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Evaluating the role of dental behaviour in oral health inequalities

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Abstract – *Objective:* The aim of this study was to describe differences in dental attendance and dental self-care behaviour between socioeconomic groups and to investigate the extent to which the socioeconomic gradient in oral health was explained by these behaviours. *Methods:* We used data from a representative sample of adults in Australia, surveyed by telephone interview and by self-complete questionnaire. The dependent variables were self-reported missing teeth and the social impact of oral conditions evaluated with the 14-item Oral Health Impact Profile (OHIP-14). Socioeconomic position was measured at the small-area level. We conducted bivariate analysis using one-way analysis of variance and 95% confidence intervals (95% CI) and adjusted for the effect of age. After adjusting for age, dental behavioural variables were entered individually into multivariate linear regression models. *Results:* Data were obtained for 3678 dentate adults aged 18–91 years. Missing teeth and OHIP-14 scores followed a social gradient with poorer adults experiencing poorer outcomes. Routine dental attendance and diligent dental self-care were associated with inverse monotonic gradients in missing teeth ($P < 0.05$) and OHIP-14 scores ($P < 0.05$). Although adults living in areas with the least disadvantage had a preventive dental attendance orientation, no socioeconomic pattern was found for dental self-care. In multivariate analysis, the slope of the socioeconomic gradient [β estimate for Index of Relative Socioeconomic Disadvantage (IRSD)] in missing teeth was not significantly attenuated by either dental attendance or dental self-care. For OHIP-14 scores, the slope of the socioeconomic gradient was significantly attenuated by dental visiting, but not by dental self-care and not by the combined effect of both behaviours. *Conclusion:* The commonly held view that the poor oral health of poor people is explained by personal neglect was not supported in this study.

Key words: health behaviours; inequalities; quality of life; small-area socioeconomic status

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Two of the most widely investigated relationships in the health literature are the role of behaviour as a determinant of health status and social inequality in the distribution of health status. Based on the former relationship, virtually all policy makers recognize the benefits of promoting healthy behaviours in individuals and providing adequate access to healthcare services to the population. Regarding the latter, there is an universal consensus that people living in socially disadvantaged circumstances have poorer health than their better-off counterparts. Social inequality in the distribution of dental disease has attracted the attention of policy makers beyond the dental community in several countries (1–3). Behavioural practices feature prominently in the oral health literature reflecting the fact that much dental disease is, at least theoretically, preventable (4), although Spencer (5) has challenged the notion that poor oral health in populations is preventable through behaviour change in individuals.

Not infrequently, these two relationships are linked together as an explanation of poorer health among poorer people. Such a link was first proposed in the 1980 Black Report where the 'cultural

behavioural' hypothesis offered one of four causal explanations for social inequality in mortality in Britain (6). According to this hypothesis, people who occupied lower positions on the social hierarchy were more likely to engage in risk-taking behaviours. Consequently, their health was worse in comparison with people of higher social position.

The idea that a gradient in health behaviour may account for the socioeconomic gradient is plausible. Compared with the more affluent, adults of low social position lack the necessary economic or educational resources to respond promptly to health promotion initiatives. Indeed, as nicotine dependence may be greater among disadvantaged groups (7) behaviour change may be harder for these individuals. Hence, the incentive to forgo risk behaviours in exchange for some future health gain may be less appealing for adults in disadvantaged circumstances. Moreover, supporting the hypothesis is the barrier to dental care imposed by financial constraints (8). This is particularly the case in Australia, where oral health is the least subsidized area of health care (5).

The evidence for these two relationships has emerged from two independent lines of inquiry. The hypothesis that the poor oral health of poor people is explained by poor behaviour, although compelling, has been widely accepted with very little testing. If poor oral health behaviour can account for the socioeconomic inequalities in oral health status, then tailoring behavioural interventions to suit disadvantaged groups may be a simpler way to reduce the gradient in oral health than targeting financial barriers to dental care.

The objective of the study was to determine the extent to which the gradient in adult oral health across socioeconomic levels in Australia was explained by dental attendance and dental self-care behaviours. After demonstrating the socioeconomic gradient in oral health, three hypotheses were tested. The first was that routine dental attendance and relatively thorough dental self-care were associated with better oral health outcomes. The second was that oral health behaviours followed a socioeconomic gradient. The third was that these behaviours substantially accounted for socioeconomic differences in oral health outcomes.

