

Material, behavioural, cultural and psychosocial factors in the explanation of socioeconomic inequalities in oral health

Denise Duijster,¹ Joost Oude Groeniger,² Geert J.M.G. van der Heijden,¹ Frank J. van Lenthe²

¹ Department of Social Dentistry, Academic Center for Dentistry Amsterdam, University of Amsterdam and VU University, Amsterdam, The Netherlands

² Department of Public Health, Erasmus University Medical Centre, Rotterdam, The Netherlands

Correspondence: Denise Duijster, Department of Social Dentistry, University of Amsterdam and VU University, Gustav Mahlerlaan 3004, 1081LA Amsterdam, The Netherlands, Tel: +31 20 5980230, e-mail: d.duijster@acta.nl

Background: This study aimed to assess the contribution of material, behavioural, cultural and psychosocial factors in the explanation of socioeconomic inequalities (education and income) in oral health of Dutch adults. **Methods:** Cross-sectional data from participants (25–75 years of age) of the fifth wave of the GLOBE cohort were used ($n=2812$). Questionnaires were used to obtain data on material factors (e.g. financial difficulties), behavioural factors (e.g. smoking), cultural factors (e.g. cultural activities) and psychosocial factors (e.g. psychological distress). Oral health outcomes were self-reported number of teeth and self-rated oral health (SROH). Mediation analysis, using multivariable negative binomial regression and logistic regression, was performed. **Results:** Education level and income showed a graded positive relationship with both oral health outcomes. Adding material, behavioural, cultural and psychosocial factors substantially reduced the rate ratio for the number of teeth of the lowest education group from 0.79 (95% confidence interval (CI): 0.75–0.83) to 0.92 (95% CI: 0.87–0.97) and of the lowest income group from 0.80 (95% CI: 0.73–0.88) to 1.04 (95% CI: 0.96–1.14). Inclusion of all factors also substantially reduced the odds ratio for poor SROH of the lowest education group from 1.61 (95% CI: 1.28–2.03) to 1.12 (95% CI: 0.85–1.48) and of the lowest income groups from 3.18 (95% CI: 2.13–4.74) to 1.48 (95% CI: 0.90–2.45). **Conclusion:** In general, behavioural factors contributed most to the explanation of socioeconomic inequalities in adult oral health, followed by material factors. The contribution of cultural and psychosocial factors was relatively moderate.

Introduction

Oral diseases affect nearly 4 billion people worldwide.¹ They lead to substantial negative impacts on social functioning, educational and work performance and quality of life.^{2,3} The burden of oral diseases is disproportionately high among socially disadvantaged population groups.⁴ As with other chronic diseases, socioeconomic inequalities in oral health are not simply differences between ‘the rich’ and ‘the poor’—they are characterized by a linear socioeconomic gradient, with oral health being worse with each lower position in the social hierarchy. Socioeconomic gradients have been consistently demonstrated for dental caries, periodontal disease and tooth loss, irrespective of the indicator of socioeconomic position (SEP).^{5–8}

The mechanisms underlying socioeconomic inequalities in oral health are not sufficiently understood, which is obstructing progress to address the problem. Yet, proposed explanations can benefit from a rich literature on the explanation of socioeconomic inequalities in health.^{9,10} Suggested theories of mechanisms include the material explanation, the behavioural explanation and the psychosocial explanation.¹¹

The material explanation argues that people with a lower SEP lack the material and financial resources to secure goods and services that are essential for a healthy life, such as adequate housing and healthcare.¹² For example, limited financial means can restrict people’s ability to afford high quality dental treatment and prevention.¹³ The behavioural explanation asserts that health inequalities are the result of clustering of health-compromising behaviours in lower socioeconomic groups. Behaviours, such as smoking, sugar-snacking, low fruit and vegetable consumption, poor oral hygiene and irregular dental attendance, have been associated with an increased risk of oral diseases and these behaviours are more prevalent in individuals of lower SEP.^{14,15}

In addition, there is growing recognition that individual behaviour is largely influenced by the social environment. This is captured in the psychosocial explanation, which emphasizes the important role of social networks to provide opportunities for social support that are beneficial to health.¹⁶ It also argues that health inequalities result from differences in experienced psychological distress among socioeconomic groups.¹¹ Psychological distress—e.g. as a result of financial difficulties, low levels of social support and negative life events—could directly affect oral health via neurobiological pathways.¹⁷ Indirectly, it could undermine people’s capacity and vigilance to look after their oral health, which increases the likelihood of poor oral hygiene and episodic use of dental care.¹⁸ Lastly, recent research suggest that people’s cultural resources, such as owned books and participation in cultural activities, may also contribute to the explanation of health inequalities. Cultural resources are unequally distributed among socioeconomic groups and are suggested to influence health behaviour through information, health literacy and norms acquired through socialization.¹⁹ However, research on their role in oral health inequalities is scarce.

It is likely that a combination of the aforementioned theories underlie socioeconomic inequalities in oral health. Watt and Sheiham²⁰ incorporated the existing theories into one conceptual framework, which describes how the SEP of individuals affects oral health through material, behavioural, cultural and psychosocial determinants. To date, few studies have empirically studied all groups of determinants in the relationship between SEP and oral health simultaneously. Therefore, the aim of this cross-sectional study was to assess the contribution of material, behavioural, cultural and psychosocial factors in the explanation of socioeconomic inequalities (education and income) in oral health of Dutch adults.

Methods

Study sample and design

Subjects were participants in the fifth wave of the GLOBE study—an open population cohort study on socioeconomic health differences in the Netherlands. The GLOBE study was initiated in 1991, for which a random sample of non-institutionalized persons (age 15–74) was recruited from 18 municipal population registers in the city of Eindhoven and surrounding villages in The Netherlands. Detailed information on the objectives, design and data collection of the study are available elsewhere.²¹ The GLOBE study has been registered with the Dutch Data Protection Authority (number 1248943).

