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The shape of the socioeconomic–oral health gradient: implications for theoretical explanations

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Abstract – *Objectives:* The nature of the relationship between status and health has theoretical and applied significance. To compare the shape of the socioeconomic -oral health relationship using a measure of relative social status (MacArthur Scale of Subjective Social Status) and a measure of absolute material resource (equivalised household income); to investigate the contribution of behaviour in attenuating the socioeconomic gradient in oral health status; and to comment on three hypothesised explanatory mechanisms for this relationship (material, psychosocial, behavioural). *Methods:* In 2003, cross-sectional self-report data were collected from 2,915 adults aged 43–57 years in Adelaide, Australia using a stratified cluster design. Oral conditions were (1) <24 teeth, (2) 1+ impact/s reported fairly often or very often on the 14-item Oral Health Impact Profile; (3) fair or poor self-rated oral health, and (4) low satisfaction with chewing ability. Prevalence ratios and 95% confidence intervals (PR, 95%CI) were calculated from a logistic regression model. Covariates were age, sex, country of birth, smoking, alcohol use, body mass index, frequencies of toothbrushing and interdental cleaning. *Results:* There was an approximately linear relationship of decreasing prevalence for each oral condition across quintiles of increasing relative social status. In the fully adjusted model the gradient was steepest for low satisfaction with chewing (PR = 4.1, 95%CI = 3.0–5.4). Using equivalised household income, the shape more closely resembled a threshold effect, with an approximate halving of the prevalence ratio between the first and second social status quintiles for the adverse impact of oral conditions and fair or poor self-rated oral health. Adjustment for covariates did not attenuate the magnitude of PRs. *Conclusion:* The nature of the relationship between social status and oral conditions differed according to the measure used to index social status. Perception of relative social standing followed an approximately straight-line relationship. In contrast, there was a discrete threshold of income below which oral health deteriorated, suggesting that the benefit to oral health of material resources occurs mostly at the lower end of the across the full socioeconomic distribution.

Key words: dental health surveys; income; inequalities; middle aged; social hierarchy

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The health of populations is better at higher levels of socioeconomic position (1). Despite evidence of a graded relationship, there is a lack of empirical clarity about the shape of the gradient. Does health improve in a linear fashion across the entire socioeconomic spectrum, for instance, or are there diminishing gains above a certain threshold? Very few studies have explicitly investigated the functional form of the socioeconomic gradient in health (2–11). Findings are varied as to whether health deteriorates only below a critical level of socioeconomic resource (a threshold effect) or whether it deteriorates across the full spectrum of decreasing socioeconomic resource (a linear or curvilinear effect).

Analysis of the shape of socioeconomic-health gradient can lead to greater theoretical clarity about the production of health inequalities. Hypotheses

contend that the relationship is fundamentally based on absolute material conditions, or psychosocial response to relative social status, or status-related patterns of health behaviour (Fig. 1 illustrates these mechanisms as depicted by Brunner and Marmot (12)). These postulated mechanisms might operate simultaneously.

Apart from its theoretical contribution, there is applied value to allocative decision-making from understanding the health benefit conveyed by additional socioeconomic units. As Blakely et al (7) discussed if the shape is linear such that an additional unit of 44socioeconomic resource results in an additional unit health gain, regardless of affluence, then income redistribution from rich to poor would not affect average rates of disease in the population. Health gains for the poor would be equivalent to the health loss for the rich. Alternatively if the gradient were threshold or curvilinear, such that the slope flattened at higher levels of income, then the increased risk in health for the rich resulting from an income transfer would be smaller than the decreased risk to health for the poor. Not only would inequality in health reduce, but also overall disease rates would reduce.

To date studies examining the shape of the socioeconomic gradient have investigated indicators such as income or occupation that describe access to and control over material resources. Education has also been investigated, because it is seen to reflect acquired levels of capital, knowledge and skills. To date, no study of the shape of the socioeconomic-health gradient in the general health literature has investigated relative social status. In the oral health literature, no study has examined the shape of the relation using either relative status or absolute material resource.

The first aim of this study was to compare the shape of the socioeconomic gradient in oral conditions using an indicator of relative social status and an indicator of absolute material resource. A second aim was to determine the extent to which selected health behaviours attenuated the socioeconomic gradient in oral conditions. The third aim was to comment on three prominent hypothesized mechanisms linking socioeconomic position to oral health: the direct impact of absolute material resource; the psychosocial impact of relative comparison in a social hierarchy; and the impact of status-related patterns of behaviour.