Methods

Data were taken from the 1999 National Dental Telephone Interview Survey (9) and a self-complete questionnaire mailed to adult interviewees ($n = 6152$) immediately following their interview. In this cross-sectional survey, telephone numbers of households in all Australian States and Territories were randomly selected and a household occupant was randomly selected for the interview. The mailed questionnaire investigated social and behavioural determinants of oral health. Oral health behaviour was evaluated with an adaptation of the Dental Neglect Scale (10) that was expanded with three additional statements (see Appendix). Responses were made on a five-point Likert scale of agreement coded from 0 to 4. In computing the summary statistic, item nos 2, 7 and 8 were reverse coded so that a higher scale score reflected more favourable oral health behaviour. A principal components factor analysis of the 10 statements explored the underlying constructs of the scale and the internal consistency of resulting factors was tested.

Two measures of oral health obtained in the questionnaire formed the dependent variables. Adults were asked to account for any missing teeth in their mouth. Only those teeth classified as extracted because of decay, pain, or other dental disease were included in the count. Missing teeth quantify the accumulated burden of oral disease and the consequences of its treatment by dental extraction. To capture the social impact of oral conditions on function and quality of life, we used the 14-item Oral Health Impact Profile (OHIP-14) (11). This scale evaluates the consequences of oral conditions across dimensions of functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap. Responses to the questionnaire items are made on a five-point ordinal scale ranging from never (coded 0) to very often (coded 4). An overall OHIP-14 score was computed as the mean score across and all ordinal responses multiplied by 14 (the number of items) to produce a summary statistic that could range from 0 to 56. Higher OHIP-14 scores indicated greater impact, hence poorer oral health status. The interview and questionnaire data were linked and the data set was weighted to account for differing sampling probabilities caused by the sampling design. Data were further weighted by age and sex characteristics for each sampling stratum in all states and territories as estimated for the Australian population by the Australian Bureau of Statistics.

Socioeconomic position was measured using the Index of Relative Socioeconomic Disadvantage

(IRSD) (12) value of the respondent's postcode. We preferred IRSD to socioeconomic indicators at the individual and household levels for several reasons. IRSD values formed a finely graded continuous variable in the data set with 1204 different values assigned to the 1270 small areas. Because subject-reported socioeconomic indicators were categorical, dummy variables would be necessary in linear regression models, adding greater complexity to the interpretation of findings. In addition, household income was a coarse measure comprising six income levels. Data were not uniformly distributed as only 6.5% of the sample had household income in the lowest income group and 41.0% in the highest income group. In addition, household income data were missing for 6.7% of respondents. Consistent with the national labour force participation rate of 63.4% (13), occupation data were not reported for 36.2% of respondents. By comparison, IRSD values were assigned to all but 1.3% of respondents. The IRSD is a summary statistic generated by the Australian Bureau of Statistics for each postcode and is based on census data recording attributes such as income, educational attainment, unemployment and level of occupational skill (13). Higher IRSD indicate lower levels of disadvantage, i.e. greater advantage. In bivariate analysis, the continuous IRSD scores were divided into quintiles labelled from low to high.

One-way analysis of variance was used to obtain an estimate of differences in the mean numbers of missing teeth and mean OHIP-14 scores reported by adults across levels of socioeconomic position and across the range of scores for dental visiting and dental self-care behaviours. We computed 95% confidence intervals to define the limits between which there is 95% probability that the true mean lies. When interpreting gradients across quintiles, we regarded a lack of overlap between 95% confidence intervals as evidence of statistically significant differences.

Because increasing age is associated with missing teeth, the effect of age on both oral health outcome measures was statistically controlled. For bivariate analysis, scores on the derived oral health behaviour subscales were divided into quintiles labelled from low (the lowest 20% of the distribution) to high (the highest 20% of the distribution).

