease and treatment need were recorded using standard criteria (NIDR, 1987). Six trained dentists conducted the examinations in dental clinics using mirrors and probes under standard illumination. Prior to the fieldwork, the examiners were trained in the examination criteria using visual and written materials in a classroom situation. Following this they were calibrated against a gold-standard examiner in a clinic. Radiographs were not taken. A subset of 11 cases was re-examined by a subset of 4 examiners to assess reliability.

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Dental caries experience was recorded for all teeth present, including third molars, during the oral examination. Teeth were categorised as present or missing, and surfaces of tooth crowns were categorised as decayed, filled or sound. Five surfaces were coded for premolars and molars, with four surfaces coded for incisors and canines. Root surfaces were recorded separately. The components of DMFT were computed, with a tooth designated as decayed if any coronal surface was decayed, regardless of the status of the other coronal surfaces. If at least one coronal surface was filled, but there were no decayed surfaces, the tooth was designated as filled. The total number of teeth missing due to caries was summed. Unerupted or congenitally absent teeth were coded separately as were teeth that had been extracted for reasons other than caries, such as orthodontics, trauma or impaction. For the analysis two selected measures of caries were used: decayed teeth and missing teeth. These were chosen for their salience to social inequality, as decayed teeth represents untreated disease often involving pain and requiring treatment to arrest the disease and restore function, while missing teeth represent an unfavourable outcome of oral disease considered the dental equivalent of mortality. A range of explanatory variables was measured through the questionnaire spanning dental visit pattern, dental self-care, socio-demographics and socio-economic status. The dental visit pattern variable of *time since last dental visit* was classified into those who visited less than 12 months ago and those who visited 12 months ago or longer. The dental self-care variable of tooth brushing was classified into 0-7 times per week (corresponding to daily or less) and 8 or more times per week (more than once a day). Socio-economic status was defined using household income in the categories of under AU$30,000, $30,000 to $60,000 and over $60,000.

Response rates were adjusted by removing those subjects who did not have a chance to respond because they were not residing at the sampled address and those who were no longer residing within the geographical scope of the study (eg, were interstate or overseas). Persons who refused to participate were not counted as responses but retained in the denominator as were persons who did not respond and about which we had no information regarding their residence status. Representativeness of the sample respondents was assessed by comparison to census data (Australian Bureau of Statistics, 2006) and a range of oral health status, socio-demographic and dental visit pattern variables from another population survey (Carter and Stewart, 2003). Reliability was measured using intra-class correlation coefficients (Fleiss, 1986). Bivariate associations were assessed between the dependent variables of DT, MT, FT, DMFT and the explanatory variables of household income, and dental behaviour measured as time since last dental visit and tooth brushing frequency, using means and general linear models. A multivariate model was then constructed for the dependent variables of decayed teeth and missing teeth respectively using the complete set of three explanatory variables as main effects along with interaction terms. The association of caries experience by income was then examined stratified by dental behaviour variables for associations that showed significant interactions. The level of $p<0.05$ was adopted for statistical significance.

The research was approved by the Human Research Ethics Committee of the University of Adelaide.

Results

A total 879 persons responded giving a response rate of 43.8%, with 185 not at their sampled address, 54 out of scope and 605 refusing to participate. Oral examinations were performed on 709 persons (80.7% of participants). Participants generally showed a close approximation to the population profile (Table 1). Study participants had fewer teeth (25.4 vs 26.9 teeth), but there was no difference in denture wearing in comparison to the population-based comparison study profile. Study participants had a lower percentage visiting in the last 12 months (61.5% vs 65.4%) and fewer visits in the last 12 months (1.5 vs 1.8 visits) as well as a lower percentage that last visited privately (86.1% vs 95.2%), but there was no difference in the percentage receiving check-ups at the last dental visit. There were no differences in the percentage of females, Australian-born, of Indigenous status or from higher income households, but study participants had a higher percentage who spoke English as the main language at home (95.4% vs 91.9%) or who were concession card holders (19.0% vs 15.4%).

Intraclass correlation coefficients (ICC) were ICC=0.94 for teeth missing for any reason, ICC=0.77 for filled teeth, ICC=0.84 for DMFT, and ICC=0.59 for decayed teeth.

Unadjusted associations of caries experience by dental behaviour and income are presented in Table 2. Numbers of decayed teeth were higher among those with a longer time since last dental visit, a lower frequency of tooth brushing, and in the lower income groups. Numbers of missing teeth were higher among those with lower tooth brushing frequency and lower income groups. Numbers of filled teeth were higher for those with shorter times since last dental visit, and in the higher income groups. DMFT was higher for those with a lower frequency of tooth brushing and in the lower income groups.