Previous studies of the shape of the socioeconomic gradient have examined mortality, clinician-assessed conditions and self-assessed health (2–11), but not oral conditions. Oral conditions are highly prevalent in economically developed countries and as such, have substantial importance to population health.

Methods

Study and sampling designs

Data were from the Adelaide Small Area Dental Study, a cross-sectional study conducted in the Adelaide Statistical Division. This 1,826.9 km^2 area had an estimated resident population of 1,066,103 in 2001 and contains the capital city of South Australia and its metropolitan area. The study used

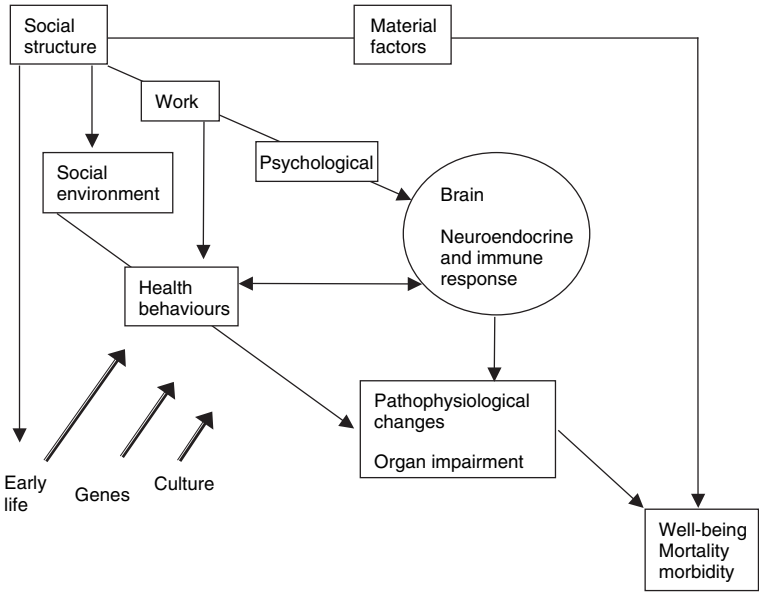

Fig. 1. The social determinants of health conceptual model showing a hypothesized direct pathway via material factors and an indirect pathway cognitve interpretation (Source: 12). By permission of Oxford University Press.

a stratified two-stage cluster design based on postcodes. To address research hypotheses, 40 persons were required from 60 small areas to yield an overall sample of 2,400 persons Adults in Australia aged 43–57 years form the numerically large post-war cohort and because they preceded the introduction of water fluoridation, this cohort has highly restored dentitions requiring ongoing dental care maintenance.

After omitting nine postcodes with small populations (n < 600) the remaining 113 postcodes were ranked according to their Index of Relative Socio-economic Disadvantage (IRSD) score (13) into deciles; from each decile six postcodes were randomly selected creating a total of 60 postcodes. Then, using electoral voting list, 70 individuals aged 43 to 57 years were selected through simple random sampling from each postcode for a total of 4,200 potential participants.

Data were collected between September and December 2003 using a self-completed mailed questionnaire to sampled adults following recommended methods for mail surveys (14).

Socioeconomic measures

Relative social status was evaluated using the MacArthur Scale of Subjective Social Status (15). This scale has been used in health research (16–21) and its test-retest reliability is established (21). In this study, participants were asked to place a cross on the rung of a 10-rung ladder and that best represented their perceived position relative to other people (see Fig. 2). The drawing was accompanied by the text of Singh-Manoux et al (19) ''Think of this ladder as representing where people stand in our society. At the top of the ladder are the people who are the best off, those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off, those who have the least money, least education, and worst jobs or no jobs. The higher up you are on this ladder, the closer you are to people at the very top and the lower you are, the closer you are to the bottom'' (p1323).

The absolute material resource indicator was equivalised household income. Respondents were asked to indicate their total household income from nine categories taken from the 2001 Census in Australia. To adjust for the size and composition of households, an equivalence factor was computed using the Modified Organisation for Economic Co-operation and Development equivalence scale (22). The midpoint value of each category of total household income was divided by the total summed points to arrive at the ''equalised income'' per household member. A midpoint estimate was arbitrarily assigned to the lowest and highest income ranges.

