Explanatory models for clinically determined and symptom-reported caries indicators in an adult population

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The aim of the present study was to analyze possible indicators of: (i) relative number of decayed and filled teeth, (ii) relative number of decayed teeth, (iii) subjectively reported toothache, and (iv) sensitive teeth, and to find explanatory models for these phenomena. Independent variables from three domains were used: (i) socio-economic factors, (ii) general health and health-related lifestyle, and (iii) dental attitudes and behaviors. The study basis was validated questionnaires from all 50-year-olds in 2 Swedish counties ($n = 8888$), response rate 71% ($n = 6343$). For a 20% subsample (58% participation) the DFT and DT were determined by calibrated dentists. Analyses were done with logistic and multiple regression. The variables born outside Sweden, gender, education, shift work, satisfaction with dental care, fear and care utilization were associated with DFT/number of teeth. For DT/number of teeth, the direction of association was reversed for the variables born outside Sweden and gender. Social class, education, general health, and use of tobacco were further covariates. Good oral hygiene gave a lower ratio of DT. For the logistic regression model of toothache, residence in cities and satisfaction with dental care had lower probability for toothache reports, while born outside Sweden, mouth dryness, use of pharmaceuticals, tobacco, fear, and high utilization increased this probability. In general, the association pattern was as could be expected: immigrants, working class, low education, smoking, dissatisfaction with dental treatment and low utilization all appeared as risk factors for both the clinically determined caries indicators, but not necessarily for subjective symptom reports. Only fear of dental treatment showed a consistent positive association with all the indicators. ☐ *Adults; dental caries; multivariate models; oral healthcare; sensitive teeth*

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Caries among adults is a complex phenomenon with many aspects and determinants. The disease in itself is difficult to delineate: exactly where in the caries pathogenesis should the qualitative definition of a disease be made (1–3)? It is often easier to define symptoms of a disease, like decayed surfaces, toothache, and sensitive teeth. In many studies, the combination of decayed and filled surfaces is used as a caries indicator (4).

The emergence of caries is a multifactorial process involving social and individual factors as well as biological factors (5). There have been attempts to construct overarching models of caries, encompassing all possible etiologic factors in one model (6–8). However, these models can be structured into subsystems, which can be analyzed as partial caries-etiologic factors explaining parts of the caries process. Such subsystems may consist of individual lifestyle and behavior, as well as social factors influencing those phenomena. The impact of these systems may work through intricate biological mechanisms, but they are also important to study explicitly. Explanatory models can contribute to a deeper understanding of such mechanisms, even if they can never be expected to give full evidence of causality (9). Another problem is the terminology, which can be confusing when creating models of multifactorial diseases (10).

In a previous study we validated a series of questionnaire-based caries indicators (11). In comparison with clinical data, it was found that survey indicators of toothache and sensitive teeth had validity in relation to the number of decayed teeth, primarily as indicators of groups with advanced disease, i.e. valid not as individual-oriented but as population-oriented indicators. The aim of this study is therefore to analyze four possible caries indicators, (i) clinically determined relative number of decayed and filled teeth, (ii) clinically determined relative number of decayed teeth, (iii) subjectively reported toothache, and (iv) subjectively reported sensitive teeth, in an attempt to construct explanatory models of these phenomena. The following categories of independent variables were used: (i) socio-economic factors, (ii) general health and health-related lifestyle, and (iii) dental attitudes and behaviors.

Material and methods

Population and response rate

In 1992, a mail questionnaire was sent to all 50-year-old people in 2 counties in Sweden, Örebro and Östergötland,

a total of 8888 persons (3633 in Örebro and 5255 in Östergötland). The final response rate was 71% (6343 persons), the same rate in both counties. A closer description of the questionnaire study is published elsewhere (12).

Dependent variables

A clinical investigation of a randomly selected subsample from the questionnaire study comprised 20% of the whole population, 1780 persons with 1041 participants (58%). The number of fillings, coronal caries lesions, and root caries lesions was determined by teams of calibrated dentists with bitewing radiographs available. Details of this study are reported elsewhere (11). The observations of lesions were aggregated into: (i) the ratio of decayed and filled teeth (DFT) in relation to the total number of teeth in each patient, expressed as a percentage, and (ii) the ratio of decayed teeth (DT) in relation to the total number of teeth in each patient, expressed as a percentage.