For the purposes of this study, cross-sectional data from the fifth wave (2014) were used. A postal questionnaire was sent to 10 668 persons, comprising 4886 (45.8%) participants of the original GLOBE cohort, supplemented with a random sample of 5782 (54.2%) newly selected persons from the municipal registers. Of the respondents ($n = 4851$, response 45.5%), those between 25 and 75 years old and (still) living in the city of Eindhoven and surroundings were eligible for the study, to ensure representativity of the target population. This resulted in a total sample of 2812 participants (1114 participants from the original GLOBE cohort).

Oral health

Two measures of oral health were used as dependent variables: self-reported number of natural teeth and self-rated oral health (SROH). Participants were asked to state how many natural teeth they have (including wisdom teeth).²² The number of natural teeth provides a quantitative estimate of the accumulated burden of experienced oral disease, with lower numbers often reflecting tooth extractions as a consequence of severe dental caries or periodontal disease. The variable was used as a count variable. SROH was assessed by the question: 'In general, how would you rate your oral health?' (coded: excellent, good, fair, poor and very poor).²³ The variable was dichotomized into good (excellent, good) and poor (fair–very poor). Good levels of agreement with clinical assessments have been reported for both questions.^{22,23}

Education level and income

Three groups of highest completed education level were distinguished using the International Standard Classification of Education (ISCED)²⁴: low (primary education, lower vocational education and lower secondary education, ISCED 0–2), middle (intermediate vocational education and higher secondary education, ISCED 3–4) and high (higher vocational education and university, ISCED 5–7). The question on net household income included five categories: €0–1200/month, €1200–1800/month, €1800–2600/month, €2600–4000/month and >€4000/month.

Material, behavioural, cultural and psychosocial factors

Material factors included housing tenure (coded: owned house, private rent and social rent) and financial difficulties (coded: no difficulties, small difficulties and big difficulties). Financial difficulties were assessed using two questions, including difficulties in the last year with paying food, rent, electricity bills, etc. and perceived difficulties with living on the monthly income.

Included health behaviours were dental attendance (coded: regularly visiting the dentist for a check-up, occasionally visiting the dentist for a check-up, only visiting the dentist for treatment or problems/never visiting the dentists), smoking (coded: non-smoker, former smoker and current smoker) and consumption of the recommended fruit and vegetable intake (coded: yes, no). According to Dutch national dietary guidelines, adults are

recommended to eat at least 200 grams of vegetables and two pieces of fruit per day. To measure whether participants met both these criteria, they were asked about the frequency of eating fruit and vegetables on a weekly basis, and the amount of fruit (number of pieces) and vegetables (serving spoons of 50 grams) they normally ate per occasion.

Two cultural factors were measured: the number of cultural activities per year, including visits to a museum, the opera or the ballet, a classical or popular concert, the theatre and architecture (coded: none, 1–2 activities, 3–4 activities and ≥ 5 activities) and the number of owned books (coded: ≥ 200 books, 101–200 books, 26–100 books, 11–25 books and 0–10 books).

Psychosocial factors included psychological distress (coded: no, yes), health-related support (coded: yes, no) and social network size, which was defined as the number of family members with close personal contact (coded: ≥ 3 family members, 1–2 family members, none). Psychological distress was determined using the methods of the mental health inventory (MHI-5),²⁵ which includes five items on anxiety, depression, positive affect and emotional control. To measure health-related support, participants were asked if they had someone to support them if they want to lose weight, become more physically active, quit smoking, drink less alcohol, eat healthier or receive medical advice. Participants who responded 'no' to all six items were classified as having no health-related support.

Demographic factors

Demographic factors included gender (coded: male, female), age (continuous), country of birth (coded: Netherlands, other) and co-habitation (coded: yes, no).

Statistical analysis

Statistical analyses were conducted in STATA, version 13 (StataCorp LP, College Station, Texas). A mediation analysis approach was followed.²⁶ Multivariable regression was used to assess the association of education level and income with the number of teeth [negative binomial regression, expressed in rate ratios (RR)] and SROH [logistic regression, expressed in odds ratios (ORs)], adjusted for demographic factors. The associations were subsequently adjusted for material factors (model 1), behavioural factors (model 2), cultural factors (model 3), psychosocial factors (model 4) and for all explanatory factors simultaneously (model 5). Significant factors ($P < 0.05$) were retained in the model using stepwise backward selection. Factors were interpreted to contribute to the explanation of oral health inequalities if adjustment for the factor attenuated the regression coefficients for education level or income. Interaction terms between education level or income and each of the factors were tested and, if present, reported.

Missing data were handled using multiple imputation.²⁷ Five imputed datasets were created and all variables were used to inform the imputation model. The oral health outcome variables were not imputed. All analyses were weighted to account for the sampling strategy within the GLOBE study.

Results

The study sample consisted of 2812 participants (45% male) with a mean age of 48.9 (SD: 15.6) years (range 25–75). The characteristics of the study sample are described in a Supplementary table. The mean number of natural teeth of participants was 24.4 (SD: 9.4), and 208 participants (8%) were edentulous ('0' natural teeth). Seven hundred and one participants (25%) reported to have poor oral health.