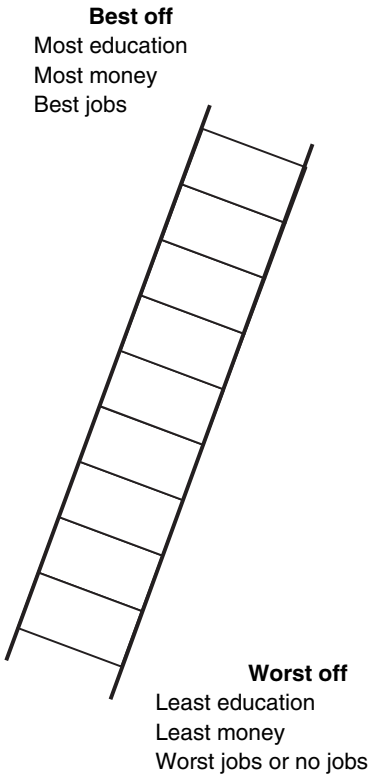

Fig. 2. The 10-rung ladder on which respondents indicated their relative social status relative to other people.

Quintiles were constructed for both status indicators. Quintiles of relative social status were derived by collapsing rungs one to four to form the 'low' category and rungs 8–10 to form the 'high' category. Rungs five, six and seven formed categories of 'low-moderate', 'moderate' and 'moderate-high' respectively. Similarly, equivalised income was divided into quintiles ranging from low to high where low represented the most financially disadvantaged 20% of the distribution. Prevalence ratios (PRs) were calculated that compared each of the first four socioeconomic quintiles with the highest quintile. Categories of both status indicators were grouped to create quintiles because we wished to compare relative degrees of socioeconomic position that contrasted approximately equal numbers of subjects using both indicators.

Measures of oral morbidity

Four self-reported oral conditions were selected. These were number of remaining teeth, the social impact of oral conditions evaluated with 14-item

Oral Health Impact Profile (23), global self-rated oral health (5-point ordinal scale), and global satisfaction with chewing ability (6-point ordinal scale). Missing teeth was evaluated by first advising participants that ''There are 16 teeth including wisdom teeth in the UPPER (upper case in text) jaw.'' Participants were then asked, ''How many of these 16 do you have remaining in the upper jaw?'' Similar information was provided to determine a count of remaining mandibular teeth and the number of teeth in both arches was summed during analysis. Previous research has shown that tooth count information obtained by self-assessment yields valid data (24–25). Self-rated oral health was evaluated with the question ''Overall, how would you rate your oral health?'' to which response categories were excellent, very good, good, fair, poor. And chewing satisfaction was evaluated by asking, ''How satisfied are you at present with your ability to chew?'' to which response categories were completely satisfied, satisfied, reasonably satisfied, a little dissatisfied, dissatisfied, completely dissatisfied''.

Each of these measures was dichotomised to produce a group with poor oral health that comprised approximately 20% of the sample. Prevalence was estimated for (1) <24 teeth, (2) one or more impact(s) reported fairly often or very often, (3) fair or poor self-rated oral health and (4) low satisfaction with chewing ability.

Several factors influenced the selection of cut points. A prevalence of approximately 20% was one factor. This represents the poorest quintile of oral health status and thus matches the quintile ranges in social status. Quintiles are commonly used in public health research. It was also considered beneficial to compare oral conditions affecting a similar proportion of the sample so that any apparent differences in socioeconomic-oral health relationships could not be attributed to an artefact of varying prevalence. Fewer than 24 remaining teeth represents less than two-thirds of the permanent dentition, and exceeds the number of missing teeth that a person might have with missing third molars and four orthodontic extractions. We followed the precedent for prevalence of social impact set by Slade et al. (26). Similarly convention determined the cut-point for self-rated oral health. The response distribution determined the cut point for chewing satisfaction. A more restricted cut-point of a little satisfied or worse included only 9.8% of the sample.

Measures of health behaviour

One hypothesis for the socioeconomic-health relationship is that the poor health of disadvantaged groups is explained by a greater propensity for risk behaviour. In advocating a collaborative approach to oral health promotion, Sheiham and Watt (27) list smoking, alcohol use and hygiene among their list of six common risk factors for many chronic conditions. We selected five behaviours with plausible associations with oral morbidity. These were smoking status, alcohol consumption, body mass index, frequency of toothbrushing and frequency of interdental cleaning. Previously we have reported that risk behaviours for general and oral health including the ones examined in this study tend to cluster together (28). Safe guidelines in Australia suggest consuming alcohol on fewer than seven days each week and observing limits for males and females of no more than two and four standard drinks per drinking session respectively. Body mass index in the overweight and obese categories reveals an energy imbalance where energy intake exceeds energy expenditure. It is likely that frequent consumption of food and beverage is an important contributing factor and this same behaviour may also be implicated in tooth loss among these individuals. BMI is also associated with periodontitis, an additional cause of tooth loss. We did not adjust for use of dental services. Unlike these health behaviours, the use of dental services is limited by factors at a policy level, and are not seem to be within the realm of individual choice in the same way as these personal behaviours.

