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Clinical factors and self-perceived oral health

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Self-perceived oral health is affected not only by awareness of the clinical status but also by comparisons with people of a similar age. This study explored the relative contributions of clinical variables assessing caries, periodontal status, and prosthetic status to self-perceived oral health within two age groups. Data of 891 adults (35–44 yr of age) and 760 older people (65–74 yr of age) from the Fourth German Oral Health Study (DMS IV, 2005) were evaluated. Self-perceived oral health was obtained from questionnaires. Numbers of decayed, filled, and unreplaced teeth, mean attachment loss, bleeding on probing (BOP), the presence of a fixed denture, and the presence of a removable denture were assessed. Multinomial logistic regression models were developed for both age groups, separately, using stepwise methods. For adults, unreplaced teeth, filled teeth, decayed teeth, the presence of a removable denture, and mean attachment loss were added to the final model. For older people, the presence of a removable denture, unreplaced teeth, decayed teeth, mean attachment loss, filled teeth, and BOP were included in the final model. Awareness of the relative contributions of clinical variables to self-perceived oral health is important for obtaining a clearer understanding of patients' subjective and objective self-perceptions of oral health.

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Recently, single-item questions of oral health have been increasingly included in dental surveys (1). As self-perceived oral health reflects patients' subjective and objective assessments of their oral health, it is highly associated with the patient's perception of treatment needs and thus with the demand for dental services. Those who regularly visit a dentist for routine dental check-ups are more likely to assess their oral health as good (2). Conversely, people who report poor oral health have a less marked dental care-seeking behavior (3).

In recent years, numerous studies have assessed self-perceived oral health by single-item questions, and a number of clinical factors were found to be associated with self-perceived oral health (1, 4–8). With respect to caries status, some studies reported that the numbers of missing and decayed teeth were proportional to the probability of rating oral health as poor (1, 8, 9). Conversely, larger numbers of filled teeth were associated with a higher probability of perceiving oral health as good (1, 9). Across the single-item responses, caries, tooth loss, and periodontitis experience showed mainly consistent gradients (8).

The understanding of periodontitis as a silent disease was questioned recently (10) when significant associations between periodontal disease severity and self-perceived oral health were found. Results consistent with this finding were also reported in other studies (1, 4). Although the sensitivity of single self-reported items in diagnosing periodontal disorders is low (11), combinations of demographic measures and self-report oral health questions perform well in predicting periodontitis (12).

Self-perceptions of general health depend on social and cultural backgrounds and are affected by prevailing social and medical ideologies (13). Thus, self-perception of health varies among social groups (13) and is partly based on comparisons with others, especially with people of a similar age (14). Different social backgrounds of age groups inherently influence people's understanding of 'normality' (15).

Only a few studies have identified the most predictive clinical factors for self-perceived oral health using an age-specific approach. Therefore, the aim of this study was to explore the relative contributions of clinical variables assessing caries, periodontal status, and prosthetic status to self-perceived oral health among participants 35–44 and 65–74 yr of age from representative samples of the German resident population.

Material and methods

Study design

The national cross-sectional Fourth German Oral Health Study ('Vierte Deutsche Mundgesundheitsstudie', DMS IV) was conducted by the Institute of German Dentists (IDZ) in 2005. Random cluster samples stratified by Federal State and by community category were drawn from 90 municipalities. Random samples were selected

from the population registry of each of these municipalities. People from East Germany were oversampled. Informed consent was obtained from all participants. The participation rates for adults (35–44 yr of age) and for older people (65–74 yr of age) were 52.1% and 55.7%, respectively. The low response rates might be explained by the fact that examiners were present at each sample point for only 2 days. Therefore, it was difficult to arrange convenient appointments for study participants. Design, sampling, and non-response analyses have previously been described in detail (16–19).

Dependent variable

Self-perceived oral health was assessed by the following question: 'Thinking of your teeth, how would you rate their condition?' (with the response options: 'very good', 'good', 'satisfactory', 'not so good', or 'poor'). After evaluation of frequency distributions, the first two answers were combined into 'very good/good' and the last two answers were combined into 'not so good/poor'. Therefore, the dependent variable had three categories: very good/good, satisfactory, and not so good/poor (referred to subsequently as good, satisfactory, and poor).