Finally, to estimate the effect of dental visiting and dental self-care on the socioeconomic gradient in oral health, continuous explanatory variables were entered into a series of four linear regression models. Age (in years) was included in each model to adjust for its effect on behaviour and missing teeth. In model 1, IRSD values were entered along with age. In model 2, we examined the effect of adding the dental visiting variable on the regression coefficient for IRSD. In model 3, we replaced the dental visiting variable with dental self-care to investigate its effect on the regression coefficient for IRSD values. In model 4, we entered both the dental visiting and dental self-care variables. The extent to which these oral health behaviours accounted for the socioeconomic gradient in oral health was evaluated by comparing IRSD regression coefficients and their 95% confidence intervals among these multivariate models. Reductions on the absolute value of the regression coefficient for IRSD were interpreted as evidence of dental visits and/or dental self-care being responsible for the socioeconomic gradient.

Results

The response rate to the telephone interview was 56.6% ($n = 7829$). Of the 6152 adults sent a questionnaire, 64.6% responded ($n = 3973$). Edentulous cases were excluded from this analysis, reducing the sample to 3678 persons. Age ranged from 18 to 91 years with a mean (SD) of 42.6 (16.7) years and males and females were equally represented. The relationship between missing teeth and the OHIP-14 scores was significant but weak (Pearson's correlation coefficient $r = 0.17$, $P < 0.001$), confirming that these measures evaluated different dimensions of oral health status.

There was a large inverse gradient between IRSD and both measures of oral health, whether or not the effect of age was controlled (Table 1). The 20% of adults living in the areas with low IRSD values (most disadvantaged) had more than twice the number of missing teeth compared with the 20% of adults living in the areas with high IRSD values (least disadvantaged). An inverse monotonic gradient in OHIP-14 scores indicated that adults living in disadvantaged areas more frequently experienced impacts in daily living because of problems with their teeth, mouth or dentures. Adjusting for age had very little effect on the socioeconomic gradient in OHIP-14 scores and age adjustment somewhat increased the gradient for missing teeth (Table 1).

A principal components factor analysis with orthogonal rotation of the 10 dental behavioural items resulted in a two-factor solution that

Table 1. Mean number of missing teeth (95% CI) and mean OHIP-14 scores for quintiles of socioeconomic disadvantage measured with the IRSD – unadjusted and adjusted for age in years

	Missing teeth		OHIP-14 scores	
	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]
IRSD quintiles				
Low[a]	3.91 (3.45–4.37)	4.19 (3.85–4.63)	8.37 (7.77–8.96)	8.38 (7.79–8.98)
Low to moderate	3.83 (3.38–4.29)	3.54 (2.98–3.85)	7.80 (7.14–8.46)	7.78 (7.13–8.44)
Moderate	3.44 (2.99–3.89)	3.81 (3.52–4.23)	7.46 (6.91–8.00)	7.47 (6.92–8.01)
Moderate to high	2.82 (2.37–3.28)	3.29 (3.01–3.76)	7.30 (6.73–7.87)	7.32 (6.75–7.89)
High	2.76 (2.30–3.22)	1.95 (1.84–2.51)	6.60 (6.09–7.10)	6.58 (6.07–7.09)

[a]Low scores indicate high levels of socioeconomic disadvantage in postcode areas.

explained 47.6% of the variance. The five items that loaded onto factor 1 were about dental visiting and the remaining five items loading onto factor 2 were about dental self-care. Internal consistency of the dental visiting subscale showed acceptable reliability (with a Cronbach alpha of 0.76), but was lower for dental self-care ($\alpha = 0.62$). Higher scores for dental visiting reflected an asymptomatic, preventive orientation to the use of dental services, while lower scores indicated episodic problem-oriented attendance. Higher dental self-care scores reflected a stronger sense of health self-efficacy and greater attention to oral hygiene, dietary control and attention to professional recommendations. These two aspects of oral health behaviour were correlated and the strength of association was moderate (Pearson's $r = 0.44$; $P < 0.001$).

The relationship between socioeconomic position and dental behaviour was confounded by age as older adults reported higher scores than younger adults for both behaviours. After adjusting for age, we observed an inverse monotonic relationship between dental visiting scores and both missing teeth and OHIP-14 scores (Table 2). The difference in mean OHIP-14 scores between groups with low and high dental visit quintiles was greater than twofold. Although the relationships were not monotonic for dental self-care, higher self-care scores were significantly associated with fewer missing teeth and lower OHIP-14 scores.