The University of Adelaide Human Ethics and Research Committee approved the study (#H80-2002).

Hypothesised mechanisms

Three prominent hypothesized mechanisms link socioeconomic position to health status *viz*. the direct impact of absolute material resource; the psychosocial impact of relative comparison in a social hierarchy; and the impact of status-related behaviours. The conceptual diagram of Brunner and Marmot (Fig. 1) shows each of these pathways labelled ''Material factors'', ''Psychological'' and ''Health behaviours'' respectively. Ultimately, the behavioural and psychosocial mechanisms are thought to affect health indirectly via biological process, whereas absolute material resource is shown in the conceptual model to impact health directly. The two socioeconomic indicators pertain

to two of these hypotheses. Equivalised household income is an indicator of absolute material resource while relative social status is an indicator of psychosocial processes. These pathways are illustrated in Fig. 1 along with the behavioural pathway.

Statistical analysis

To test the first aim, we computed prevalence ratios (PRs) as the primary indicator of socioeconomic inequality across quintiles of social status. PRs and their 95% confidence intervals (95% CI) were computed using parameter estimates and their variances/covariances obtained from binary logistic regression models (29). We used PRs rather than odds ratios as the latter are a poor approximation of proportional disease frequency and produce biased estimates when the condition is frequently occurring (30). To test the second aim, three models were constructed. Model 1 was unadjusted, and therefore contained only four dummy variables (one for the four lowest quintiles of socioeconomic position) as predictor variables. To reduce potential confounding, age in years, sex and country of birth (Australia or other), were entered in Model 2. These demographic factors are associated with socioeconomic resource but are not believed to be in the causal pathway. Model 3 additionally adjusted for health related behaviours.

Data were weighted to correct for different probabilities in both sampling and in response. These weights produced estimates of prevalence and PR that were representative of the population of electors in this age group in this geographic area. Analysis was conducted using SUDAAN to adjust for the clustered sampling design and was limited to cases with non-missing values for all the variables analysed in the study.

Results

A response rate of 69.4% was achieved (n = 2,915). Males comprised 45.7%, the mean age was 50.1 years and 70% were born in Australia. Of the behaviours examined, 18% were current smokers, 18% exceeded Australian guidelines for safe alcohol consumption and 60% were overweight or obese. The range of responses for weekly toothbrushing frequency was 0–55 (mean = 11.5) and for interdental cleaning was 0–30 (mean = 2.9). Non-response to the subjective social status question was 2.7% (n = 80) and to household income, 9.6% (n = 281). Data for 2,221 individuals were analysed after omitting cases with missing values for any of the variables examined.

The four dichotomised oral conditions had moderate to strong, bivariate associations, as indexed by prevalence ratios between each pair of conditions. Correlations ranged from 3.8 for the association between <24 teeth and fair or poor self-rated oral health to 9.8 for the association between one or more impact(s) reported fairly often or very often and low satisfaction with chewing ability. Equivalised income and relative social status were moderately correlated, as evidenced by Pearson's correlation coefficient of 0.41.

A graphic presentation (Fig. 3) revealed a consistent shape in the relationship between relative social status and each oral condition of a linear, monotonic relationship with prevalence decreasing at higher levels of perceived social status. Linearity was most evident for dissatisfaction with chewing. For this condition, prevalence decreased from 40.0 percent in the lowest quintile to 11.3 percent in the highest quintile.

A different, but consistent, shape was observed for absolute material resource. It was characterised as a threshold effect with a steep decrease in prevalence between the low and the low-moderate quintiles, followed by flatter, less pronounced decrease, across the remaining three quintiles. For three oral conditions (impacts experienced fairly/very often, fair or poor self-rated oral health and low satisfaction with chewing ability), prevalence did not differ significantly between the moderate, moderate-high and high quintiles. When the preceding relationships were investigated separately for each sex, there was similar socioeconomic patterning in the oral conditions for males and females (not reported).

