Explanatory models for total edentulousness, presence of removable dentures, and complete dental arches in a Swedish population

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On the basis of data from a questionnaire study of 3000 inhabitants of Örebro County, Sweden, aged 45–69 years, the relative importance of various socioeconomic factors for dental conditions were analyzed in stepwise logistic regression models. Two different patterns were found: one in relation to the best dental condition (complete dental arches), another in relation to the poorest conditions (total edentulousness and presence of removable dentures). Next to age, education and income showed the highest predictive values in relation to the presence of removable dentures and total edentulousness. Place of residence and gender seemed to be of less importance than earlier. In relation to complete dental arches, there were lower values for most variables. One of only four significant variables was the attitude variable 'importance of good dental appearance'. The results may indicate the development of a new pattern of influences on dental conditions, mainly based on education and attitudes.
☐ *Dental health; multivariate analyses; questionnaires; socioeconomic factors*

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Several reports published since the 1960s have shown that dental conditions vary in accordance with socioeconomic status in Scandinavian populations, especially among the elderly (1–17). The importance and order of socioeconomic factors seem to differ between populations and to change over a period of time (9, 10, 12, 15, 17). It is evident from these studies that dental conditions are transient and rapidly changing.

In a previous paper (16) we showed that, although dental conditions had improved in general, socioeconomic inequalities were still closely related to variations in dental conditions. The purpose of the present paper was to analyze the relative importance of several demographic and socioeconomic factors for self-assessed dental conditions and to find multivariate models that parsimoniously could explain this relationship. Three dental conditions were used as dependent variables: total edentulousness, presence of removable dentures, and complete dental arches.

Materials and methods

The study was performed in 1989–1990 in Örebro County, Sweden. The county has about 275,000 inhabitants. From official population registers, 3000 persons aged 45–69 years were randomly selected. A questionnaire was mailed to this sample. The response rate was 79.4%. The design of the study and distribution of non-responders has been reported earlier (16). The validity of answers with regard to dental conditions has been analyzed separately (18).

On the basis of self-assessment of dental conditions, each subject was grouped into one of the following seven categories: 1) all teeth remaining (no missing tooth, no

denture of any type); 2) all missing teeth replaced by fixed prosthodontics (no missing tooth unreplaced, no removable denture); 3) one or two single teeth missing and not replaced (fixed partial denture(s) might be present as well but no removable denture); 4) several teeth missing and not replaced (fixed partial denture(s) might be present as well, but no removable denture); 5) wearing removable denture(s) (might have fixed partial denture(s) as well, not totally edentulous in any jaw); 6) totally edentulous in one jaw (but not in both jaws); and 7) totally edentulous in both jaws.

Information on the following demographic, social, and economic variables was included in the questionnaire and used in this study: age (45–49 years, 50–54 years, 55–59 years, 60–64 years, 65–69 years); gender (male, female); marital status (married, other status); place of residence (city; village or rural); education (short, up to and including 9 years of schooling; middle or long, more than 9 years); individual income (subjects grouped in quartiles: SEK 0–84,000; 85,000–120,000; 121,000–150,000; 151,000– per year before tax); and SES = socio-economic status (not working, blue-collar worker, white-collar worker, or employer). The grouping was performed in accordance with Statistics Sweden (19).

Information on several attitude variables was also included in the questionnaire. Two variables were extracted by principal components factor analysis: dental appearance (importance of good dental appearance: unimportant, less important, important, very important) and dental function (importance of good dental function: unimportant, less important, important, very important).

The distribution of subjects in dental categories is shown in Table 1. The unadjusted, self-assessed percentages are given, as are the corrected percentages. The correction was done in accordance with a clinical examination of 100 randomly selected subjects (18, 20). For the multivariate analyses in the present paper the unadjusted data were used, since it was impossible to correct on an individual level. The following dichotomies were used as dependent variables in the multivariate analyses: total edentulousness or not, presence of removable dentures or not, and having all teeth remaining (complete dental arches) or not.