Education level and income showed a graded relationship with both oral health outcomes (tables 1–4, crude estimates in first column and footnote). Those in the lowest education and income category had 21 and 20% less natural teeth (RR = 0.79 and 0.80) and

Table 1 RR for number of teeth by education level, adjusted for material, behavioural, cultural and psychosocial factors

	Number of teeth					
	Crude ^a	Material model ^a (model 1)	Behavioural model ^a (model 2)	Cultural model ^a (model 3)	Psychosocial model ^a (model 4)	Full model ^a (model 5)
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Education level ^b						
High (47%)	1	1	1	1	1	1
Middle (25%)	0.96 (0.92; 1.00)	0.97 (0.93; 1.02)	0.99 (0.95; 1.03)	1.00 (0.95; 1.05)	0.96 (0.92; 1.00)	1.02 (0.97; 1.06)
Low (28%)	0.79 (0.75; 0.83)	0.83 (0.79; 0.88)	0.84 (0.80; 0.88)	0.85 (0.80; 0.90)	0.79 (0.75; 0.83)	0.92 (0.87; 0.97)
Material factors						
Housing tenure						
Owned house (63%)		1				1
Private rent (11%)		0.88 (0.82; 0.94)				0.90 (0.85; 0.95)
Social rent (26%)		0.87 (0.83; 0.91)				0.91 (0.87; 0.95)
Behavioural factors						
Dental attendance						
Regular check-up (71%)			1			1
Occasional check-up (12%)			0.90 (0.85; 0.95)			0.92 (0.87; 0.97)
Never/problems (18%)			0.57 (0.55; 0.60)			0.58 (0.55; 0.61)
Smoking						
Non-smoker (45%)			1			1
Former smoker (37%)			0.97 (0.93; 1.01)			0.96 (0.93; 1.00)
Current smoker (18%)			0.90 (0.86; 0.95)			0.90 (0.86; 0.95)
Cultural factors						
Number of cultural activities						
None (17%)				1		NA
1–2 (25%)				1.08 (1.01; 1.15)		NA
3–4 (31%)				1.11 (1.04; 1.19)		NA
5–7 (28%)				1.10 (1.02; 1.18)		NA
Number of owned books						
>200 (18%)				1		1
101–200 (14%)				0.99 (0.93; 1.07)		0.99 (0.93; 1.05)
26–100 (28%)				0.97 (0.91; 1.03)		0.96 (0.91; 1.01)
11–25 (17%)				0.96 (0.89; 1.03)		0.93 (0.88; 0.99)
0–10 (23%)				0.92 (0.86; 0.99)		0.91 (0.86; 0.96)
Psychosocial factors					NA	NA

Notes: Negative binomial regression, Rate ratio (RR) were weighted to account for the sampling strategy within the GLOBE study. '1' refers to the reference category. NA (not applicable) refers to a variable that was excluded from the model using stepwise backward selection.

a: All models are adjusted for age, sex, ethnicity and cohabitation.

b: Mean number of teeth: 27.6 ± 6.1 (high education), 25.1 ± 8.5 (middle education) and 18.0 ± 11.6 (low education).

1.61 and 3.18 higher odds of poor SROH, respectively, compared with the highest education and income category (after adjustment for age, gender, ethnicity and cohabitation).

Table 1 shows that the association between education level and the number of teeth was attenuated by the inclusion of material factors (model 1), behavioural factors (model 2) and cultural factors (model 3) but not by psychosocial factors (model 4). In the full model (model 5), the simultaneous inclusion of material, behavioural, psychosocial and cultural factors substantially attenuated the RR for number of teeth of the lowest education category from 0.79 (95% confidence interval (CI): 0.75–0.83) to 0.92 (95% CI: 0.87–0.97). However, the association between education level and the number of teeth remained statistically significant. In the full model, rented housing, irregular dental attendance, smoking and owning <25 books were significantly associated with a lower number of natural teeth.

Table 2 shows that the association between income and the number of teeth was moderately attenuated by the separate inclusion of material, behavioural and cultural factors (models 1–3). Joined inclusion of all factors (model 5) substantially reduced the slope of the income gradient to a point where the association between income and number of teeth almost lost its statistical significance; the RR for the number of teeth of the lowest income category altered from 0.80 (95% CI: 0.73–0.88) to 1.04 (95% CI: 0.96–1.14). In addition to housing tenure, dental attendance, smoking and the number of books, the number of cultural activities and social network size were significantly associated with the number of natural teeth in the full model.

As presented in table 3, the association between education level and SROH disappeared after the inclusion of behavioural factors (model 2), which suggests that irregular dental attendance, smoking and low fruit and vegetable consumption substantially accounted for the association between low education level and poor SROH. In the full model (model 5), all factors combined substantially attenuated the OR for poor SROH of the lowest education category from 1.61 (95% CI: 1.28–2.03) to 1.12 (95% CI: 0.85–1.48). In this model, financial difficulties, owning less books, psychological distress and no health-related support were significantly associated with poor SROH, in addition to the behavioural factors.

Table 4 shows that the slope of the income gradient in SROH was substantially attenuated by the inclusion of material factors (model 1) and behavioural factors (model 2) but not by cultural and psychosocial factors (models 3 and 4). In the full model (model 5), the association between income and SROH was no longer statistically significant after the combined inclusion of material, behavioural, cultural and psychosocial factors. Simultaneous inclusion reduced the OR for poor oral health of the lowest income category from 3.18 (95% CI: 2.13–4.74) to 1.48 (95% CI: 0.90–2.45). The same factors as in table 3, model 5 were significantly associated with poor SROH, with the exception of psychological distress.