There were monotonic decreases in unadjusted prevalence ratios across quintiles of relative social status for all four oral conditions (Table 1, Model 1) Unadjusted PRs for persons in the lowest compared with the highest quintile ranged from 3.3 (95% CI: 2.6, 4.3) for fair or poor self-rated oral health to 4.5 (95% CI: 3.3, 6.2) for oral health impacts. Adjustment for sex, age in years and country of birth in Model 2 did not noticeably affect the magnitude of those PRs. Further adjustment for behaviour in Model 3 tended to attenuate the magnitude of PRs marginally, consistent with a flatter gradient, although PRs for most quintiles of relative social status remained statistically significant, as evidenced by 95% CIs that excluded one.

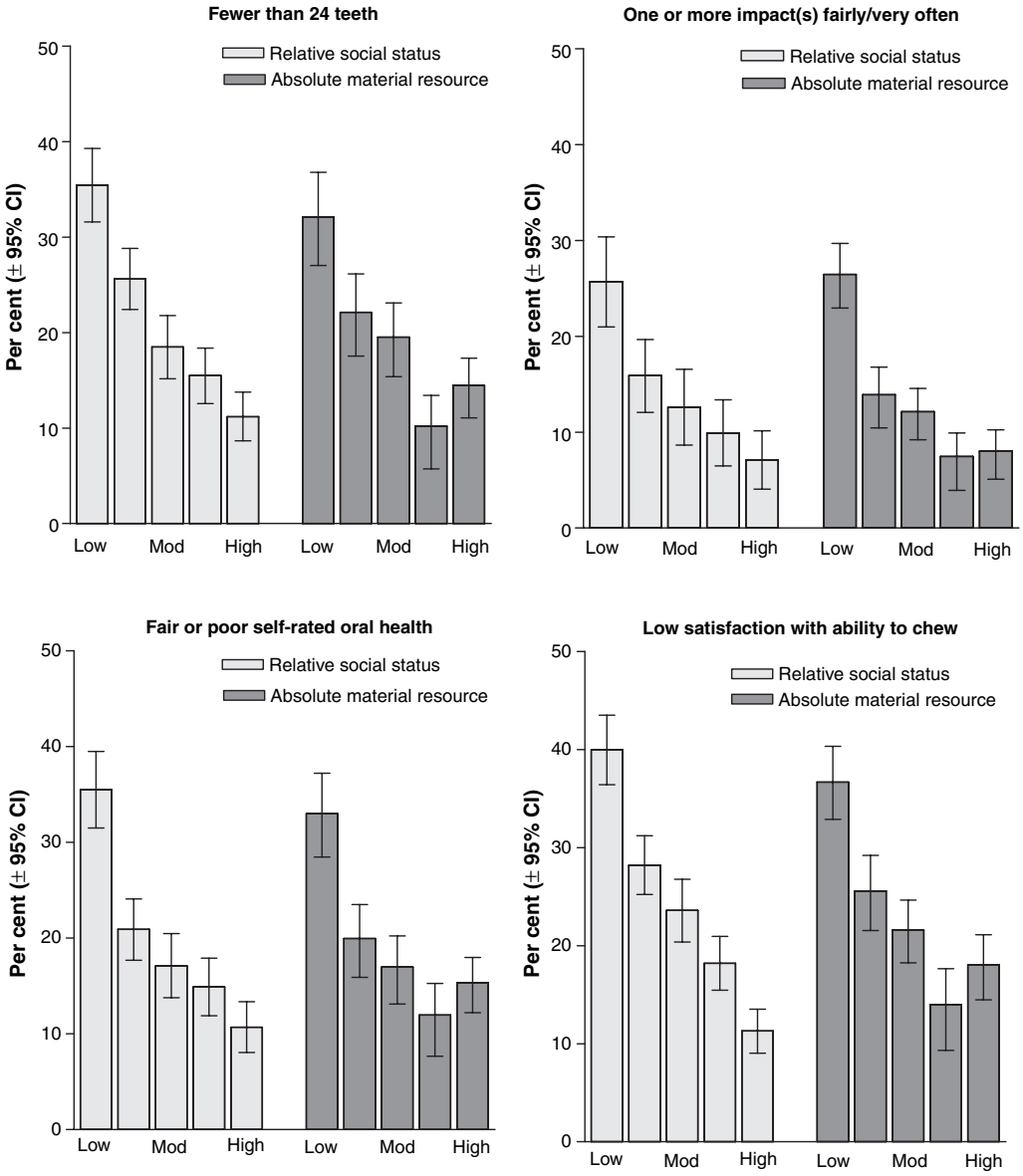

Fig. 3. Prevalence of oral morbidity according to relative social status and absolute material resource (weighted data).