Covariates

Sociodemographic and behavioral variables, including age, gender (female/male), region (West Germany/East Germany), school education (<10/10/>10 yr), smoking status (never/former/current), cohabiting (no/yes), and dental visit within the last 12 months (yes/no), were obtained from questionnaires. In addition, self-perceived general health was assessed by the question: 'How would you rate your general health status?' with the possible answers (in this order): 'very good', 'good', 'satisfactory', 'not so good', or 'poor'. The multimorbidity score was defined as the sum of all positive answers to questions assessing self-reported general systemic diseases, namely hypertension, circulatory disorders of the heart, myocardial infarction, cardiac insufficiency, stroke, varicose veins, bronchial asthma, gastritis, gastric or duodenal ulcer, diabetes mellitus with or without insulin treatment, cancer, arthrosis, inflammatory joint or spine disease, osteoporosis, mental illness, or the presence of other diseases not mentioned in the questionnaire. The multimorbidity score was considered as a continuous variable and ranged from 0 to 17. A participant was given a multimorbidity score of 0 if none of the above questions was answered with 'yes'. Conversely, the highest score, of 17, was achieved if all the questions were answered with 'yes'. All interviews were conducted as verbal and personal face-to-face interviews by specially trained interviewers.

Oral status

Decayed and filled teeth were assessed visually in a full-mouth examination (20). The number of missing teeth that had not been replaced with either a fixed/removable denture or by an implant were determined. These teeth are subsequently referred to as unreplaced teeth. Teeth were extracted because of caries and other reasons. Third molars were excluded from the analysis. Because the distribution of the number of decayed teeth was skewed, participants were classified into those with no decayed teeth versus those with at least one decayed tooth. Filled and unreplaced teeth were considered as continuous variables.

Periodontal status was assessed by measuring attachment loss and calculation of the papillary bleeding index (PBI) (21). Periodontal measurements were performed at 12 index teeth (17, 16, 11, 24, 26, 27, 47, 46, 44, 31, 36, and 37; two-digit notation according to the FDI World Dental federation), using a periodontal probe (PCP 11.5 WHO probe; M1W Dental, Büdingen, Germany). Attachment loss was measured at three sites per tooth (mesiobuccal, midbuccal, and distolingual). The PBI was assessed at two sites per tooth (buccal and lingual). To avoid collinearity problems, probing pocket depth was not considered.

Mean attachment loss was calculated and tertiles were determined because linearity assumptions in regression models were not met. Tertiles were specific for both age groups (adults: 1st tertile, −0.91 to 2.28; 2nd tertile, 2.29–2.97; and 3rd tertile, 2.99–8.81; and older people: 1st tertile, 1.08–3.50; 2nd tertile, 3.53–4.67; and 3rd tertile, 4.70–11.67). The PBI was dichotomized as present or absent bleeding at site level, and the percentage of sites with bleeding on probing (BOP) was determined. Bleeding on probing was considered as a continuous variable.

To evaluate the prosthetic status, participants were classified into those with no fixed denture versus those with at least one fixed denture and into those with no removable denture versus those with at least one removable denture.

Study participants

Of 925 adults originally included in the study, there was no information on self-perceived oral health for four, who were therefore excluded. Additionally, we excluded eight edentulous participants and three participants without periodontal measurements. Nineteen other participants had missing covariate data, leaving 891 adult participants for analyses. Of 1,040 older people originally included in the study, there was no information on self-perceived oral health for 29, who were therefore excluded. Moreover, we excluded 215 edentulous participants and four participants without periodontal measurements. Thirty-two other participants had missing covariate data, leaving 760 older participants for analyses.

Statistical analyses

Chi-square tests and Kruskal–Wallis tests were applied to analyze differences in various variables among participants with good, satisfactory, and poor self-perceived oral health. Multinomial logistic regression was applied to assess associations of self-perceived oral health with clinical oral health variables. Multinomial logistic regression is an extension of the binary logistic regression for outcome variables with more than two categories. A separate binary logit is estimated for each pair of outcome categories (22). Good self-perceived oral health was chosen as the reference category.

Separate regression models were developed for each age group. Stepwise forward and backward regression analyses were performed considering all clinical oral health variables. To test for all categories of one categorical variable simultaneously, overall Wald tests were used. P for inclusion was 0.15 and P for exclusion was 0.20 (23). The analyses were weighted. For each step, areas under receiver-operating characteristic (ROC) curves (AUC) were determined. Because the dependent variable had three categories, the following AUCs (with 95% CI) were calculated: AUC separating good from satisfactory/poor,

AUC separating satisfactory from good/poor, and AUC separating good/satisfactory from poor. To internally validate final models, bootstrap analyses with 200 replications were performed and optimism-corrected estimates of AUC values were calculated.