In the questionnaire there was one question, related to the last-reported latest experience of toothache, with the following response alternatives: "during last 3 months", "during last year", "more than 1 year ago", "have never had toothache", and "do not remember". This variable was dichotomized and used as a dependent variable in logistic regression modeling. Those reporting toothache during the last year were set as 1 (13%) and the remainder as 0 (87%), ($n = 6283$). Another question in the questionnaire concerned problems with sensitive teeth, with the response alternatives: "no problems", "some problems", "rather many problems", and "great problems". A binary variable was constructed with those reporting no problems with sensitive teeth set as 0 (65%) and the remainder as 1 (34%), ($n = 6069$).

Independent variables

The independent variables in this study can be divided into "social factors", "general health and health-related factors", and "dental attitudes and behaviors". The following eight variables were included for social factors: (i) gender, (ii) self-assessment of place of residence (city, town, rural, included as dummy variable with city as reference category), (iii) born outside Sweden or not, (iv) education (primary education, secondary education, high school/grammar school, college education, included as dummy variable with primary education as reference category), (v) marital status (single versus married or cohabiting), (vi) working hours (full time >35 h/week, part time 1–34 h/week, none, included as dummy variable with full time as reference category), (vii) shift-work (yes/no), and (viii) occupation (open-ended question amended with a subquestion about entrepreneur or not).

A categorization of occupation with four categories, based on the one-digit level of SEI, SocioEconomic Index, was used (13). This is the official occupational classification of Statistics, Sweden. The four categories were: (i) blue-collar workers, (ii) white-collar workers, (iii) professionals and white-collar workers in leading positions, and (iv) entrepreneurs and farmers. They were included in the models as three dummy variables with "blue-collar workers" as reference category.

There was a series of questions in the questionnaire regarding "general health and health-related lifestyle factors". These asked if the respondents considered themselves healthy, if they regarded their health as better or worse than peers of similar age, whether they had used pharmaceuticals in the last fortnight, whether they were sick-listed during the last 3 months, and whether or not they had visited a physician during the same period. The responses were combined into a general health index with two categories: (i) those with good health (healthy or better, better or equal health than peers of similar age, sick-listing once or less, and physician contact once or less) and (ii) all others. Use of pharmaceuticals was included as a separate question, asking about use of any drugs during the last 2 weeks. Responses were set as a binary variable of "yes" or "no", where "no" included those answering "don't remember".

Mouth dryness was measured by two questions with four temporally graded response alternatives each ("yes, often", "yes, sometimes"; "no, seldom"; "no, never") asking for experience of mouth dryness in daytime or at night, respectively. The variable was used as a combined index, where, of the combined variables, 17% indicated a response that at least included one "yes" response on either.

Additionally, an index of smoking and/or use of smokeless tobacco was included in two categories—daily use of tobacco or not.

Oral hygiene habits were included as a combined index of frequent (twice daily) and less frequent (less than twice daily) use of a toothbrush, combined with regular use of interdental cleaning aids or not. Those who brushed their teeth twice a day or more and who also used interdental cleaning aids were set as a category of good dental hygiene habits, contrasted with all others.

Regarding "dental attitudes and behavior", there were four groups of attitudes included in the models: (i) Dental appearance and (ii) dental function, where the measures by Söderfeldt et al. (14) were used. Dichotomies were used for both these indicators, with the highest category indicating high importance of appearance and function set as 1, the remainder as 0. (iii) Satisfaction with dentist as indicated by desire to change dentist during the previous 5 years, and by a general question about satisfaction with received care. The two variables were combined and dichotomized with high satisfaction and no desire to change dentist as one category versus all other options. (iv) Possible fear of dental care, measured by a combined index from four VAS (Visual Analog Scale) questions about pain, inconvenience, calmness and care at latest dental visit, added and dichotomized so that the 20% most frightened, worried and inconvenient were set as 1 and the remaining respondents as 0.