The linear shape to the gradient persisted in the adjusted models for all four oral conditions.

Compared with the preceding findings, there was a weaker, unadjusted association between absolute material resource and each oral condition as evidenced by smaller PRs for the lowest quintile (Table 1). For example, the lowest quintile of equivalised income had a 2.5-fold increase in unadjusted prevalence of tooth loss compared with the highest quintile, whereas the corresponding PR using relative status was 3.4. Furthermore, at levels of material resource above the lowest quintile, unadjusted PRs were close to one, and in many instances they were not statistically significant. PRs for two oral conditions (<24 teeth and dissatisfaction with ability to chew) remained unaltered after adjusting for demographic and behavioural variables (Model 2). PRs for the other two oral conditions were slightly attenuated in Model 3 compared with Model 1, but not significantly so.

Discussion

When measured using relative social status, the shape of the socioeconomic gradient was approximately linear for all four oral conditions. The shape resembled more of a threshold effect for all conditions characterised by a substantial decrease in prevalence from the first to the second quintile. For two conditions the prevalence ratios approximately halved between the first and second quintiles in the

Table 1. Prevalence ratios (PR) with 95% confidence intervals (95% CI) for the association between oral morbidity and socioeconomic position (relative social status and absolute material resource)

		Relative social status						Absolute material resource					
		Model 1[a]		Model 2[b]		Model 3[c]		Model 1[a]		Model 2[b]		Model 3[c]	
Oral health condition	Quintile	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Fewer than 24 teeth	Low	3.4	2.6, 4.6	3.9	2.8, 5.4	2.9	2.0, 4.1	2.3	1.7, 3.1	2.7	1.9, 3.8	2.1	1.5, 3.0
	Low-mod	2.4	1.8, 3.2	2.6	1.9, 3.6	2.1	1.5, 3.0	1.7	1.2, 2.2	1.9	1.4, 2.6	1.7	1.2, 2.4
	Moderate	1.7	1.2, 2.5	1.8	1.3, 2.6	1.5	1.0, 2.2	1.4	1.1, 1.9	1.7	1.2, 2.4	1.6	1.1, 2.3
	Mod-high	1.5	1.1, 2.0	1.6	1.2, 2.3	1.4	1.0, 2.0	0.7	0.5, 1.2	1.0	0.6, 1.6	0.9	0.6, 1.5
	High (ref)	1.0		1.0		1.0		1.0		1.0		1.0	
1+ impact(s) fairly often or very often	Low	4.5	3.3, 6.2	4.2	3.0, 5.8	3.4	2.5, 4.7	3.7	2.7, 5.1	3.5	2.6, 4.8	3.1	2.2, 4.3
	Low-mod	2.5	1.7, 3.7	2.4	1.6, 3.5	2.1	1.4, 3.1	1.9	1.3, 2.8	1.8	1.2, 2.7)	1.7	1.1, 2.5
	Moderate	1.9	1.3, 2.9	1.8	1.2, 2.7	1.6	1.1, 2.4	1.7	1.3, 2.4	1.7	1.3, 2.4	1.7	1.2, 2.3
	Mod-high	1.5	1.0, 2.2	1.5	1.0, 2.1	1.3	0.9, 1.9	0.9	0.6, 1.5	0.9	0.6, 1.5	0.9	0.6, 1.5
	High (ref)	1.0	1.0	1.0		1.0		1.0		1.0		1.0	
Fair or poor self-rated oral health	Low	3.3	2.6, 4.3	3.8	2.9, 5.0	3.0	2.3, 4.0	2.2	1.8, 2.8	2.5	1.9, 3.2	2.1	1.6, 2.7
	Low-mod	1.8	1.3, 2.4	1.9	1.4, 2.6	1.6	1.1, 2.3	1.3	1.0, 1.7	1.3	1.0, 1.7	1.1	0.8, 1.5
	Moderate	1.5	1.2, 2.0	1.6	1.3, 2.1	1.4	1.1, 1.9	1.2	0.9, 1.5	1.2	0.9, 1.6	1.1	0.8, 1.5
	Mod-high	1.4	1.0, 2.0	1.4	1.0, 2.1	1.3	0.9, 1.9	0.8	0.6, 1.2	0.8	0.6, 1.2	0.8	0.6, 1.2
	High (ref)	1.0		1.0		1.0		1.0		1.0		1.0	
Low satisfaction with chewing ability	Low	3.9	3.1, 5.1	4.3	3.2, 5.8	4.1	3.0, 5.4	2.2	1.7, 2.8	2.3	1.8, 3.0	2.2	1.7, 2.9
	Low-mod	2.6	1.9, 3.5	2.7	2.0, 3.8	2.6	1.9, 3.6	1.4	1.1, 1.8	1.5	1.2, 1.9	1.5	1.1, 1.9
	Moderate	2.1	1.6, 2.8	2.2	1.6, 2.9	2.1	1.6, 2.8	1.2	1.0, 1.6	1.3	1.0, 1.7	1.3	1.0, 1.7
	Mod-high	1.7	1.3, 2.3	1.8	1.3, 2.4	1.7	1.3, 2.4	0.8	0.5, 1.2	0.9	0.6, 1.3	0.9	0.6, 1.3
	High (ref)	1.0		1.0		1.0		1.0		1.0		1.0	