The results were considered statistically significant at $P \leq 0.05$. Statistical analyses were performed with STATA/SE 11.0 (24).

Results

The proportions of participants reporting poor oral health were 18.5% in adults and 16.1% in older people (Table 1). Sociodemographic and behavioral variables were not significantly associated with self-perceived oral health, except for dental visit within the last 12 months in older people ($P < 0.001$). In contrast, the distribution of self-perceived oral health differed significantly across categories of all clinical oral health variables in both age groups (Table 2).

Stepwise regression models

In adults, all clinical oral health variables, except for the presence of a fixed denture and BOP, were included in the final model after stepwise regression analysis (Table 3). The variables entered the model in the following order: unreplaced teeth, filled teeth, decayed teeth, the presence of a removable denture, and mean attachment loss. The AUC values quantifying the separation between good and satisfactory/poor for stepwise multinomial regression models increased from 0.61 (the first step of stepwise regression analysis) to 0.71 (the final model; Table 3). The AUC values quantifying the separation between satisfactory and good/poor increased from 0.55 to 0.60, and the AUC values quantifying the separation between good/satisfactory and poor increased from 0.60 to 0.70. After bootstrap analyses, values for optimism were 0.01, 0.02, and 0.02, respectively. Thus, optimism-corrected estimates of AUC values for the final model were 0.70, 0.58, and 0.68, respectively.

In older people, all clinical oral health variables were included in the final model, except for the presence of a fixed denture (Table 4). The variables entered the model in the following order: the presence of a removable denture, unreplaced teeth, decayed teeth, mean attachment loss, filled teeth, and BOP. The AUC values increased from 0.58 to 0.68 for the separation between good and satisfactory/poor and from 0.51 to 0.61 for the separation between satisfactory and good/poor (Table 4). The AUC values for the separation between good/satisfactory and poor increased from 0.62 to 0.72. After bootstrap analyses, values for optimism were 0.02, 0.03, and 0.02, respectively. Thus, optimism-corrected estimates of AUC values for the final model were 0.66, 0.58, and 0.70, respectively.

Sensitivity analyses in older people

After addition of the multimorbidity score to the final model (Table 5), similar coefficients for clinical oral

Table 1

Distribution of socio-economic and behavioral variables according to self-perceived oral health and age group

	Self-perceived oral health of adults (35–44 yr of age)					Self-perceived oral health of older people (65–74 yr of age)				
Variable	*n*	Good	Satisfactory	Poor	*P*	*n*	Good	Satisfactory	Poor	*P*
n	891	40.9	40.6	18.5		760	38.4	45.5	16.1	
Age	891	39.5 ± 2.7	39.8 ± 3.0	39.4 ± 2.7	0.29	760	68.8 ± 2.6	68.6 ± 2.7	68.8 ± 2.8	0.50
Gender										
Female	503	42.4	37.8	19.8		392	35.7	44.9	19.4	
Male	388	38.6	43.0	18.4	0.34	368	40.5	45.1	14.4	0.17
Region										
West Germany	591	39.7	40.0	20.3		508	37.4	44.5	18.1	
East Germany	300	44.3	42.2	13.5	0.055	252	40.2	47.1	12.7	0.18
School education										
<10 yr	208	37.9	39.9	22.2		494	35.8	48.1	16.1	
10 yr	391	38.7	42.5	18.8		110	38.1	42.1	19.8	
>10 yr	292	44.3	38.6	17.1	0.47	156	45.1	37.2	17.7	0.20
Smoking status										
Never	400	44.3	39.5	16.2		474	39.4	45.1	15.5	
Former	178	38.9	44.0	17.1		237	35.4	45.9	18.7	
Current	313	36.7	39.4	23.9	0.10	49	36.6	40.8	22.6	0.65
Cohabiting										
Non-cohabiting	171	37.5	43.8	18.7		158	38.3	41.1	20.6	
Cohabiting	720	41.2	39.6	19.2	0.64	602	37.9	46.1	16.0	0.37
Dental visit within last 12 months										
Yes	809	41.6	40.4	18.0		690	39.2	45.9	14.9	
No	82	30.7	40.5	28.8	0.06	70	26.6	37.6	35.8	<0.001

Data are presented as mean ± SD or as row percentages. Analyses were weighted.
n, number.