Table 1. Multiple regression model of share of damaged teeth (DFT/total number of teeth) in per cent units ($n = 919$)

Independent variables	Regression coefficients b	*P*
Social attributes		
Marital status: single	−0.5	0.7357
Gender: men	−3.0	0.0260
Residence		
Rural residence	0.3	0.8387
Town residence	−0.3	0.8330
City residence (ref cat)	–	–
Born outside Sweden	−13.9	0.0001
Occupational status		
White-collar workers in leading positions	0.7	0.7628
White-collar workers	1.1	0.4532
Entrepreneurs	−1.3	0.6338
Blue-collar workers (ref cat)	–	–
Working hours		
Not working	2.4	0.3342
Part time	−0.1	0.9530
Full time (ref cat)	–	–
Shift-work	4.8	0.0142
Education		
College	−6.2	0.0017
High school/grammar school	−5.1	0.0267
Secondary education	−3.4	0.0191
Primary education (ref cat)	–	–
Health variables		
General self-perceived health: good	2.4	0.4853
Mouth dryness	2.1	0.1902
Use of pharmaceuticals	0.1	0.9555
Tobacco user	0.1	0.9394
Dental attitudes and behaviors		
Appearance important	1.2	0.2813
Function important	0.4	0.7675
Satisfied with dental care	−3.4	0.0035
Fear of dental treatment	3.1	0.0434
Utilization of dental care	3.2	0.0229
Good dental hygiene	0.5	0.6875

F:3.72,, 24 df, $P \leq 0.0001$.
Adj. $R^2 = 0.07$.

Utilization of dental care was indicated with a question concerning frequency of visits combined with a question on expenses last year. The questions were combined into an index in which those with high utilization were contrasted with others (more than 1 visit a year and expenses over SEK 300 last year versus all others).

Statistical methods

The data were analyzed by multiple regression analysis for DFT/number of teeth and DT/number of teeth as dependent variables. Model fit was assessed by F-test, by R^2, indicating explained variance, and by outlier analysis using Cook distances. A jack-knife procedure was used to check the linearity. Residual plots were examined for determination of heteroscedasticity, unequal distribution of residuals along the regression line. For those models where the response variable was binary, logistic models were used (15). Model fit was assessed by classification plots, outlier analysis, improvement of the 2LL statistic, and by residual plots. For categorical independent variables, dummy variables were calculated in all models (16). All data analyses were done in SPSS (Statistical Package for the Social Sciences).

Results

The first model to be run was a multiple regression model of the ratio of damaged teeth, DFT/number of teeth. The model is given in Table 1. It was assessed concerning linearity by dividing the dependent variable into three equal intervals and re-running the model in each interval. Results were stable, indicating no non-linearity in the model. Results were also stable removing influential outliers according to Cook distances. The model as a whole was significant, as indicated by the F-value. The share of explained variance was low as indicated by the R-square.

There was a number of independent variables showing influence on the dependent variable. Of the social factors, being born outside Sweden gave almost 14% fewer lesions and/or fillings. Men had a 3% lower ratio of DFT than women. There were no differences in occupational status, but strong differences in education, where college-educated had a 6% lower share of damaged teeth in relation to those only having primary education, with the difference getting smaller with less education. The only work-related variable that had effects was shift-work, with an almost 5% higher ratio of damaged teeth. None of the health variables had any relation to the dependent variable, while satisfaction, fear, and utilization had effects in expected directions of about the same size, i.e., 3%.

The second model concerns only DT. The model did not include those with no caries lesions, since the large numbers of those with no active caries biased the model. Thus, the associations found refer only to changes in the relative number of lesions on the premise that there was at least 1 such lesion. Linearity and outliers were both studied analogically to the previous model and with similar results. The model is stated in Table 2.