Adults living in the most disadvantaged areas (low IRSD) had significantly lower dental visiting scores than all other adults and adults in areas with high IRSD values reported higher visiting scores than all other adults. There were small and inconsistent differences in dental visiting behaviour for the 60% of adults living in areas with IRSD values in the low to moderate, moderate and moderate to high ranges (Table 3). This trend was observed with and without age adjustment. Dental self-care was very weakly associated with socioeconomic position. Mean dental self-care scores and their 95% confidence intervals were identical for adults living in areas with low, low to moderate, and moderate IRSD values. In fact, adults living in areas with moderate to high IRSD values reported significantly lower dental self-care scores than the 60% of adults living in less advantaged areas.

Table 2. Mean number of missing teeth (95% CI) and mean OHIP-14 scores for adults based on scores for dental visiting and dental self-care behaviour grouped in quintile ranges – unadjusted and adjusted for age in years

	Missing teeth		OHIP-14 scores	
	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]
Dental visiting				
Low	3.67 (3.19–4.15)	4.37 (4.00–4.75)	10.21 (9.65–10.77)	10.32 (9.76–10.89)
Low to moderate	3.13 (2.69–3.58)	3.94 (3.58–4.31)	8.27 (7.73–8.81)	8.37 (7.82–8.91)
Moderate	3.35 (2.93–3.76)	3.29 (2.94–3.63)	7.31 (6.79–7.83)	7.31 (6.79–7.83)
Moderate to high	3.18 (2.77–3.58)	2.72 (2.36–3.07)	5.73 (5.19–6.26)	5.66 (5.12–6.19)
High	3.42 (2.95–3.90)	1.87 (1.45–2.30)	5.20 (4.56–5.84)	5.01 (4.36–5.66)
Dental self-care				
Low	3.19 (2.77–3.61)	3.87 (3.50–4.24)	9.63 (9.07–10.18)	9.70 (9.14–10.26)
Low to moderate	3.61 (3.22–4.01)	4.07 (3.76–4.38)	7.84 (7.37–8.30)	7.88 (7.41–8.35)
Moderate	3.88 (3.34–4.42)	3.62 (3.20–4.04)	6.38 (5.74–7.02)	6.36 (5.73–7.00)
Moderate to high	2.74 (2.36–3.11)	2.30 (1.95–2.66)	6.64 (6.10–7.18)	6.61 (6.07–7.15)
High	3.31 (2.78–3.84)	2.05 (1.60–2.50)	5.71 (5.03–6.38)	5.59 (4.91–6.27)

Table 3. Mean (95% CI) scores for dental visiting and dental self-care according to levels of socioeconomic disadvantage of areas (grouped as quintiles) – unadjusted and adjusted for age in years

	Dental visiting		Dental self-care	
	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]	Unadjusted [mean (95% CI)]	Adjusted for age [mean (95% CI)]
IRSD quintiles				
Low[a]	2.35 (2.28–2.41)	2.36 (2.30–2.42)	2.38 (2.33–2.43)	2.39 (2.34–2.44)
Low to moderate	2.51 (2.45–2.57)	2.49 (2.43–2.56)	2.40 (2.35–2.45)	2.39 (2.34–2.44)
Moderate	2.46 (2.40–2.53)	2.48 (2.42–2.54)	2.38 (2.33–2.43)	2.39 (2.34–2.44)
Moderate to high	2.52 (2.45–2.58)	2.54 (2.48–2.60)	2.29 (2.24–2.34)	2.30 (2.26–2.35)
High	2.77 (2.71–2.84)	2.73 (2.67–2.80)	2.53 (2.48–2.58)	2.51 (2.46–2.55)

[a]Low scores indicate high socioeconomic disadvantage in postcode areas.