There was significant interaction between education level and income with dental attendance in the models of tables 1–3: the association between irregular dental attendance and poor oral health (lower number of teeth or poor SROH) was much stronger in the high education and high income group, compared with the lower

Table 2 RR for number of teeth by income, adjusted for material, behavioural, cultural and psychosocial factors

	Number of teeth					
	Crude ^a	Material model ^a (model 1)	Behavioural model ^a (model 2)	Cultural model ^a (model 3)	Psychosocial model ^a (model 4)	Full model ^a (model 5)
	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)	RR (95% CI)
Net household income ^b						
>€4000/month (17%)	1	1	1	1	1	1
€2600–4000/month (30%)	0.96 (0.90; 1.02)	0.97 (0.91; 1.03)	0.98 (0.93; 1.03)	0.97 (0.92; 1.03)	0.96 (0.90; 1.02)	1.00 (0.95; 1.05)
€1800–2600/month (26%)	0.88 (0.82; 0.94)	0.92 (0.86; 0.98)	0.91 (0.86; 0.96)	0.91 (0.85; 0.97)	0.88 (0.82; 0.94)	0.97 (0.92; 1.03)
€1200–1800/month (16%)	0.77 (0.72; 0.84)	0.83 (0.77; 0.90)	0.82 (0.77; 0.88)	0.83 (0.77; 0.90)	0.77 (0.72; 0.84)	0.92 (0.85; 0.99)
€0–1200/month (11%)	0.80 (0.73; 0.88)	0.89 (0.81; 0.98)	0.92 (0.85; 1.00)	0.86 (0.79; 0.95)	0.81 (0.74; 0.88)	1.04 (0.96; 1.14)
Material factors						
Housing tenure						
Owned house (63%)		1				1
Private rent (11%)		0.88 (0.82; 0.94)				0.88 (0.83; 0.93)
Social rent (26%)		0.86 (0.81; 0.90)				0.90 (0.85; 0.94)
Behavioural factors						
Dental attendance						
Regular check-up (71%)			1			1
Occasional check-up (12%)			0.92 (0.87; 0.97)			0.93 (0.89; 0.98)
Never/problems (18%)			0.56 (0.54; 0.59)			0.57 (0.54; 0.60)
Smoking						
Non-smoker (45%)			1			1
Former smoker (37%)			0.97 (0.93; 1.01)			0.97 (0.93; 1.01)
Current smoker (18%)			0.89 (0.85; 0.94)			0.90 (0.85; 0.94)
Cultural factors						
Number of cultural activities						
None (17%)				1		1
1–2 (25%)				1.08 (1.01; 1.16)		1.06 (1.00; 1.13)
3–4 (31%)				1.13 (1.06; 1.21)		1.07 (1.01; 1.14)
5–7 (28%)				1.11 (1.04; 1.20)		1.07 (1.00; 1.14)
Number of owned books						
>200 (18%)				1		1
101–200 (14%)				1.01 (0.94; 1.09)		1.01 (0.95; 1.08)
26–100 (28%)				0.98 (0.93; 1.05)		0.97 (0.92; 1.03)
11–25 (17%)				0.96 (0.89; 1.03)		0.93 (0.88; 0.99)
0–10 (23%)				0.92 (0.86; 0.99)		0.92 (0.87; 0.98)
Psychosocial factors						
Social network size						
≥3 family members (71%)					1	1
1–2 family members (24%)					1.04 (0.99; 1.09)	1.05 (1.01; 1.10)
None (6%)					0.91 (0.83; 1.00)	0.94 (0.87; 1.02)

Notes: Negative binomial regression, Rate ratio (RR) were weighted to account for the sampling strategy within the GLOBE study. '1' refers to the reference category.

a: All models are adjusted for age, sex, ethnicity and cohabitation.

b: Mean number of teeth: 28.2 ± 5.1 (>€4000/month), 26.2 ± 7.5 (€2600–4000/month), 22.9 ± 10.2 (€1800–2600/month), 20.8 ± 11.4 (€1200–1800/month) and 23.0 ± 10.3 (€0–1200/month).

education or income group. No interactions were found between education level and income and any of the other mediators.

Discussion

The findings of this study suggest that material, behavioural, cultural and psychosocial factors are all important factors contributing to the explanation of socioeconomic inequalities in adult oral health. In general, for both educational level and income level, behavioural factors contributed most to the explanation followed by material factors, while the contribution of cultural and psychosocial factors was relatively moderate.

Our study supports the view that oral health behaviours contribute to socioeconomic inequalities in oral health and should be included in explanatory models. This is in contrast to three previous studies^{28–30} who showed that variation in health behaviours accounted for only little of the socioeconomic gradient in oral health. Yet, our results of the relative importance of the behavioural explanation require some remarks. First, only a subset of oral behaviours were assessed in this study, with dental attendance

being the main contributing behavioural factor. However, Sabbah et al.,³¹ showed that the impact of dental attendance on educational gradients in caries increment was relatively low in comparison to other key behaviours, such as toothbrushing (and the concomitant use of fluoride) and sugar consumption. Hence, the contribution of behavioural factors in our study, such as dental attendance, could have been overestimated by the absence of other relevant oral health behaviours. Second, edentulous people have lower needs of care³² and may be less inclined to regularly visit the dentist. This too may have led to an overestimation of the contribution of dental attendance. Third, there is conflicting evidence whether regular dental attendance in higher socioeconomic groups actually leads to better oral health or whether it is an indication of general attitudes, healthy lifestyle and concern.¹¹ Meanwhile, poor care seeking in lower socioeconomic groups is more likely a reflection of barriers to costs and poor access to dental services,^{15,33} which affirms the material explanation.