Table 2

Distribution of clinical oral health variables according to self-perceived oral health and age group

	Self-perceived oral health of adults (35–44 yr of age)					Self-perceived oral health of older people (65–74 yr of age)				
Variable	*n*	Good	Satisfactory	Poor	*P*	*n*	Good	Satisfactory	Poor	*P*
n	891	40.9	40.6	18.5		760	38.4	45.5	16.1	
Decayed teeth										
0	675	44.8	40.2	15.0		588	41.3	43.4	15.3	
>0	216	27.1	41.1	31.8	<0.001	172	26.6	50.7	22.7	0.002
Filled teeth	891	10.9 ± 4.9	12.4 ± 4.6	12.3 ± 4.9	<0.001	760	10.7 ± 5.3	10.6 ± 5.0	8.1 ± 4.9	<0.001
Unreplaced teeth	891	1.0 ± 1.5	1.6 ± 1.9	2.0 ± 2.3	<0.001	760	1.4 ± 1.8	1.9 ± 2.3	2.6 ± 3.9	0.002
Mean AL (mm)										
1st tertile	301	43.2	39.7	17.1		262	42.2	47.5	10.3	
2nd tertile	293	48.6	35.2	16.2		248	43.0	42.2	14.8	
3rd tertile	297	30.1	46.0	23.9	<0.001	250	27.7	45.3	27.0	<0.001
BOP (%)	891	53.3 ± 26.1	57.1 ± 25.9	64.5 ± 25.6	<0.001	760	65.4 ± 27.6	71.9 ± 26.5	77.2 ± 25.2	<0.001
Fixed denture										
No	611	43.6	39.5	16.9		357	35.6	41.8	22.6	
Yes	280	33.9	42.5	23.6	0.02	403	40.0	47.7	12.3	0.002
Removable denture										
No	852	41.5	40.5	18.0		383	45.2	44.5	10.3	
Yes	39	16.8	37.7	45.5	<0.001	377	30.3	45.6	24.1	<0.001

Data are presented as mean ± SD or as row percentages. Analyses were weighted.
AL, attachment loss; BOP, bleeding on probing; *n*, number.

Table 3

Outcome of stepwise multinomial regression analysis for adults (35–44 yr of age)

	Final multinomial model				Discriminatory power for stepwise built models		
	Satisfactory versus Good		Poor versus Good		AUC (95% CI) for the three classes		
Variable	RRR (95% CI)	*P*	RRR (95% CI)	*P*	Good	Satisfactory	Poor
Unreplaced teeth (cont.)	1.27 (1.14–1.40)	<0.001	1.42 (1.25–1.61)	<0.001	0.61 (0.58–0.65)	0.55 (0.51–0.59)	0.60 (0.55–0.65)
Filled teeth (cont.)	1.10 (1.06–1.14)	<0.001	1.12 (1.06–1.18)	<0.001	0.66 (0.62–0.70)	0.58 (0.54–0.62)	0.62 (0.57–0.67)
Decayed teeth							
0 (ref.)	1.00		1.00				
>0	1.68 (1.08–2.60)	0.02	3.45 (2.11–5.65)	<0.001	0.68 (0.64–0.72)	0.59 (0.55–0.63)	0.67 (0.62–0.72)
Removable denture							
No (ref.)	1.00		1.00				
Yes	2.71 (0.99–7.45)	0.053	8.46 (3.09–23.19)	<0.001	0.70 (0.66–0.73)	0.59 (0.55–0.64)	0.70 (0.65–0.74)
Mean AL (mm)							
1st tertile (ref.)	1.00		1.00				
2nd tertile	0.68 (0.46–1.00)	0.052	0.64 (0.37–1.10)	0.11			
3rd tertile	1.40 (0.92–2.13)	0.12	1.35 (0.80–2.28)	0.26	0.71 (0.67–0.75)	0.60 (0.56–0.65)	0.70 (0.65–0.75)

Analyses were weighted. The reference category for the dependent variable was 'Good'.
AL, attachment loss; AUC, area under the receiver–operating characteristics (ROC) curve for stepwise inclusion of predictive variables; cont., continuous; ref., reference; RRR, relative risk ratio.

health variables were observed. The multimorbidity score was significantly associated with self-perceived oral health ($P < 0.001$) when poor self-perceived oral health was compared with good self-perceived oral health. The corresponding AUC values increased by 0.01 for the separation between satisfactory and good/poor and by 0.02 for the separation between good/satisfactory and poor.