The multivariate model of decayed teeth (Model $p<0.0001$, R-squared=19.6%) showed significant main effects of income, dental visiting and brushing frequency ($p<0.0001$), along with significant two-way interactions between visiting and brushing frequency ($p<0.05$), income and visiting ($p<0.01$), and between income and brushing frequency ($p<0.01$), as well as a significant three-way interaction (see Figure 1) between visiting, brushing frequency and income ($p<0.01$). The multivariate model of missing teeth (Model $p<0.0001$, R-squared=8.2%) showed significant main effects for income ($p<0.0001$) and brushing frequency ($p<0.01$), but not for dental visiting ($p=0.436$). The only significant interaction term was the two-way interaction (see Figure 2) observed between income and brushing frequency ($p<0.05$). The multivariate model of filled teeth (Model $p<0.0001$, R-squared=6.2%) showed significant main effects of dental visiting and income, but no interactions. The multivariate model of DMFT (Model $p=0.0002$, R-squared=5.6%) showed significant main effects of brushing frequency and income, but no interactions.

Table 1. Distribution of explanatory variables and comparison of study participants with the population profile

	(a) Census data	*(b) Comparison data*	*Study participants*	
Oral health status				(95% CI)
Number of teeth – mean	-	26.9	25.4	(24.9-25.8)
Denture (upper jaw) - %	-	13.7	13.6	(11.4-15.9)
Denture (lower jaw) - %	-	5.8	6.4	(4.7-8.0)
Dental visit pattern				
Last dental visit <12 months - %	-	65.4	61.5	(58.3-64.7)
Check-up at last dental visit - %	-	41.7	43.4	(40.1-46.7)
Last visit for relief of pain - %	-	-	15.4	(12.7-18.1)
Number of dental visits in last 12 months - mean	-	1.8	1.5	(1.4-1.7)
Visited private at last dental visit - %	-	95.2	86.1	(83.8-88.4)
Dental behaviour				
Tooth brushing 8 or more times per week - %	-	-	78.7	(75.6-81.8)
Use of mouth rinse 1 or more times / week - %	-	-	26.4	(23.1-29.7)
Cleaned between teeth 1 or more times / wk - %	-	-	32.1	(28.6-35.6)
Socio-demographics				
Female sex - %	48.5	51.2	52.0	(48.7-55.3)
Australian born - %	70.7	70.8	70.9	(67.9-74.0)
Indigenous - %	0.7	1.3	0.4	(0-4.3)
English main language at home - %	-	91.9	95.4	(94.0-96.8)
Education level of diploma or degree - %	-	-	42.3	(38.6-46.0)
Socio-economic status				
Concession card holder - %	-	15.4	19.0	(16.4-21.7)
Household income AU$80,000 or more - %	-	24.5	23.8	(20.9-26.6)

(a): Census 2006: Adelaide 45-54 year-olds
(b): National Dental Telephone Interview Survey 2002: South Australia – Adelaide 45-54 year-olds

Table 2. Distributions and bivariate associations with caries experience

		Decayed teeth		*Missing teeth*		*Filled teeth*		*DMFT*	
	%	*Mean*	*(SE)*	*Mean*	*(SE)*	*Mean*	*(SE)*	*Mean*	*(SE)*
Dental visit pattern		**		ns		**		ns	
within last 12 months	63.7	0.2	(0.03)	5.0	(0.18)	11.7	(0.21)	16.8	(0.24)
over 12 months	36.3	0.7	(0.09)	5.7	(0.33)	9.8	(0.32)	16.2	(0.37)
Dental self-care (Tooth brushing)		**		**		ns		**	
0-7 times per week	21.2	0.8	(0.14)	6.5	(0.48)	10.6	(0.44)	17.9	(0.48)
8 or more times/week	78.8	0.3	(0.03)	4.9	(0.17)	11.2	(0.20)	16.3	(0.23)
Socio-economic status (Income)		**		**		**		**	
under AU$30,000	24.0	0.8	(0.13)	6.6	(0.41)	9.8	(0.38)	17.1	(0.45)
AU$30-$60,000	29.4	0.4	(0.07)	5.6	(0.36)	11.5	(0.33)	17.5	(0.25)
over AU$60,000	46.6	0.2	(0.03)	4.3	(0.18)	11.3	(0.25)	15.8	(0.28)

**p<0.01, ns Not statistically significant

Among those who had not made a dental visit in the last 12 months the number of decayed teeth varied by income within the 0-7 times per week brushing frequency strata, and varied by brushing frequency within the low income group (Figure 1). Among those who had made a dental visit in the last 12 months the number of decayed teeth varied by income within the 8 or more times per week strata of tooth brushing frequency, and varied by brushing frequency within the medium income group (Figure 1). Missing teeth varied by income within both strata of brushing frequency, but only varied by brushing frequency within the medium income group (Figure 2).