Material factors also explained a substantial proportion of socioeconomic inequalities in oral health. Material risk factors, such as financial difficulties and poor living conditions, could

Table 3 OR for poor SROH by education level, adjusted for material, behavioural, cultural and psychosocial factors

	Poor SROH (reference = good)					
	Crude ^a	Material model ^a (model 1)	Behavioural model ^a (model 2)	Cultural model ^a (model 3)	Psychosocial model ^a (model 4)	Full model ^a (model 5)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Education level ^b						
High (47%)	1	1	1	1	1	1
Middle (25%)	1.31 (1.05; 1.64)	1.13 (0.90; 1.42)	1.16 (0.92; 1.46)	1.29 (1.02; 1.64)	1.27 (1.02; 1.59)	1.08 (0.84; 1.38)
Low (28%)	1.61 (1.28; 2.03)	1.32 (1.04; 1.67)	1.22 (0.95; 1.55)	1.51 (1.15; 1.98)	1.53 (1.21; 1.92)	1.12 (0.85; 1.48)
Material factors						
Financial difficulties						
No difficulties (40%)		1				1
Small difficulties (53%)		1.65 (1.34; 2.02)				1.49 (1.20; 1.85)
Big difficulties (7%)		2.99 (2.12; 4.20)				2.20 (1.53; 3.17)
Behavioural factors						
Dental attendance						
Regular check-up (71%)			1			1
Occasional check-up (12%)			1.34 (0.99; 1.82)			1.33 (0.98; 1.82)
Never/problems (18%)			3.06 (2.45; 3.83)			2.99 (2.37; 3.76)
Smoking						
Non-smoker (45%)			1			1
Former smoker (37%)			1.26 (1.02; 1.56)			1.22 (0.98; 1.52)
Current smoker (18%)			1.68 (1.31; 2.15)			1.49 (1.15; 1.93)
Recommended fruit and vegetable intake						
Yes (14%)			1			1
No (86%)			1.39 (1.04; 1.84)			1.36 (1.01; 1.82)
Cultural factors						
Number of cultural activities						
None (17%)				1		NA
1–2 (25%)				0.86 (0.65; 1.13)		NA
3–4 (31%)				0.79 (0.59; 1.06)		NA
5–7 (28%)				0.73 (0.53; 1.00)		NA
Number of owned books						
>200 (18%)				1		1
101–200 (14%)				0.90 (0.65; 1.24)		0.93 (0.67; 1.29)
26–100 (28%)				0.65 (0.49; 0.86)		0.67 (0.50; 0.90)
11–25 (17%)				0.81 (0.59; 1.11)		0.85 (0.61; 1.17)
0–10 (23%)				0.87 (0.63; 1.19)		0.80 (0.58; 1.09)
Psychosocial factors						
Psychological distress						
No (73%)					1	1
Yes (27%)					1.29 (1.06; 1.58)	1.25 (1.00; 1.55)
Health-related support						
Yes (85%)					1	1
No (15%)					1.77 (1.41; 2.22)	1.48 (1.16; 1.88)

Notes: Logistic regression, Odds ratio (OR) were weighted to account for the sampling strategy within the GLOBE study. '1' refers to the reference category. NA (not applicable) refers to a variable that was excluded from the model using stepwise backward selection.

a: All models are adjusted for age, sex, ethnicity and cohabitation.

b: Percentage with poor SROH: 20% (high education), 26% (middle education) and 33% (low education).

exert a direct influence on oral health.³⁴ Though their influence likely operates, to a larger extent, through health behaviours and psychosocial factors. Much research inferred that health behaviours are embedded in the social environment and are thus determined by material living conditions and (resulting) psychosocial factors, such as stress and social support.^{22,35,36} This suggests that there might be 'overlap' in the contribution of material, behavioural and psychosocial factors in explaining socioeconomic inequalities in oral health, because of their independent (direct) as well as their shared (indirect) influence. The mechanism through which cultural factors are related to oral health inequalities is worth further investigation.

Significant interaction was found between education level or income with dental attendance, showing a stronger association between irregular dental attendance and poor oral health in the high education or high income group, compared with the lower education or income group. In the high education or income

group, participants with poor oral health were much more likely to never visit the dentist or for emergency treatment only, compared with participants with good oral health. In the lower education or income group, participants were generally more likely to never visit the dentist or for emergency treatment only in comparison to the high education or income group, irrespective of their oral health status. This could indicate that people from lower SEP may perceive other barriers to regularly visit the dentist than people from higher SEP, which could plausibly relate to financial or attitudinal factors.

Explanatory factors were slightly different depending on the oral health outcome studied. For example, financial difficulties and health-related support were significantly associated with SROH, while housing tenure was associated with the number of remaining teeth. Although both SROH and tooth count information provide valid information on a person's clinical oral health status,^{22,23} they measure different aspects of oral health. SROH is a

Table 4 OR for poor SROH by income, adjusted for material, behavioural, cultural and psychosocial factors