Because the dental categories did not form an interval scale, logistic regression models were used to describe the multivariate relations between the demographic, social, economic, and attitude factors and dental conditions. The models were built in three steps to minimize the number of independent variables and to control for multicollinearity. The first step was crosstabulation and multiple regression of the independent variables; the second step was bivariate logistic regression; and the third step multivariate stepwise logistic regression, using forward selection with the likelihood ratio criterion (21). The independent variables in the final

Table 1. Percentage distribution of subjects by dental category and gender. Corrected figures (20) in parentheses

Dental categories	Men (n = 1119)	Women (n = 1228)	Total (n = 2347)
1. All teeth remaining	23 (18)	25 (19)	24 (18)
2. All missing teeth replaced by fixed prosthodontics	13 (11)	10 (10)	11 (11)
3. One or two single teeth missing and not replaced	27 (20)	27 (20)	27 (20)
4. Several teeth missing and not replaced	14 (27)	15 (28)	15 (28)
5. Wearing removable partial denture(s)	8 (8)	6 (6)	7 (7)
6. Totally edentulous in one jaw	8 (8)	7 (7)	7 (7)
7. Totally edentulous in both jaws	7 (7)	10 (10)	9 (9)

models were selected in accordance with the results of the two first steps. The independent variables are presented in the tables in the order in which they were included in the stepwise regressions.

In the regression of the independent variables the strongest association with the other variables was found for socioeconomic status ($R^2 = 0.37$). This variable was therefore excluded from the models because of the risk for multicollinearity.

The calculations were made in SPSS (21).

Results

The first model had total edentulousness as the dependent variable (Table 2). Age was the first independent variable to enter the equation, followed by education, income, residence, and marital status. Gender was not significantly associated with total edentulousness in the multivariate model, although it was bivariately. The attitude variables showed no significant association with total edentulousness.

Table 2. A stepwise logistic regression model with total edentulousness or not as the dependent variable. The order of the independent variables is the same as the order in which they were included in the equation. Relative risks for total edentulousness expressed as odds ratios with 95% confidence intervals. The bivariate odds ratios for all studied independent variables are also given

Independent variables	Bivariate odds ratios	Multivariate odds ratios	95% confidence intervals for multivariate odds ratios
Age			
45–49 years (ref. cat.)	—	—	
50–54 years	0.52	0.66	0.41–1.05
55–59 years	1.03	0.93	0.62–1.41
60–64 years	1.89	1.66	1.20–2.31
65–69 years	3.50	2.52	1.86–3.42
Education			
Middle or long (ref. cat.)	—	—	
Short	9.09	5.41	2.13–13.74
Income			
⩾ SEK151,000 (ref. cat.)	—	—	
SEK121,000–150,000	0.75	0.84	0.57–1.25
SEK85,000–120,000	1.60	1.22	0.88–1.68
⩽ SEK84,000	2.92	1.85	1.36–2.51
Residence			
City (ref. cat.)	—	—	
Village or rural	1.83	1.71	1.21–2.42
Marital status			
Married (ref. cat.)	—	—	
Other status	1.75	1.71	1.16–2.52
Gender		Not included	
Male (ref. cat.)	—		
Female	1.43		
Dental appearance		Not included	
Important or very important (ref. cat.)	—		
Less important or unimportant	1.09		
Dental function		Not included	
Important or very important (ref. cat.)	—		
Less important or unimportant	0.91		

The model predicts correctly 92.55% of those totally edentulous in both jaws ($n = 2052$). −2 log likelihood chi-square = 937.35, df = 2041.

The second model had presence of removable dentures as the dependent variable (Table 3). Age was the first independent variable to enter the equation. Education was the second and income the third variable to enter the model. Other significant independent variables were (in order) marital status, gender, importance of dental appearance, and residence. In this model male sex was significantly associated with a higher risk of wearing a removable denture, although gender was not significant in the bivariate analysis.