After addition of self-perceived general health to the final model (Table 6), similar coefficients for clinical oral health variables were observed. Self-perceived general health was significantly associated with self-perceived oral health in all categories ($P < 0.05$). For each separation, the respective AUC values increased by 0.06.

Discussion

This study explored the relative contributions of clinical characteristics (such as caries, periodontal status, and prosthetic status) to self-perceived oral health among adult (35–44 yr of age) and older (65–74 yr of age) participants in the DMS IV study. In multivariate modeling, the number of unreplaced teeth showed the strongest association with self-perceived oral health in adults,

Table 4

Outcome of stepwise multinomial regression analysis for older people (65–74 yr of age)

	Final multinomial model				Discriminatory power for stepwise built models		
	Satisfactory versus Good		Poor versus Good		AUCs (95% CI) for the three classes		
Variable	RRR (95% CI)	*P*	RRR (95% CI)	*P*	Good	Satisfactory	Poor
Removable denture							
No (ref.)	1.00		1.00				
Yes	2.18 (1.43–3.33)	<0.001	5.37 (3.07–9.38)	<0.001	0.58 (0.54–0.62)	0.51 (0.47–0.54)	0.62 (0.58–0.67)
Unreplaced teeth (cont.)	1.18 (1.07–1.29)	<0.001	1.33 (1.20–1.47)	<0.001	0.64 (0.60–0.68)	0.55 (0.50–0.59)	0.69 (0.64–0.74)
Decayed teeth							
0 (ref.)	1.00		1.00				
>0	1.76 (1.15–2.70)	0.01	2.07 (1.17–3.64)	0.01	0.66 (0.62–0.70)	0.57 (0.52–0.61)	0.69 (0.65–0.74)
Mean AL (mm)							
1st tertile (ref.)	1.00		1.00				
2nd tertile	0.81 (0.54–1.22)	0.31	1.18 (0.63–2.23)	0.61			
3rd tertile	1.22 (0.78–1.93)	0.38	2.24 (0.19–4.22)	0.01	0.66 (0.62–0.70)	0.59 (0.55–0.63)	0.71 (0.67–0.76)
Filled teeth (cont.)	1.04 (1.00–1.09)	0.03	1.00 (0.95–1.06)	0.98	0.67 (0.63–0.71)	0.60 (0.56–0.64)	0.72 (0.67–0.76)
BOP (%) (cont.)	1.01 (1.00–1.01)	0.03	1.01 (1.00–1.02)	0.06	0.68 (0.64–0.72)	0.61 (0.56–0.65)	0.72 (0.67–0.77)

Analyses were weighted. The reference category of the dependent variable was 'Good'.
AL, attachment loss; AUC, area under the receiver–operating characteristics (ROC) curve for stepwise inclusion of predictive variables; BOP, bleeding on probing; cont., continuous; ref., reference; RRR, relative risk ratio.

Table 5

Outcome of sensitivity analyses (including the multimorbidity score) after stepwise multinomial regression analysis for older people (65–74 yr of age; n = *758[a])*

	Final multinomial model				Discriminatory power for stepwise built models		
	Satisfactory versus Good		Poor versus Good		AUCs (95% CI) for the three classes		
Variable	RRR (95% CI)	*P*	RRR (95% CI)	*P*	Good	Satisfactory	Poor
Removable denture							
No (ref.)	1.00		1.00				
Yes	2.18 (1.43–3.34)	<0.001	5.51 (3.12–9.70)	<0.001	0.58 (0.54–0.62)	0.51 (0.47–0.54)	0.62 (0.58–0.67)
Unreplaced teeth (cont.)	1.20 (1.09–1.31)	<0.001	1.35 (1.22–1.50)	<0.001	0.64 (0.60–0.68)	0.55 (0.50–0.59)	0.69 (0.64–0.74)
Decayed teeth							
0 (ref.)	1.00		1.00				
>0	1.76 (1.15–2.70)	0.01	2.11 (1.20–3.72)	0.01	0.66 (0.62–0.70)	0.57 (0.52–0.61)	0.69 (0.65–0.74)
Mean AL (mm)							
1st tertile (ref.)	1.00		1.00				
2nd tertile	0.81 (0.54–1.21)	0.30	1.16 (0.62–2.20)	0.64			
3rd tertile	1.27 (0.80–2.00)	0.31	2.50 (1.31–4.76)	0.01	0.66 (0.62–0.70)	0.59 (0.55–0.63)	0.71 (0.67–0.76)
Filled teeth (cont.)	1.05 (1.01–1.09)	0.02	1.01 (1.00–1.07)	0.68	0.67 (0.63–0.71)	0.60 (0.56–0.64)	0.72 (0.67–0.76)
BOP (%) (cont.)	1.01 (1.00–1.01)	0.03	1.01 (1.00–1.02)	0.06	0.68 (0.64–0.72)	0.61 (0.56–0.65)	0.72 (0.67–0.77)
Multimorbidity score (cont.)	1.05 (0.95–1.16)	0.37	1.27 (1.12–1.45)	<0.001	0.68 (0.64–0.72)	0.62 (0.58–0.66)	0.74 (0.69–0.79)