Discussion

This paper showed that dental self-care and visiting were associated with variation in oral health in relation to level of SES. In particular, among those who had not made a recent visit, low tooth brushing frequency was associated with more decayed teeth compared to higher brushing frequency, but only for low SES levels not high SES.

These findings need to be considered in the context of social gradients in oral health reported from a range of countries. For example, lower SES has been related to tooth loss in the USA (Gilbert *et al*., 2003) and other

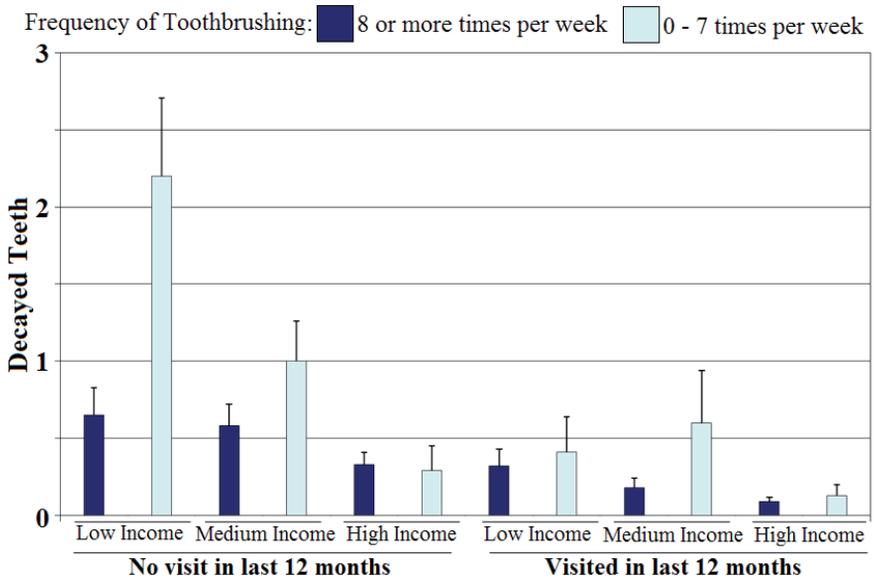

Figure 1. *Decayed teeth by income stratified by tooth brushing: among those who had and had not visited a dentist in the last 12 months*

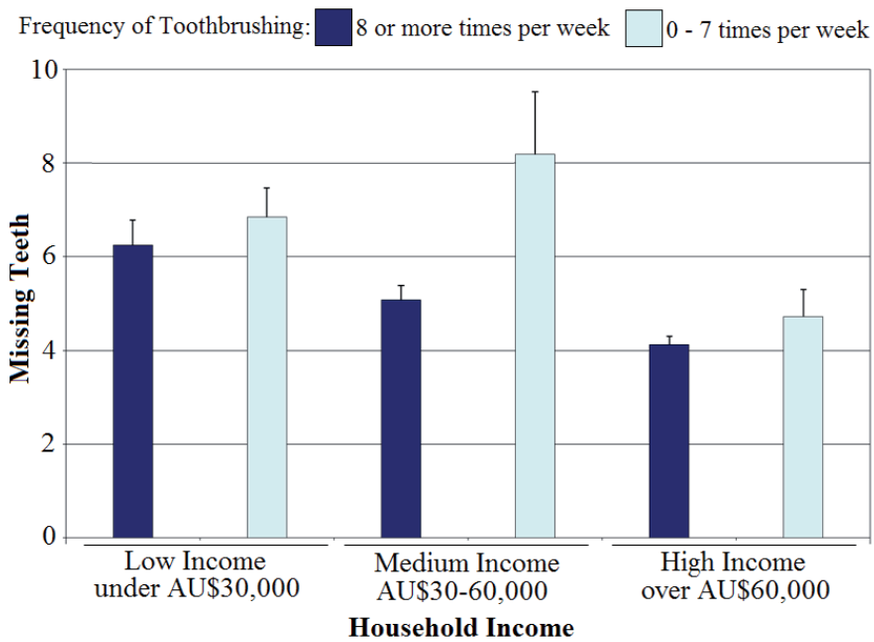

Figure 2. *Missing teeth by income stratified by tooth brushing frequency*

findings from the USA have reported similar income and education gradients in both oral and general health (Sabbah *et al*., 2007). Significant social gradients in periodontal disease have been reported among adolescents in Chile (Lopez *et al*., 2006). Inequalities in oral health have been reported between social classes in the UK (Watt and Sheiham, 1999). Socioeconomic inequalities in oral health in childhood and adulthood have been reported from a New Zealand birth cohort (Thomson *et al*., 2004). Income gradients in oral health-related quality-of-life have been reported from UK, Finland and Australia (Sanders *et al*., 2009). Inequity in access to dental care has been attributed to socioeconomic disparities in oral health in Sweden (Wamala *et al*., 2006). However, findings from the USA have indicated that improvements in health-related behaviours may lessen, but not eliminate socioeconomic disparities in oral health (Sabbah *et al*., 2009).