The third model had complete dental arches as the dependent variable (Table 4). Only four independent variables were significantly associated with complete dental arches. Age was the first variable to enter the equation, followed by education, residence, and importance of dental appearance. Income, marital status, gender, and importance of dental function showed no significant association with the dependent variable.

Discussion

The seven-category measurement scale for classifying dental conditions used in the present study is not an interval scale. There-

Table 3. A stepwise logistic regression model with presence of removable dentures or not as the dependent variable. The order of the independent variables is the same as the order in which they were included in the equation. Relative risks for wearing a removable denture expressed as odds ratios with 95% confidence intervals. The bivariate odds ratios for all studied independent variables are also given

Independent variables	Bivariate odds ratios	Multivariate odds ratios	95% confidence intervals for multivariate odds ratios
Age			
45–49 years (ref. cat.)	—	—	
50–54 years	0.67	0.78	0.61–1.01
55–59 years	0.85	0.78	0.60–1.00
60–64 years	1.62	1.62	1.31–2.00
65–69 years	2.89	2.09	1.68–2.59
Education			
Middle or long (ref. cat.)	—	—	
Short	6.02	3.80	2.48–5.82
Income			
≥ SEK151,000 (ref. cat.)	—	—	
SEK121,000–150,000	0.84	0.84	0.67–1.05
SEK85,000–120,000	1.58	1.28	1.06–1.56
≤ SEK 84,000	2.30	1.94	1.54–2.44
Marital status			
Married (ref. cat.)	—	—	
Other status	1.71	2.03	1.54–2.67
Gender			
Female (ref. cat.)	—	—	
Male	1.02	1.80	1.37–2.36
Dental appearance			
Important or very important (ref. cat.)	—	—	
Less important or unimportant	1.10	1.16	1.05–1.29
Residence			
City (ref. cat.)	—	—	
Village or rural	1.57	1.37	1.08–1.74
Dental function		Not included	
Important or very important (ref. cat.)	—		
Less important or unimportant	0.98		

The model predicts correctly 80.12% of those wearing removable dentures (n = 2052). − 2 log likelihood chi-square = 1807.28, df = 2039.

fore, conventional multiple regression analyses were inappropriate for studying multivariate correlations. Instead, logistic stepwise regression analyses were used, with dental conditions dichotomized in different ways.

In all three models, age was the first variable to enter the equations. But there was no consistent gradient among the five age groups. The two oldest groups differed significantly from the three younger groups. Even though the study is strictly cross-sectional, one might suspect from these data that the pattern of dental conditions is changing. This would imply that in another 10 years the subjects in the age group 50–59 years will have better dental conditions than those aged 60–69 years had in the present study. One possible explanation for this development could be that most of the subjects in the two oldest groups did not benefit from organized dentistry during childhood, whereas the opposite was true for most of the subjects in the younger groups. However, from the present study no conclusion can be drawn as to whether this has been a causal factor.

Besides age, the independent variables

Table 4. A stepwise logistic regression model with complete dental arches or not as the dependent variable. The order of the independent variables is the same as the order in which they were included in the equation. Relative risks for *not* having all teeth remaining expressed as odds ratios with 95% confidence intervals. The bivariate odds ratios for all studied independent variables are also given