	Poor SROH (reference = good)					
	Crude ^a	Material model ^a (model 1)	Behavioural model ^a (model 2)	Cultural model ^a (model 3)	Psychosocial model ^a (model 4)	Full model ^a (model 5)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Net household income ^b						
>€4000/month (17%)	1	1	1	1	1	1
€2600–4000/month (30%)	1.36 (0.98; 1.90)	1.22 (0.87; 1.71)	1.25 (0.90; 1.76)	1.35 (0.96; 1.90)	1.39 (0.99; 1.94)	1.17 (0.82; 1.66)
€1800–2600/month (26%)	1.71 (1.23; 2.39)	1.39 (0.98; 1.96)	1.47 (1.05; 2.07)	1.75 (1.24; 2.46)	1.66 (1.19; 2.31)	1.29 (0.89; 1.86)
€1200–1800/month (16%)	2.16 (1.48; 3.15)	1.55 (1.02; 2.34)	1.69 (1.13; 2.51)	2.20 (1.47; 3.30)	2.05 (1.40; 3.00)	1.35 (0.85; 2.13)
€0–1200/month (11%)	3.18 (2.13; 4.74)	1.95 (1.25; 3.04)	2.01 (1.28; 3.14)	3.28 (2.13; 5.05)	2.78 (1.85; 4.18)	1.48 (0.90; 2.45)
Material factors						
Financial difficulties						
No difficulties (40%)		1				1
Small difficulties (53%)		1.52 (1.22; 1.90)				1.42 (1.13; 1.78)
Big difficulties (7%)		2.55 (1.76; 3.68)				2.06 (1.39; 3.05)
Behavioural factors						
Dental attendance						
Regular check-up (71%)			1			1
Occasional check-up (12%)			1.31 (0.96; 1.77)			1.33 (0.97; 1.81)
Never/problems (18%)			2.93 (2.34; 3.67)			2.97 (2.36; 3.75)
Smoking						
Non-smoker (45%)			1			1
Former smoker (37%)			1.26 (1.02; 1.56)			1.23 (0.99; 1.53)
Current smoker (18%)			1.65 (1.28; 2.11)			1.51 (1.17; 1.95)
Recommended fruit and vegetable intake						
Yes (14%)			1			1
No (86%)			1.38 (1.04; 1.83)			1.34 (1.00; 1.80)
Cultural factors						
Number of owned books						
>200 (18%)				1		1
101–200 (14%)				0.90 (0.66; 1.24)		0.91 (0.66; 1.27)
26–100 (28%)				0.66 (0.50; 0.88)		0.67 (0.50; 0.89)
11–25 (17%)				0.84 (0.62; 1.15)		0.84 (0.61; 1.15)
0–10 (23%)				0.95 (0.72; 1.27)		0.79 (0.59; 1.06)
Psychosocial factors						
Psychological distress						
No (73%)					1	NA
Yes (27%)					1.27 (1.04; 1.55)	NA
Health-related support						
Yes (85%)					1	1
No (15%)					1.67 (1.32; 2.10)	1.48 (1.16; 1.88)

Notes: Logistic regression, Odds ratio (OR) were weighted to account for the sampling strategy within the GLOBE study. '1' refers to the reference category. NA (not applicable) refers to a variable that was excluded from the model using stepwise backward selection.

a: All models are adjusted for age, sex, ethnicity and cohabitation.

b: Percentage with poor SROH: 15% (>€4000/month), 21% (€2600–4000/month), 26% (€1800–2600/month), 31% (€1200–1800/month) and 40% (€0–1200/month).

subjective measure, which could reflect current disease, pain and functional limitations, while number of teeth could be an indication of disease history. This may explain why some potentially time-varying factors, such as financial difficulties, were related to SROH, and potentially more stable factors, such as housing tenure, were indicative of number of teeth.

The findings of this study should be considered in the context of some limitations. This study included a balanced and literature-based selection of relevant factors representing the explanatory mechanisms. Yet, inequalities in the number of natural teeth persisted for the lowest income and education group after full adjustment of behavioural, material, psychosocial and cultural factors. This suggests that there are other relevant explanatory factors that have not been investigated in this study, including e.g. working conditions, life events, health beliefs, coping or other aforementioned oral behaviours, such as oral hygiene and the frequency of sugar consumption. Inclusion of these factors may yield a more complete and potentially different estimate for each contribution. Another limitation is that all factors were assessed once at a single point in time. Because some factors are not

temporally stable, repeated measurements over time would improve the accuracy of estimates. In addition, all factors were assessed through self-report, which could have introduced bias as a result of socially desirable answers. These potential errors in measurement may also explain why inequality in the number of teeth persisted in fully adjusted models. Furthermore, this study was based on cross-sectional data, since longitudinal data was only available for 40% of participants of the fifth wave of the GLOBE study, and earlier waves of the GLOBE study did not include information on oral health. The cross-sectional design limits the possibilities for causal inferences. Follow-up data is needed to corroborate our findings and investigate causal pathways. Moreover, there is a possibility of reverse causality, with oral diseases leading to lower educational attainment, low self-esteem, reduced work opportunity and subsequent lower SEP. This risk is however minimal, as most evidence shows that health inequalities are not driven by selection effects and that SEP precedes health outcomes.³⁷

Apart from the material, behavioural cultural and psychosocial theory, the literature describes the lifecourse theory as another perspective to explain health inequalities. The lifecourse theory asserts

that health status at any given age is the result of material, psychosocial and biological advantages and disadvantages experienced over an individual's entire lifespan, from conception onwards.¹¹ There are two models within this theory: the cumulative model suggests that exposures throughout life have a cumulative effect on health, and the critical periods model suggests that an exposure during a specific time window can have an irreversible effect on later health. Despite the evidence supporting the application of the lifecourse perspective to oral health,^{11,38} this study could not employ a lifecourse approach because it heavily depends on the availability of longitudinal data, ideally from birth cohort studies. However, its findings are useful to inform future longitudinal research to assess how the explanatory factors from this study influence the development of oral health inequalities from early life to old age.

In conclusion, findings of this study showed that material, behavioural, cultural and psychosocial factors all contribute to the explanation of educational and income-related inequalities in adult oral health. This corresponds with literature on inequalities in general self-rated health and mortality.^{35,39} Although behavioural factors contributed most to the explanation, interventions should not narrowly focus on behaviours alone. According to our findings, to effectively address socioeconomic inequalities in oral health, material, psychosocial and cultural conditions should also be taken into account.

Acknowledgements

The authors thank Prof. Dr J.P. Mackenbach for reading and commenting on the article.

Supplementary data

Supplementary data are available at *EURPUB* online.

Conflicts of interest: None declared.

Funding

The study was supported by a grant from the Netherlands Organisation for Health Research and Development (grant number 200500005).