Table 4. Beta coefficients (β) and 95% confidence intervals (95% CI) for the relationship between IRSD score and missing teeth, controlling for age, dental visiting and dental self-care behaviours

	Model 1[a] [β (95% CI)]	Model 2[b] [β (95% CI)]	Model 3[c] [β (95% CI)]	Model 4[d] [β (95% CI)]
Parameter (constant)	3.37 (1.12 to 5.62)	3.63 (1.38 to 5.87)	5.27 (2.98 to 7.55)	5.00 (2.72 to 7.27)
IRSD (per 100 units)	−0.88 (−1.10 to −0.66)	−0.72 (−0.94 to −0.50)	−0.82 (−1.04 to −0.60)	−0.74 (−0.96 to −0.52)
Age in years	0.21 (0.20 to 0.22)	0.22 (0.21 to 0.23)	0.22 (0.21 to 0.23)	0.22 (0.21 to 0.23)
Dental visiting: factor 1[e]		−0.87 (−1.06 to 0.67)		−0.59 (−0.80 to −0.37)
Dental self-care: factor 2[f]			−1.16 (−1.41 to −0.92)	−0.85 (−1.12 to −0.58)

[a]Model 1: Adjusted for age. Model summary statistics $F(2, 3507) = 906.94$, $P < 0.001$; adjusted $R^2 = 0.341$.
[b]Model 2: Adjusted for age, dental visiting. Model summary statistics $F(3, 3470) = 622.55$, $P < 0.001$; adjusted $R^2 = 0.349$.
[c]Model 3: Adjusted for age, self-care. Model summary statistics $F(3, 3470) = 626.98$, $P < 0.001$; adjusted $R^2 = 0.351$.
[d]Model 4: Adjusted for age, visiting, dental self-care. Model summary statistics $F(4, 3469) = 481.39$, $P < 0.001$; adjusted $R^2 = 0.356$.
[e]Scores derived by summing responses to the five items with large loadings on factor 1 in principal components factor analysis.
[f]Scores derived by summing responses to the five items with large loadings on factor 2 in principal components factor analysis.

However, adults in the most advantaged areas (high IRSD) reported significantly higher dental self-care scores than all other adults.

In multivariate regression analysis, IRSD values remained statistically significantly associated with missing teeth (Table 4) after adjusting for age (model 1), dental visiting (model 2), dental self-care (model 3) and all of these variables combined (model 4). In fact, the slope of the gradient was not significantly altered by the inclusion of any of these variables as indicated by the beta coefficients for IRSD in models 2, 3 and 4 remaining within the 95% CI for the estimate in model 1. For OHIP-14 scores (Table 5), the inclusion of dental visiting scores (model 2) did bring about a significant reduction in the beta coefficient in IRSD. However, in model 3 where dental self-care was entered and dental visiting omitted, the attenuation was not statistically significant. Finally, in the presence of dental self-care, dental visiting scores failed to significantly attenuate the beta coefficient (model 4) compared with model 1. Importantly, the slope of the socioeconomic gradient (beta estimate for IRSD) was not altered significantly for either outcome measure after adjusting for age, dental visiting and self-care behaviour.

Discussion

The central finding of this study was that although dental visiting and dental self-care were associated with missing teeth and OHIP-14 scores, dental self-care did not significantly attenuate the socioeconomic gradient in either outcome. Dental visiting did significantly decrease the socioeconomic gradient in OHIP-14 scores but not the gradient in missing teeth. This means that although these behaviours are associated with oral health outcomes in the adult population, they account for little, if any, of the socioeconomic gradient in oral health. Although low visiting scores are more prevalent in disadvantaged groups, it is likely that the cost barriers to access or the rationing of dental

Table 5. Beta coefficients (β) and 95% confidence intervals (95% CI) for the relationship between IRSD score and OHIP-14 score, controlling for age, dental visiting and dental self-care behaviours

	Model 1[a] [β (95% CI)]	Model 2[b] [β (95% CI)]	Model 3[c] [β (95% CI)]	Model 4[d] [β (95% CI)]
Parameter				
Constant	17.94 (14.49 to 21.39)	18.40 (14.97 to 21.82)	21.26 (17.74 to 24.77)	20.29 (16.81 to 23.76)
IRSD (per 100 units)	−1.05 (−1.38 to −0.71)	−0.70 (−1.04 to −0.37)	−0.97 (−1.31 to −0.63)	−0.72 (−1.06 to −0.39)
Age in years	0.00 (−0.01 to 0.02)	0.03 (0.01 to 0.04)	0.02 (0.00 to 0.03)	0.03 (0.02 to 0.05)
Dental visiting: factor 1[e]		−1.95 (−2.24 to −1.65)		−1.57 (−1.90 to −1.25)
Dental self-care: factor 2[f]			−1.97 (−2.35 to −1.59)	−1.16 (−1.57 to −0.75)