The results of the second model were in some respects different from those of the first one. Primarily, the association with being born outside Sweden changed direction, where those born outside Sweden in the second model had almost 5% more lesions than the rest. The strong association between this variable and the DFT variable in the first model can thus be ascribed to the presence of fillings among Swedes compared to those born outside Sweden. Similarly, the gender association was reversed in this model, where men had 3% more lesions than women. The occupational status variable made a difference in this model, with especially entrepreneurs having almost 6% fewer lesions than workers. The

Table 2. Multiple regression model of share of teeth with decayed teeth (DT/total number of teeth) in per cent units ($n = 513$, cases with 0 decayed teeth removed)

Independent variables	Regression coefficients	
	b	*P*
Social attributes		
Marital status: single	2.2	0.0961
Gender: men	3.0	0.0110
Residence		
Rural residence	0.9	0.5432
Town residence	−0.6	0.5958
City residence (ref cat)	–	–
Born outside Sweden	4.8	0.0201
Occupational status		
White-collar workers in leading positions	−1.3	0.5106
White-collar workers	0.3	0.8044
Entrepreneurs	−5.7	0.0200
Blue-collar workers (ref cat).	–	–
Working hours		
Not working	−3.2	0.1590
Part time	2.3	0.1179
Full time (ref cat)	–	–
Shift work	1.7	0.3180
Education		
College	−4.4	0.0118
High school/grammar school	−5.0	0.0165
Secondary education	−2.7	0.0369
Primary education (ref cat)	–	–
Health variables		
General self-perceived health: good	−5.9	0.0547
Mouth dryness	−0.9	0.5397
Use of pharmaceuticals	0.5	0.6355
Tobacco user	3.6	0.0013
Dental attitudes and behaviors		
Appearance important	−1.3	0.1966
Function important	0.9	0.4432
Satisfied with dental care	−2.2	0.0337
Fear of dental treatment	3.7	0.0062
Utilization of dental care	0.5	0.6958
Good dental hygiene	−2.9	0.0061

F:3.72, 24 df, $P \leq 0.0001$.
Adj. $R^2 = 0.11$.

Table 3. A logistic regression model for those stating toothache experience versus all others ($n = 4666$)

Independent variables	Regression coefficients		
	b	*P*	OR
Social attributes			
Marital status: single	0.09	0.4593	1.09
Gender: men	0.01	0.9174	1.01
Residence			
Rural residence (ref cat)	–	–	–
Town residence	−0.37	0.0031	0.69
City residence	−0.39	0.0025	0.67
Born outside Sweden	0.41	0.0229	1.51
Occupational status			
White-collar workers in leading positions	−0.29	0.1098	0.75
White-collar workers	−0.05	0.6555	0.95
Entrepreneurs	0.02	0.9404	0.98
Blue-collar workers (ref cat)	–	–	–
Working hours			
Not working	0.14	0.4899	1.15
Part time	−0.12	0.3655	0.88
Full time (ref cat)	–	–	–
Shift-work	0.15	0.3515	1.17
Education			
College	0.35	0.0245	1.42
High school/grammar school	0.28	0.1175	1.32
Secundary education	−0.11	0.3840	0.90
Primary education (ref cat)	–	–	–
Health variables			
General self-perceived health: good	−0.31	0.3628	0.73
Mouth dryness	0.45	0.0001	1.57
Use of pharmaceuticals	0.37	0.0010	1.45
Tobacco user	0.26	0.0081	1.30
Dental attitudes and behaviors			
Appearance important	0.04	0.7234	1.03
Function important	−0.04	0.7202	0.96
Satisfied with dental care	−0.60	0.0000	0.55
Fear of dental treatment	0.68	0.0000	1.97
Utilization of dental care	0.58	0.0000	1.79
Good dental hygiene	0.04	0.6695	1.04

-2LL improvement: 229.5, 24 df, $P \leq 0.0001$.
87.7% correctly predicted.

education gradient was weakened, but retained, and the association with shift-work disappeared.

Of the health variables, there appeared to be an association with the general health variable; those with good health having almost 6% fewer lesions. Tobacco use was discerned as a risk factor in this model. Of the attitudinal and behavioral variables, satisfaction and fear retained their associations. The covariation with utilization disappeared in this model. Those with subjectively good oral hygiene also had a lower share of caries lesions.