Key points

- Socioeconomic inequalities in oral health have been consistently reported in many countries across the world.
- Various theories exist to explain the underlying mechanisms of oral health inequalities, yet evidence for these theories relies on few empirical studies.
- Findings of this study showed that material, behavioural, cultural and psychosocial factors all contribute to the explanation of educational and income-related inequalities in adult oral health. Behavioural factors contributed most to the explanation, followed by material factors.
- Action to reduce socioeconomic inequalities in oral health should not narrowly focus on behaviours alone but should also address material, cultural and psychosocial factors.

References

- Marcenes W, Kassebaum NJ, Bernabé E, et al. Global burden of oral conditions in 1990–2010: a systematic analysis. *J Dent Res* 2013; 92:592–7.
- Al-Harthi LS, Cullinan MP, Leichter JW, Thomson WM. The impact of periodontitis on oral health-related quality of life: a review of the evidence from observational studies. *Aust Dent J* 2013; 58:274–7.
- Jackson SL, Vann WF Jr, Kotch JB, et al. Impact of poor oral health on children's school attendance and performance. *Am J Public Health* 2011;101:1900–6.
- Watt RG, Listl S, Peres M, Heilmann A. Social inequalities in oral health: from evidence to action. International Centre for Oral Health Inequalities Research & Policy (ICOHIRP). University College London, 2015.
- Costa SM, Martins CC, Bonfim Mde L, et al. A systematic review of socioeconomic indicators and dental caries in adults. *Int J Environ Res Public Health* 2012; 9:3540–74.
- Locker D. Deprivation and oral health: a review. *Community Dent Oral Epidemiol* 2000; 28:161–9.
- Schwendicke F, Dörfer CE, Schlattmann P, et al. Socioeconomic inequality and caries: a systematic review and meta-analysis. *J Dent Res* 2015; 94:10–8.
- Sanders AE, Slade GD, Turrell G, et al. The shape of the socio-economic-oral health gradient: implications for theoretical explanations. *Community Dent Oral Epidemiol* 2006; 34:310–9.
- Fair Society, Healthy Lives. The Marmot review. Strategic review of health inequalities in England post-2010. UCL Institute of Health Equity, 2010. Available at: <http://www.instituteofhealthequity.org/projects/fair-society-healthy-lives-the-marmot-review> (22 December 2016, date last accessed)
- Townsend P, Davidson N. *Inequalities in Health (the Black Report)*. Harmondsworth, UK: Penguin Books, 1989.
- Sisson KL. Theoretical explanations for social inequalities in oral health. *Community Dent Oral Epidemiol* 2007; 35:81–8.
- Macintyre S. The Black report and beyond: what are the issues?. *Soc Sci Med* 1997; 44:723–45.
- Osterberg T, Lundgren M, Emilson C-G, et al. Utilization of dental services in relation to socioeconomic and health factors in the middle aged and elderly Swedish population. *Acta Odontol Scand* 1998; 56:41–7.
- Singh A, Rouxel P, Watt RG, Tsakos G. Social inequalities in clustering of oral health related behaviors in a national sample of British adults. *Prev Med* 2013; 57:102–6.
- Sanders AE, Spencer AJ, Stewart JF. Clustering of risk behaviours for oral and general health. *Community Dent Health* 2005; 22:133–40.
- Sanders AE, Spencer AJ, Slade GD. Evaluating the role of dental behaviour in oral health inequalities. *Community Dent Oral Epidemiol* 2006; 34:71–9.
- Sabbah W, Tsakos G, Sheiham A, Watt RG. The role of health-related behaviors in the socio-economic disparities in oral health. *Soc Sci Med* 2009; 68:298–303.
- Berkman LF, Glass T. Social integration, social networks, social support and health. In: Berkman LF, Kawachi I, editors. *Social Epidemiology*. New York: Oxford University Press, 2000; 137–73.
- Trombelli L, Scapoli C, Tatakis D, Grassi L. Modulation of clinical expression of plaque induced gingivitis: effects of personality traits, social support and stress. *J Clin Periodontol* 2005; 32:1143–50.
- Sanders AE, Slade GD, Turrell G, et al. Does psychological stress mediate social deprivation in tooth loss?. *J Dent Res* 2007; 86:1166–70.
- Fisman AS, Samdal O, Torsheim T. Family affluence and cultural capital as indicators of social inequalities in adolescent's eating behaviours: a population-based survey. *BMC Public Health* 2012; 12:1036.
- Watt RG, Sheiham A. Integrating the common risk factor approach into a social determinants framework. *Community Dent Oral Epidemiol* 2012; 40:289–96.
- van Lenthe FJ, Kamphuis CB, Beenackers MA, et al. Cohort profile: understanding socioeconomic inequalities in health and health behaviours: the GLOBE study. *Int J Epidemiol* 2014; 43:721–30.
- Matsui D, Yamamoto T, Nishigaki M, et al. Validity of self-reported number of teeth and oral health variables. *BMC Oral Health* 2016;17:17.
- Kojima A, Ekuni D, Mizutani S, et al. Relationships between self-rated oral health, subjective symptoms, oral health behavior and clinical conditions in Japanese university students: a cross-sectional survey at Okayama University. *BMC Oral Health* 2013; 13:62.
- International Standard Classification of Education – ISCED 2011. Unesco Institute for Statistics, 2012.
- Berwick DM, Murphy JM, Goldman PA, et al. Performance of a five-item mental health screening test. *Med Care* 1991; 29:169–76.
- Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *JPSA* 1986; 51:1173–82.
- Royston P, White IR. Multiple imputation by chained equations (MICE): Implementation in Stata. *J Stat Softw* 2011; 45: 20.