Independent variables	Bivariate odds ratios	Multivariate odds ratios	95% confidence intervals for multivariate odds ratios
Age			
45–49 years (ref. cat.)	—	—	
50–54 years	0.73	0.78	0.63–0.96
55–59 years	0.87	0.91	0.72–1.14
60–64 years	1.35	1.23	0.97–1.55
65–69 years	3.43	3.10	2.26–4.25
Education			
Middle or long (ref. cat.)	—	—	
Short	3.36	2.58	2.06–3.24
Residence			
City (ref. cat.)	—	—	
Village or rural	1.55	1.39	1.12–1.74
Dental appearance			
Important or very important (ref. cat.)	—	—	
Less important or unimportant	1.10	1.11	1.01–1.23
Gender		Not included	
Male (ref. cat.)	—		
Female	1.10		
Marital status		Not included	
Marital (ref. cat.)	—		
Other status	1.22		
Income		Not included	
≥ SEK151,000 (ref. cat.)	—		
SEK121,000–150,000	0.92		
SEK85,000–120,000	1.21		
≤ SEK84,000	1.68		
Dental function		Not included	
Important or very important (ref. cat.)	—		
Less important or unimportant	0.98		

The model predicts correctly 76.17% of those with all teeth remaining (n = 2052). −2 log likelihood chi-square = 2041.54, df = 2044.

were differently related to the studied dependent variables.

Earlier there were great, although decreasing, differences between the genders concerning the prevalence of total edentulousness (1, 2, 4, 5, 10, 12, 13). In the bivariate logistic regression women showed 43% higher risk than men for total edentulousness. In the multivariate analysis, however, gender showed no significant association with total edentulousness. The influence of the variables education, income, and marital status seems to be responsible for this result. In women, the percentage of subjects having other marital status than 'married' is much higher than in men. Further, low education and income levels are associated with the female sex.

In the model with presence of removable dentures as the dependent variable, the pattern was similar to that for total edentulousness. However, the attitude towards dental appearance showed a significant association with the wearing of removable dentures: considering dental appearance of limited importance was associated with a somewhat higher risk for having a removable denture. The male sex was also associated with a higher risk for wearing such an appliance, which is noteworthy in view of the discussion of gender influences on total edentulousness.

In our study there were high odds ratios for the education variable in relation to total edentulousness and to the presence of removable dentures but low values for the residence variable. This is not in agreement with the results of studies based on nationwide Swedish and Norwegian data (15, 17). A simple explanation could be that Örebro county differs from Sweden as a whole. More likely, the results did not correspond owing to the use of different variables for measuring 'urbanization'. In our study city residence was compared with living in villages or in rural areas, whereas the variables used by Statistics Sweden (10, 12, 17) and in the Norwegian study (15) measured regional differences and not city versus non-city residence. However, the importance of residence for dental conditions might really have decreased.

The pattern associated with complete dental arches (all teeth remaining) differed from the pattern noted for total edentulousness and presence of removable dentures. For complete dental arches the variables income, gender, and marital status were not significantly associated with the dependent variable. But a high odds ratio was noted for the education variable.

Only four of the studied independent varibles were significantly associated with complete dental arches (all teeth remaining), and for two of these variables (residence and dental appearance) there were low relative risks. Consequently, the model for complete dental arches had a lower predictive value than the other models. This indicates that socioeconomic factors are of less importance in relation to complete dental arches than in relation to total edentulousness and to the presence of removable dentures. However, it is important to remember that total edentulousness and the wearing of removable dentures often reflect socioeconomic conditions many years ago.

From the present data no conclusions can be drawn about the influence of the dental insurance system that was introduced in Sweden in 1974. It is well known that this system has resulted in more fixed prostheses and fewer removable dentures. But the system may also have created new patterns of demand for different kinds of dental treatment, based more than earlier on attitudes and level of education.

Our results may indicate a changing social pattern, in which socioeconomic variables, particularly education, will become more important than demographic variables such as gender and residence. If this is the case, we might expect a development of variations in dental conditions corresponding to the increased inequalities in general health noted in Swedish society during the past decade (22, 23). Such a development can occur independently of an improvement of the dental health as well as the general health.

From the present study we can conclude that two different patterns of socioeconomic influences were noted, one in relation to the best dental condition (all teeth remaining) and one in relation to the poorest conditions

(wearing of removable dentures and total edentulousness). Further, our results may indicate a changing pattern in relation to the poorest conditions: education–income seem to be more important than gender–residence.

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