Those with no lesions were excluded from this model. Running a logistic regression model on the presence or absence of lesions resulted in a strong relation to utilization, with an odds ratio of 0.3 for those with high utilization ($P \leq 0.0001$).

Results from the entire questionnaire were the basis for testing the third model, with toothache experience last year or not as the dependent variable. Since the dependent variable was categorical, a logistic regression model was used. Most of the cases were correctly predicted, with a high share especially with regard to the prevalence of reports. The model was significant (Table 3).

In this model, the residence variable proved to be significant, with those living in rural areas and/or born outside Sweden having higher probability to report toothache. There was no association with occupational status or working time, and the education variable was only relevant for college education. Of the health variables, mouth dryness, use of pharmaceuticals and tobacco all increased the probability to report toothache. Of the attitudinal and behavioral variables, those satisfied with dental care showed lower probability to report toothache, while fear and high utilization were positively associated. There was no relation with oral hygiene.

Table 4. A logistic regression model for those stating sensitive teeth versus all others ($n = 4587$)

Independent variables	Regression coefficients		
	b	*P*	OR
Social attributes			
Marital status: single	0.03	0.7100	1.03
Gender: men	−0.36	0.0001	0.70
Residence			
Rural residence (ref cat)	–	–	–
Town residence	−0.05	0.5895	0.95
City residence	−0.06	0.5312	0.94
Born outside Sweden	−0.16	0.2860	0.85
Occupational status			
White-collar workers in leading positions	0.05	0.6893	1.05
White-collar workers	0.22	0.0097	1.24
Entrepreneurs	0.13	0.4207	1.14
Blue-collar workers (ref cat)	–	–	–
Working hours			
Not working	−0.20	0.2385	0.82
Part time g	−0.06	0.5012	0.94
Full time (ref cat)	–	–	–
Shift-work	0.04	0.7519	1.04
Education			
College	0.19	0.0869	1.21
High school/grammar school	0.32	0.0103	1.38
Secondary education	0.10	0.2146	1.11
Primary education (ref cat)	–	–	–
Health variables			
General self-perceived health: good	−0.66	0.0035	0.52
Mouth dryness	0.46	0.0001	1.58
Use of pharmaceuticals	0.18	0.0092	1.20
Tobacco user	−0.10	0.1561	0.90
Dental attitudes and behaviors			
Appearance important	−0.01	0.8591	0.99
Function important	−0.01	0.9304	0.99
Satisfied with dental care	−0.56	0.0001	0.57
Fear of dental treatment	0.48	0.0001	1.61
Utilization of dental care	0.16	0.0362	1.17
Good dental hygiene	−0.05	0.4492	0.95

-2LL improvement: 268.6, 24 df, $P \leq 0.0001$.
66.2% correctly predicted.

Independent variables	DFT	DT	Ache	Sens
Social attributes				
Marital status: single				
Gender: men	−	+		−−
Residence				
Rural residence (ref cat)				
Town residence			−−	
City residence			−−	
Born outside Sweden	−−−	++	++	
Occupational status				
White-collar workers in leading positions				
White-collar workers				+
Entrepreneurs		−		
Blue-collar workers (ref cat).				
Working time				
Not working				
Part time				
Full time (ref cat)				
Shift-work	++			
Education				
College	−−	−−	+	(+)
High school/grammar school	−−	−−	(+)	+
Secondary education	−	−		
Primary education (ref cat)				
Health variables				
General self-perceived health: good		−−		−−
Mouth dryness			++	++
Use of pharmaceuticals			++	+
Tobacco user		+	++	
Dental attitudes and behaviors				
Appearance important				
Function important				
Satisfied with dental care	−	−	−−	−−
Fear of dental treatment	+	+	+++	++
Utilization of dental care	+		+++	+
Good dental hygiene		−		
Model fit	R^2 = 0.07	R^2 = 0.11	Impr. 0.04%	Impr. 1.1%

Fig. 1. Associational patterns for different dependent variables.