- 30 Polk DE, Weyant RJ, Manz MC. Socioeconomic factors in adolescents' oral health: are they mediated by oral hygiene behaviors or preventive interventions?. *Community Dent Oral Epidemiol* 2010; 38:1–9.
- 31 Sabbah W, Suominen AL, Vehkalahti MM, et al. The role of behaviour in inequality in increments of dental caries among Finnish adults. *Caries Res* 2015;49:34–40.
- 32 Steele JG. The dental status, needs and demands of the elderly in three communities. PhD thesis, University of Newcastle upon Tyne, January 1994.
- 33 Freeman R. The psychology of dental patient care: barriers to accessing dental care: patient factor. *Br Dent J* 1999;187:141–4.
- 34 Lee JY, Divaris K. The ethical imperative of addressing oral health disparities. A unifying framework. *J Dent Res* 2014; 93:224–30.
- 35 Moor I, Spallek J, Richter M. Explaining socioeconomic inequalities in self-rated health: a systematic review of the relative contribution of material, psychosocial and behavioural factors. *J Epidemiol Community Health* 2017;71: 565–75.
- 36 World Health Organisation. *Closing the gap in a generation: health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health*. Geneva: World Health Organisation, 2008.
- 37 Chandola T, Bartley M, Sacker A, et al. Health selection in the Whitehall II study, UK. *Soc Sci Med* 2003; 56:2059–72.
- 38 Heilmann A, Tsakos G, Watt RG. Oral health over the lifecourse. In: Burton-Jeangros C, Cullati S, Sacker A, Blane D, editors. *A Lifecourse Perspective on Health Trajectories and Transitions*. Springer, 2015; 39–59.
- 39 Van Oort FVA, van Lenthe FJ, Mackenbach J. Material, psychosocial, and behavioural factors in the explanation of educational inequalities in mortality in the Netherlands. *J Epidemiol Community Health* 2005; 59:214–20.

.....
The European Journal of Public Health, Vol. 28, No. 4, 597–603

© The Author(s) 2017. Published by Oxford University Press on behalf of the European Public Health Association.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted reuse, distribution, and reproduction in any medium, provided the original work is properly cited.

doi:10.1093/eurpub/ckx212 Advance Access published on 8 December 2017

The role of financial strain and self-control in explaining health behaviours: the GLOBE study

Mariëlle A. Beenackers¹, Joost Oude Groeniger¹, Frank J. van Lenthe¹, Carlijn B.M. Kamphuis²

¹ Department of Public Health, Erasmus University Medical Centre, Rotterdam, The Netherlands

² Department of Human Geography and Spatial Planning, Utrecht University, Utrecht, The Netherlands

Correspondence: Mariëlle A. Beenackers, Department of Public Health, Erasmus University Medical Centre, PO Box 2040, 3000 CA Rotterdam, The Netherlands, e-mail: m.beenackers@erasmusmc.nl

Background: Why lower socioeconomic groups behave less healthily can only partly be explained by direct costs of behaving healthily. We hypothesize that low income increases the risk of facing financial strain. Experiencing financial strain takes up cognitive 'bandwidth' and leads to less self-control, and subsequently results in more unhealthy behaviour. We therefore aim to investigate (i) whether a low income increases the likelihood of experiencing financial strain and of unhealthy behaviours, (ii) to what extent more financial strain is associated with less self-control and, subsequently, (iii) whether less self-control is related to more unhealthy behaviour. **Methods:** Cross-sectional survey data were obtained from participants (25–75 years) in the fifth wave of the Dutch GLOBE study ($N=2812$) in 2014. The associations between income, financial strain, self-control and health-behaviour-related outcomes (physical inactivity in leisure-time, obesity, smoking, excessive alcohol intake, and weekly fruit and vegetable intake) were analysed with linear regression and generalized linear regression models (log link). **Results:** Experiencing great compared with no financial strain increased the risk of all health-behaviour-related outcomes, independent of income. Low self-control, as compared with high self-control, also increased the risk of an unhealthy lifestyle. Taking self-control into account slightly attenuated the associations between financial strain and the outcomes. **Conclusion:** Great financial strain and low self-control are consistently associated with unhealthy behaviours. Self-control may partly mediate between financial strain and unhealthy behaviour. Interventions that relieve financial strain may free up cognitive bandwidth and improve health behaviour.

Introduction

Socioeconomic health inequalities are an important societal challenge.^{1,2} Unhealthy behaviours, such as smoking and physical inactivity, explain a large part of these inequalities since low socioeconomic groups generally act more unhealthily.^{3–5} Partly, this may be attributed to lower socioeconomic groups often having a lower disposable income, which may be a barrier for purchasing goods or services that are needed for behaving healthily (e.g. sports equipment). However, smoking is more prevalent in lower socioeconomic groups but actually costs money, while recreational walking is more prevalent in higher socioeconomic groups and free of costs. Therefore, other mechanisms through which poor material circumstances contribute to inequalities in health behaviours must also play a role.

Poorer material circumstances can co-occur with financial strain: i.e. having difficulties making ends meet, and paying bills for basic needs such as food, housing, and electricity. Financial strain is a constant stressor that forces daily difficult financial decision making on basic matters such as food and clothing. This relentless stress and feeling of lack of control negatively impacts health.^{6,7} The 'scarcity theory'^{8,9} suggests that dealing with scarcity (such as scarcity of money) takes up 'cognitive bandwidth', i.e. 'our computational capacity, our ability to pay attention, to make good decisions, to stick with our plans, and to resist temptations' (pp. 41–42).⁹ An important pathway through which a reduced cognitive bandwidth may impede a healthy lifestyle is via self-control. Self-control is regarded as the capacity to 'regulate cognition and behaviour in order to achieve long-term goals'.¹⁰ Self-control is a limited resource and can be depleted when demands are high.^{9,10}