Analyses were weighted. The reference category of the dependent variable was 'Good'.
AL, attachment loss; AUC, area under the receiver–operating characteristics (ROC) curve for stepwise inclusion of predictive variables; BOP, bleeding on probing; cont., continuous; RRR, relative risk ratio; [a]two subjects were excluded in the sensitivity analyses because of missing values for the multimorbidity score and self-perceived general health.

whereas in older people the presence of at least one removable denture was the most important factor. Although periodontal variables were included in the final model in both age groups, they were not as strongly associated with self-perceived oral health as were variables assessing caries and prosthetic status. The AUC values showed an acceptable ability of classification (23), indicating an acceptable perception of clinical oral health variables by both adults and older people.

Some limitations deserve consideration. First, self-perceived oral health was assessed using a single-item question. Although multi-item scales are more consistent and stable (25), single-item questions have advantages over multi-item scales in that they are cost-effective and easily interpretable (25). Furthermore, a single-item question, similar to the one used in this study, was successfully validated in a recent study of 35- to 44-yr-old adults (8). Here, caries, tooth loss, and periodontitis experiences showed mostly consistent gradients across single-item responses. Second, analyses were restricted to dentates for whom periodontal measures were available. Consequently, the numbers of adults and older people were reduced by 3.7% and 26.9%, respectively. Especially in older people, the association

Table 6

Outcome of sensitivity analyses (including self-perceived general health) after stepwise multinomial regression analysis for older people (65–74 yr of age; n = *758[a])*

	Final multinomial model				Discriminatory power for stepwise built models		
	Satisfactory versus Good		Poor versus Good		AUCs (95% CI) for the three classes		
Variable	RRR (95% CI)	*P*	RRR (95% CI)	*P*	Good	Satisfactory	Poor
Removable denture							
No (ref.)	1.00		1.00				
Yes	2.06 (1.33–3.20)	0.001	5.02 (2.79–9.04)	<0.001	0.58 (0.54–0.62)	0.51 (0.47–0.54)	0.62 (0.58–0.67)
Unreplaced teeth (cont.)	1.20 (1.09–1.32)	<0.001	1.34 (1.20–1.49)	<0.001	0.64 (0.60–0.68)	0.55 (0.50–0.59)	0.69 (0.64–0.74)
Decayed teeth							
0 (ref.)	1.00		1.00				
>0	1.76 (1.12–2.75)	0.01	1.95 (1.07–3.56)	0.03	0.66 (0.62–0.70)	0.57 (0.52–0.61)	0.69 (0.65–0.74)
Mean AL (mm)							
1st tertile (ref.)	1.00		1.00				
2nd tertile	0.69 (0.46–1.05)	0.09	0.97 (0.50–1.86)	0.92			
3rd tertile	1.22 (0.76–1.96)	0.41	2.57 (1.31–5.05)	0.01	0.66 (0.62–0.70)	0.59 (0.55–0.63)	0.71 (0.67–0.76)
Filled teeth (cont.)	1.05 (1.01–1.09)	0.01	1.01 (0.95–1.07)	0.71	0.67 (0.63–0.71)	0.60 (0.56–0.64)	0.72 (0.67–0.76)
BOP (%) (cont.)	1.01 (1.00–1.01)	0.03	1.01 (1.00–1.02)	0.07	0.68 (0.64–0.72)	0.61 (0.56–0.65)	0.72 (0.67–0.77)
Self-perceived general health							
Very good/good (ref.)	1.00		1.00				
Satisfactory	3.42 (2.35–5.00)	<0.001	4.04 (2.31–7.07)	<0.001			
Not so good/poor	2.20 (1.09–4.45)	0.03	13.13 (5.95–28.95)	<0.001	0.74 (0.70–0.78)	0.67 (0.63–0.71)	0.78 (0.74–0.83)