The fourth model was also based on the questionnaire, with reports of sensitive teeth as dependent variable. This variable was bivariately strongly associated with the previous dependent variable, reports of toothache (OR = 3.1, 95% CI 2.6–3.6, $P \leq 0.0001$). Although the model had lower correct prediction of cases, it still had two-thirds correctly classified. This was significant (Table 4).

There was a gender association, with men less likely to report sensitive teeth. There was no relation to residence, and a weak relation to white-collar compared to blue-collar workers. Education, too, had a weak relation, in this case those with high school having a somewhat higher tendency to report sensitive teeth. Of the health variables, there were clear associations, primarily with the general health variable, where those stating good health only had half the probability to report sensitive teeth as compared to those not reporting good health. Those stating mouth dryness and use of pharmaceuticals had independent probabilities to report sensitive teeth. Use of tobacco had no relation. The same three attitudinal/behavioral variables that showed relations in the previous models also had associations here, especially fear and satisfaction. There was no relation with dental hygiene.

Discussion

The results in this study are many and complex. To facilitate the discussion, one can summarize the results focusing on the associational patterns that appear in the various models (Fig. 1). An indication of model fit is also included. In this Table, an association is marked with a plus or minus sign. Strong associations are indicated with

more than one sign. Some associations were only significant at the 10% level and are indicated with a parenthesis around the sign when the respective regression coefficient was deemed by us as substantial. Since the effects refer to multivariate regression analysis, all indications of associations refer to independent effects of the variable in question, with all the other variables kept constant.

Gender and being born outside Sweden were important in almost all the models. Only three variables—education, satisfaction, and fear—showed a relation to all the dependent variables, although the directions of the associations differed for education. The health- and job-related variables showed inconsistent patterns. Attitudes as well as marital status had no importance in any model. Occupational status showed weak and inconsistent patterns in all models.

It is important to bear in mind that the dependent variables capture very different aspects of the caries disease. The probably most valid and reliable indicator for active ongoing caries activity is DT. DFT includes cumulative caries history of the individual (17), thus being less relevant for active caries, but perhaps more relevant for the relations between social/behavioral factors and caries, insofar as they mirror the caries history (15). Compared with many other studies, we have chosen not to include DMFT as a caries indicator. The argument is primarily that both DFT and DT are relatively "pure" indicators of past or present caries, while DMFT includes all other reasons for losing teeth than caries, e.g. periodontitis, trauma, or orthodontic treatment. Another argument in this context is that in a previous study we have analyzed the missing component separately, finding fairly complex mechanisms for different aspects of tooth loss (18).

Being born outside Sweden appeared to be an important determinant. The covariation was very strong for DT, but equally strong in the opposite direction for DFT. A reasonable interpretation is that those born outside Sweden have more caries, but have received considerably less dental care than Swedes. It is interesting to note how clearly this appears despite the fact that the variable is not very "clean"—there are people from vastly different ethnic backgrounds included in this category, ranging from former child refugees from the Baltic states after World War II to adult Kurds or Assyrians arriving in Sweden during the 1980s.

The two questionnaire-based variables, toothache and sensitive teeth, rely on self-reports and not on observational data. In the methodological literature, there is a concept called "common method variance" (19). This means that the measurement method in itself can give rise to spurious associations. In those two models,we are indeed relating self-reports to other self-reports, which might distort the results. Lacking independent data, the exact extent of this possible fault cannot be assessed. However, one has to consider the size of the material and the nature of the questions. The questions are not particularly affective in their orientation but rather ask for factual circumstances. One could guess that common method variance is not too extensive. An argument in that context could be that the only two explicitly affective variables, the function and appearance attitudes, consistently show no associations. If there was a strong common method variance, associations should have appeared when shifting from "objective" to "subjective" dependent variables.

Continuing this discussion, it is obvious how, for example, college education has different covariations between the two observational variables on the one hand, and with the questionnaire variables on the other. If one believes the clinical study, college education gives less caries. If one believes the questionnaire, it gives more 'caries', at least more self-reported toothache. This could be due to common method variance. It could also be due to a "princess on the pea" effect—well-educated people may be more delicate and sensitive, feeling their 'caries' more. The lack of effect from occupational status and working time could indicate that this is the case. Incidentally, the lack of a social gradient in toothache might be unique to Sweden, confirming our previous observations of great social equality in dental conditions in Sweden (11).