[a]Model 1: unadjusted.
[b]Model 2: adjusted for sex; age in years; country of birth (Australia or not Australia).
[c]Model 3: adjusted for sex; age in years; country of birth (Australia or not Australia); smoking status; body mass index; frequency of toothbrushing; frequency of interdental cleaning.

fully adjusted model. For impacts fairly often or very often, the PR estimate decreased from 3.1 (95%CI: 2.2, 4.3) to 1.7 (95%CI: 1.1, 2.5) between the low and low-mod quintiles and for fair or poor self-rated oral health the PR estimate decreased from 2.1 95%CI: to 1.1 (95% CI: 2.2, 4.3). For all four oral conditions, the slope of the socioeconomic gradient was flatter using equivalised household income than the relative social status indicator.

There is some uncertainty whether the shape of the relationship across relative social status quintiles is linear or curvilinear. Examination of the ratio of estimated prevalence between successive quintiles in the fully adjusted model does not reveal a flattening of the relationship at higher levels of status that would be consistent with a curvilinear relationship. For example, for fewer than 24 remaining teeth, the prevalence ratio between successive relative status quintiles was 1.4, 1.4, 1.1 and 1.4 respectively. For the other three oral conditions the prevalence ratio between the mod-high and high quintiles was greater than it was between the moderate and mod-high quintiles, also non-consistent with curvilinearity. Yet dispersion around the point estimates is of sufficient magnitude that either shape is possible. We decided against the expression ''curvilinear'' since decrease in prevalence for all four oral conditions did not *diminish* at each successive quintile.''

One explanation for socioeconomic inequality in health is that risk behaviours lie in the causal pathway between socioeconomic position and oral health and are more prevalent among socioeconomically disadvantaged groups. We thought it instructive to examine this explanation, and our results demonstrate an insignificant role played by these behaviours in explaining inequalities in these oral conditions Adjustment for demographic and behavioural risk factors did not significantly attenuate the gradient for any oral health condition. In other research we found evidence that while use of dental services flattened the slope of gradient in self-reported oral health, dental self-care behaviour did not significantly attenuate the gradient (31). It is possible that while risk behaviours are important determinants of health, they do not account for relationships between social status and oral health observed here. In one intervention study that provided oral hygiene instruction to children, oral hygiene practices were found to produce a steeper

socioeconomic gradient in oral health as the desired behaviour was adopted more quickly among the more advantaged individuals (32).

A strength of this study was the comparison of two theoretically different socioeconomic indicators. Findings of a different functional form for each will be useful in debate over possible mechanisms underlying the reasons for socioeconomic inequalities. Such debate is beyond the scope of this paper, but findings support the view that beliefs about relative socioeconomic position may be more strongly associated with health status than objective indicators of absolute material resource (16) among more advantaged population groups, while absolute income may matter more at the disadvantaged tail of the distribution.

A potential limitation is non-reporting of household income. If non-reporting is socioeconomically patterned, missing data may adversely affect the estimates for low socioeconomic groups if these have a greater proportion of missing responses. However Turrell (33) found that respondents on high incomes were most likely to not report their income and that income non-reporting was lowest among the unemployed and those receiving government support. Another limitation is the clustering in the responses around the central rungs of the ladder used here to measure relative social status. This necessitated collapsing rungs 1–4 and rungs 8–10 which compromised the sensitivity of the scale and our ability to present what was otherwise a finely graduated monotonic linear distribution across the 10 rungs for all four oral health outcomes. The use of quintiles was an empirically defensible method of creating approximately numerically equivalent groups. We recommend that methodological work be conducted on the psychophysical properties of the ladder that could enable its use as an interval scale rather than as ordinal level of measurement.