[a]Model 1: Adjusted for age. Model summary statistics $F(2, 3571) = 18.61$, $P < 0.001$; adjusted $R^2 = 0.010$.
[b]Model 2: Adjusted for age, dental visiting. Model summary statistics $F(3, 3533) = 67.18$, $P < 0.001$; adjusted $R^2 = 0.053$.
[c]Model 3: Adjusted for age, dental visiting. Model summary statistics $F(3, 3533) = 46.83$, $P < 0.001$; adjusted $R^2 = 0.037$.
[d]Model 4: Adjusted for age, visiting, dental self-care. Model summary statistics $F(4, 3532) = 58.48$, $P < 0.001$; adjusted $R^2 = 0.061$.
[e]Scores derived by summing responses to the five items with large loadings on factor 1 in principal components factor analysis.
[f]Scores derived by summing responses to the five items with large loadings on factor 2 in principal components factor analysis.

services for the one-third of Australian adults eligible for public dental care suppress care-seeking behaviour. Hence the socioeconomic gradient in adult oral health is largely explained by factors other than these two oral health behaviours. This finding disputes the notion that poorer adults care less about their oral health than the more affluent ones.

The major strengths of this study were the large sample size and the fact that the sample was representative of the Australian adult population in terms of sex, age and geographic location. Therefore, the findings are generalizable to the Australian adult population. We used two distinct measures of oral health status and found that the associations with socioeconomic position and behaviour were robust. We also tested the two oral health behaviours separately in the belief the economic barriers to dental visiting are less likely to affect self-care practices.

The hypothesis that these behaviours were associated with oral health was strongly supported. Furthermore, poor oral health was not confined to those with the lowest behavioural scores. We found clear monotonic gradients between dental visiting and both oral health outcomes. Adults with visiting scores in the low quintile had more than twice as many missing teeth than those in the high quintile and their OHIP-14 scores were more than twice as high. The oral health outcomes associated with self-care were less dramatic, but were nevertheless statistically significant and likely to be of clinical importance. This finding supported those of previous studies that frequent, asymptomatic dental attendance enhances quality of life (14, 15) and is associated with greater tooth retention, fewer teeth with untreated dental caries (16) and less tooth mobility and bone loss (17).

The hypothesis of a socioeconomic gradient in dental behaviour was only partially supported when bivariate analysis was used. Dental visiting behaviour followed a social gradient, but dental self-care did not. Poorer adults were equally inclined to practice recommended preventive behaviours as more affluent adults. This seemingly contradictory finding serves to emphasize that the 'failure' of poorer adults to seek dental care is probably more a reflection of the organization and subsidy of dental care services than an expression of individual need or values.

For this analysis, we chose an area-level indicator of social position. Obtaining valid measures of social position poses methodological difficulties that have been discussed in detail elsewhere (18, 19). Occupation is less varied over life than income, yet it is limited in population surveys where a large portion of the sample is not currently working. Similarly, education is also of limited use in population surveys that include both young and elderly adults and as education is categorized into levels of attainment it yields less information than ordinal and continuous variables. Apart from wage earnings, income may include dividends, interest, or other monetary income not captured by survey methods. Frequently, measures of household income do not take into account the number of persons dependent on the income. Non-response and inaccurate reporting of sensitive income-

related matters pose difficulties in analysing data. In the oral health literature, Locker (20, 21) has discussed these methodological and theoretical difficulties and recommended a greater use of area-based measures. These too have limitations. For instance, they tend to underestimate the effects of socioeconomic variation, and assume that measured characteristics are stable and homogeneous within the geographic area. More fundamentally, area-based measures of socioeconomic position reflect the socioeconomic context in which people live, rather than their personal wealth or background. Among the advantages of the census-based index used in this study is that it is a finely graduated continuous variable that is based on a number of variables correlated with social disadvantage. The scale is readily interpreted and widely used in Australia.

Although not reported in this paper, we repeated the analyses using household income as the socioeconomic measure and obtained findings almost identical to those obtained for IRSD values. Yet in these other analyses, neither dental visiting nor dental self-care attenuated the income gradient in either oral health outcome measure.