In a previous ambitious attempt at modeling caries determinants, a clear finding was that social and behavioral variables had to be taken into account in order to understand the caries disease (6). A shortcoming in the present study is of course that no biological determinant was included. The conclusions in (6), however, point to the importance of such social and behavioral factors that were analyzed here. The low explained variances that were recorded in the present models point to a possible omission of important variables. The models were well balanced with no signs of heteroscedasticity. There is a dilemma in research here. Questionnaires are cheap and simple, allowing large materials but low precision. Clinical studies, especially those measuring biological risk factors, are expensive with high precision but small materials. The relative similarity in results concerning social and behavioral factors between this and other studies indicates, however, that questionnaire studies can be used for monitoring large populations.

In general, one could conclude that the associational patterns were as could be expected. Immigrants, working class, low educated, smokers, dissatisfied and low utilizers all appeared as risk groups for clinically determined caries lesions, but not necessarily for subjective symptom reports.

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References

1. Feinstein A. Clinical judgment. New York: Krieger; 1967.
2. Juul Jensen U. Practice and progress. A theory for the modern health care system. London: Blackwell; 1987.

3. Pitts N. Diagnostic tools and measurements—impact on appropriate care. Community Dent Oral Epidemiol 1997;25:24–35.
4. World Health Organization, Oral Health Surveys—basic methods. 3rd ed. Geneva: World Health Organization; 1984.
5. Fejerskov O, Thylstrup A. Different concepts of dental caries and their implications. In: Thylstrup A, Fejerskov O, editors. Textbook of clinical cariology. 2nd ed. Copenhagen: Munksgaard; 1994. p. 209–17.
6. Bjertness E, Eriksen HM. Design of a socio-ecologic caries model and testing on 50-year-old citizens of Oslo, Norway. Acta Odontol Scand 1992;50:151–62.
7. Jenny J, Frazier J, Bagramian A, Proshek J. Explaining variability in caries experience using an ecological model. J Dent Res 1974;53:554–64.
8. Drake CW, Beck JD. Models for coronal caries and root fragments in an elderly population. Caries Res 1992;26:402–7.
9. Blalock H. Causal inferences in non-experimental research. Chapel Hill, NC: University of North Carolina Press; 1964.
10. Beck JD. Risk revisited. Community Dent Oral Epidemiol 1998;26:220–5.
11. Unell L, Söderfeldt B, Halling A, Paulander J, Birkhed D. Oral disease, impairment, and illness: congruence between clinical and questionnaire findings. Acta Odontol Scand 1997;55:127–32.
12. Unell L, Söderfeldt B, Halling A, Solén G, Paulander J, Birkhed D. Equality in satisfaction, perceived need, and utilization of dental care in a 50-year-old Swedish population. Community Dent Oral Epidemiol 1996;24:191–5.
13. SCB 1982:4. Reports on Statistical Co-ordination, Swedish socioeconomic classification. Stockholm: Statistiska Centralbyrån; 1982.
14. Söderfeldt B, Palmqvist S, Arnbjerg D. Factors affecting attitudes toward dental appearance and dental function in a Swedish population aged 45–69 years. Community Dent Health 1993; 10:123–30.
15. Demaris A. Logit modeling. Practical applications. Newbury Park, CA: SAGE; University papers; 1992.
16. Lewis-Beck M. Applied regression—an introduction. Beverly Hills: SAGE University papers; 1980.
17. Manji F, Fejerskov O. An epidemiological approach to dental caries. In: Thylstrup A, Fejerskov O, editors. Textbook of clinical cariology. 2nd ed. Copenhagen: Munksgaard; 1994. p. 159–91.
18. Unell L, Söderfeldt B, Halling J, Birkhed D. Explanatory models for oral health expressed as number of remaining teeth in an adult population. Community Dent Health 1998;15:155–61.
19. Spector P. Method variance as an artifact in self-reported affect and perceptions at work: myth or significant problem? J Appl Psychol 1987;72:438–43.

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