We compared participants with missing and non-missing values for the variables examined in this study. Participants with missing values were significantly more likely ($p < 0.05$, Chi-square) to be female, to have lower relative social status scores and fewer than 24 remaining teeth. We found no significance difference ($p > 0.05$, Chi-square) for country of birth, equivalised income and the three other oral health conditions. Two variables that stood out as having substantially higher frequencies of missing values were equivalised income and body mass index. We also examined variation in study participation as equal proportions had been sampled from each decile of area disadvantage. Response tended to be lower in more disadvantaged deciles. Hence the 10 sampling deciles individually represented between 7.3% and 13.1% of the total sample yield. It was less than 10% in three of the five most disadvantage deciles, but in only one of the five least disadvantaged deciles.

It is possible that a characteristic such as positive or negative affect may influence perceptions of both relative social status and perceptions of oral conditions in one direction. Nevertheless these perceptions of status and health are real regardless of whether or not they are subject to psychological impact. We point out that missing teeth, while self-reported, is still an objective condition as are household income and family composition. The fact that the shape of the relationships was consistent irrespective of whether the oral condition measure was subjective or objective and irrespective of whether the socioeconomic measure was subjective or objective indicates that any bias that might arise by such mechanisms is not evident in these results.

Previous studies that examined the MacArthur Scale of Subjective Social Status have not reported the shape of the socioeconomic gradient and hence comparisons with this study are not possible. Several studies have examined the shape using material resource indicators (2–11), including equivalised income. For example, a comparison of health survey data collected from 10 European countries found the gradient between quintiles of equivalised household income and fair/poor self-rated general health was linear (11). Yet a threshold effect separated the lowest income quintile from the remainder of the population in Britain, while the Nordic countries of Finland, Sweden, Norway and Denmark had flatter gradients. A near linear relationship was also observed between net equivalised household income and mortality in a prospective study in Finland (9). Ecob and Davey Smith (4) investigated the gradient between equivalised household income and both self-assessed and examiner-assessed health using national survey data in the United Kingdom. They found the gradient for each health measure was approximately linear between the 10th and 90th percentile, but differed significantly from linearity at the extreme ends of the distribution.

A curvilinear gradient characterised by a steep slope at lower levels of the socioeconomic distribution and a gradual attenuation at higher levels

has also been observed (2, 3, 6, 10). Such a gradient implies that health at the low end of social status is more sensitive to changes in income than is health at the upper end of social status. Although a threshold effect is less commonly reported, Backlund et al (2) found a threshold effect in the shape of gradient between income and mortality in the United States in some age-sex groups where differences in mortality ceased above a particular level of income.

If poor health precedes socioeconomic position in the causal pathway, then there would be little point in addressing socioeconomic factors to reduce socioeconomic inequalities in health. However selection or reverse causation plays only a minor role and most evidence shows that socioeconomic conditions precede health outcomes (34, 35). In 1998 the World Health Organization in Europe (36) listed the social gradient first among ten factors identified as the key social determinants of health and a major contributor to unequal health outcomes in populations.

A problem that continues to baffles theorists and policy makers alike is how socioeconomic conditions translate into health outcomes. Various theoretical perspectives have been put forward and of these, two commonly contended explanations are the materialist and the psychosocial arguments. The former asserts health is responsive to absolute levels of material resource. Not only does income permit access to timely and comprehensive health care, it also provides opportunities for a whole constellation of choices that affect health. In this study, equivalised household income was an indicator of absolute material resource that might be used to explore this explanation. The psychological explanation places much less emphasis on material resource per se, but rather asserts that the meaning that people assign to their relative social standing is critical. The relative social status indicator in this study specifically is consistent with this explanation. The findings suggest that perceptions of relative position influenced oral health over and above the influence of absolute levels of material resource. However at the lower tail of the socioeconomic distribution, absolute material resources are associated with greatest gains to oral health.

Conclusion

The shape of the socioeconomic-oral health relationship differs according to the socioeconomic indicator used. We suggest that the two indicators are tapping different mechanisms that contribute to observe social inequalities in oral conditions. The introduction of relative social status into studies of the shape of the socioeconomic gradient in health highlights the importance of perceived social relativities. Results supported the role of psychosocial factors in explaining variation in health at the advantaged tail of the distribution while absolute material resource was more sensitive at the most disadvantaged tail of the distribution. To maximise the value of the MacArthur Scale of Subjective Social Status we encourage more work into its psychophysical properties. Results add further doubt to the importance of the behavioural hypothesis for explaining health inequalities.

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