The missing teeth dependent variable was assessed by self-report and previous research has shown that tooth count information obtained by self-assessment is valid (22, 23). The findings of this study also depend upon the validity of the scale used to measure dental visiting and dental self-care. Originally, the seven-item scale was developed using parental ratings of child dental behaviour in Australia where its ability to measure differences in behaviour among children was validated by Thomson and colleagues in 1996 (24). It was later adapted by Thomson and Locker (25) who validated its properties with a sample of young adults and the scale has since been used in a random sample of adults in Dunedin (26). In its present form, it comprises six items and is conceptually based on the notion of dental neglect. As far as we know, it has not been subjected to test–retest reliability in any version.

Although it has its critics, the behavioural hypothesis for health inequalities retains strong support. Several conceptual frameworks in the oral health literature have included oral health behaviour as a key construct to explain social inequality in the oral health of adult (27) and child populations (28). The findings of this study do not necessarily refute the hypothesis, but rather serve to highlight that there is wide variation in what is commonly described as oral health behaviour. Our study did not address behaviours such as tobacco smoking or cariogenic diet, which are recognized as common risk factors for a wide range of chronic health conditions including oral disease (29, 30). There is evidence that these behaviours are indeed more prevalent among disadvantaged populations.

Yet, even if this hypotheses were affirmed, there is no evidence that behaviours are amenable to existing methods of intervention at the individual level. Dental health education is ineffective in producing sustained changes in oral health behaviour or altering caries rates (31, 32) and may even exacerbate the social gradient in dental caries experience (33). On the one hand, improving personal behaviour is likely to produce overall gains in population oral health. On the other, investments in programmes that address behaviours in individuals are unlikely to reduce the social inequalities in the distribution of oral disease and its social impact. Disease prevention strategies that focus solely on personal behaviour have a narrow focus. McKinlay (34) summarized the limitations of policies that target only behaviour. He argued that 'such policies: divert limited resources away from upstream healthy public policy; blame the victim; produce a lifestyle approach to health policy, instead of a social policy approach to healthy lifestyles; decontextualise risk behaviors and overlook the ways in which such behaviours are culturally generated and structurally maintained.' (p. 77).

Increasingly, the social epidemiological literature is focused on the sociopolitical determinants upstream from behaviour that ultimately shape living and working environments in which health-related behaviours are supported. Unless greater attention is given to determinants at this level, efforts to reduce social inequalities in health are unlikely to succeed.

Despite a relatively large literature detailing oral health inequalities among adults, our knowledge about the gradient and the mechanisms that sustain it remains rudimentary. This study has advanced the understanding by evaluating the role of dental-relevant behaviour in explaining the social gradient in oral health at the population level. The fact that poorer adults were less likely than more affluent ones to make regular dental visits is likely to be explained by cost and structural barriers to dental care. We found no evidence of socioeconomic differences in dental self-care behaviour. These

behaviours did not significantly attenuate the socioeconomic gradient in oral health.

Conclusion

The implications of this study are that if oral health promotion is to reduce social inequalities in adult oral health, efforts need to be directed to factors other than the dental behaviours of individuals. Although these are strongly associated with oral health, they do not appear to account for the socioeconomic gradient in oral health status. Rather than focusing on individuals alone, the approach needs to achieve a better balance of targeting both individual level factors and also the social environments in which health behaviours of individuals are developed and sustained.

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Appendix

Modified Dental Neglect scale

Item no.	Subscale	Item
1.	(V)	It is good practice to have regular dental check-ups
2. (R)	(V)	I avoid seeking dental care even when I think I have a dental problem
3.	(V)	I generally make dental appointments for check-ups even when I believe there is no problem
4.	(S-C)	I brush my teeth at least once every day
5.	(S-C)	I succeed in any effort I make to have good dental health
6.	(S-C)	I carefully follow any instructions my dental professional gives me about home-care
7. (R)	(V)	When I have a dental problem, it is not a high priority
8. (R)	(V)	If I had a toothache, I would deal with it myself for at least a week
9.	(S-C)	I floss my teeth every day
10.	(S-C)	I control snacking between meals

(R), reversal of coding during scoring; (V), items on the dental visiting subscale derived from principal components factor analysis; (S-C), items on the dental self-care subscale derived from principal components factor analysis.