While the response yield provided sufficient numbers for analysis, the response rate was lower than anticipated, particularly since multiple follow-ups were employed to increase the response rate as per the Total Design Method (Dillman, 1978). The use of the electoral roll should provide an adequate sampling frame for a population survey of 45-54 year-olds. Generally, a response rate of 60% is considered adequate (Mangione, 1995), with lower response rates requiring evidence to determine whether bias has been introduced. However, response rate is considered only an indirect indication of the extent

of non-response bias, and more attention is required to assessment of bias rather than to specific response rate thresholds (Lee *et al*., 2009). The issue is whether a lower response rate involved differential response among population sub-groups that could produce bias. While direct comparison of respondents and non-respondents would be desirable to assess response bias, we were only able to compare the profile of respondents with limited population and other population-based sample data. Comparison of some key demographic characteristics including the percentage that were female (48.5%), Australian-born (70.7%) and Indigenous (0.7%) from the 2006 Census among 45-54 year-old Adelaide residents showed a close approximation to that observed in the study (Australian Bureau of Statistics, 2006). Comparison with other sample data with an adequate response rate (65%) showed a range of generally small differences between these data and the study participants, with the main difference being the lower percentage of survey respondents that visited privately at the last dental visit. Reliability of the clinical measures was excellent for missing teeth and good for decayed teeth (Fleiss, 1986). However, the cross-sectional nature of the study design limits the ability to comment on the observed associations in terms of causal relationships.

Clear gradients in oral health were observed across income groups for decayed and missing teeth. Numbers of both decayed and missing teeth were inversely related to income group. These findings are consistent with previous reports of SES gradients in the general health literature such as the relationship between mortality and social class (Marmot *et al*., 1987). Analysis of the shape of socioeconomic-oral health gradients has indicated that at low levels of SES absolute material resources are associated with greatest gains in oral health (Sanders *et al*., 2006).

It has been suggested that meticulous tooth brushing once per day may be sufficient to prevent caries, but as most people are not effective enough in home care tooth brushing twice daily is recommended (Attin and Hornecker, 2005). Another review reinforced the importance of daily tooth brushing with fluoridated toothpaste for preventing caries, but cautioned that long-term studies among adult age groups were lacking (Topping and Assaf, 2005). However, frequent tooth brushing has been reported to be associated with retention of teeth from a study of older adults aged about 69 years (Yysniauskaite *et al*., 2005). Dental visiting has been shown to be related to coronal decay in adults with higher mean numbers of decayed surfaces among those who usually visit for a dental problem rather than a check-up (Slade *et al*., 2007). Previous reports have shown that frequent dental visits help postpone tooth loss and maintain dental function, but do not prevent the onset of further disease (Sheiham *et al*., 1985).

The findings indicated a protective benefit from tooth brushing at lower income levels, while the uniformly lower level of decay at higher income levels suggests that other unobserved protective factors associated with higher income were operating independently of tooth brushing. The lower level of decay for those who made a recent dental visit compared to those that did not visit indicates a role for access to services. Other potential candidates could be other lifestyle factors such as diet, as well as other potential determinants of health like psychosocial factors such as stress and sense of control. While tooth brushing also showed an interaction with income for missing teeth, this mainly reflected the association of the medium income group at low brushing frequency and hence was not a consistent effect.

Given that poorer people seem to pay a bigger penalty for less favourable dental behaviours than those in higher income groups, this presents a challenge to address this downstream effect while continuing to make progress on upstream determinants of health. It is acknowledged that many health promotion interventions have been ineffective. However, there is great potential to produce more effective outcomes. Unless theoretical formulations of health behaviours take SES into account it is likely that interventions will be targeting factors irrelevant for the target groups (Emmons, 2000).

In conclusion, dental behaviour in terms of brushing and visiting was associated with social gradients in oral health for decayed teeth across income groups, with less favourable dental behaviour having stronger negative associations with oral health among lower income groups.

Acknowledgements

Data collection was funded by a National Health and Medical Research Council project grant (#250316) for 2003-2005.

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