Analyses were weighted. The reference category of the dependent variable was 'Good'.
AL, attachment loss; AUC, area under the receiver–operating characteristics (ROC) curve for stepwise inclusion of predictive variables; BOP, bleeding on probing; cont., continuous; RRR, relative risk ratio; [a]two subjects were excluded in the sensitivity analyses because of missing values for the multimorbidity score and self-perceived general health.

between the presence of a removable denture and self-perceived oral health might have been underestimated. Third, the periodontal recording protocol required assessment of attachment loss only at three sites per tooth, at 12 index teeth. Compared with a full-mouth protocol, index teeth include a high percentage of molars and mandibular incisors, which are more often afflicted by periodontitis (26). Thus, mean attachment loss might have been slightly overestimated in the present study. The bias caused by assessing only three sites per tooth, instead of six sites, might be negligible. Fourth, we used mean attachment loss to assess periodontal disease experience. Although mean attachment loss estimates are robust against probe- or examiner-associated bias, their use might reduce much of the interindividual variation. Extent measures of attachment loss would not reduce much of the interindividual variation. However, because both estimates performed comparatively well regarding their discriminative power for the specific outcome, we decided to use mean attachment loss in this study. Finally, the high percentage of nonresponders might have led to selection bias. Short basic questionnaires sent to nonresponders revealed that adult nonresponders were more often men (54.7% vs. 50.6%) and visited the dentist for regular check-ups less frequently (64.9% vs. 76.1%). Conversely, in older people, nonresponders were more often women (57.9% vs. 53.8%). Thus, periodontal and carious prevalences might have been affected differentially. However, as there were only minor differences between responders and nonresponders, selection bias might be marginal.

We generally assume that awareness of adverse oral conditions implies poor self-perceived oral health. However, answers to an open-ended question about factors influencing the self-perception of health revealed that most participants reported comparing their health with that of reference groups, especially with that of their age peers (13). Social factors, such as culture, class, and race, also influence the extent of translation of adverse clinical conditions into poor self-perceived oral health (15).

Many participants were satisfied with their oral health; only 18.5% of adults and 16.1% of older people reported having poor oral health. Apparently, older people consider an impaired oral health status as being part of the ordinary aging process (27, 28). In our study, sensitivity analyses revealed that the multimorbidity score was significantly associated with self-perceived oral health in older people when poor self-perceived oral health was compared with good self-perceived oral health. Apparently, the presence of other medical diseases was also associated with self-perceived oral health in older people. The more medical diseases reported, the higher the likelihood that participants rated their oral health as poor.

Overall, the number of unreplaced teeth was the most important factor. It was the first variable to enter the model for adults and the second variable to enter the model for older people. Strong associations between missing teeth and self-perceived oral health were also observed in other studies (1, 9, 29). Possible reasons are the reduced chewing efficiency, the unfavorable appearance, and the necessity for prosthetic restorations.

Factors assessing caries status were highly predictive. In both age groups, the number of decayed teeth was the third variable to enter the model. This strong

association is consistent with other studies (1, 9). In adults, both bivariate and multinomial analyses revealed that the probability of assessing oral health as poor increased proportionally to the number of filled teeth. In contrast, older people with a higher number of filled teeth tended to rate their oral health as good or satisfactory; however, this effect was severely diminished in multivariate regression. Discrepancies between these age groups might be explained by the fact that older people with removable dentures have fewer natural teeth, which, in turn, implies a low maximum number of possibly filled teeth. Additionally, filled teeth also encompassed crowned teeth, which are needed to attach removable dentures, and thus they were perceived as being necessary and inevitable. Other studies consistently reported that in older participants a higher number of filled teeth correlated with a higher probability of perceiving oral health as good (1, 9). These findings once more underline the age-dependent shift of perception.

Mean attachment loss was included in the final model in both age groups but it was not as strongly associated with self-perceived oral health as caries and prosthetic factors. The AUC values only slightly improved after the addition of mean attachment loss in both age groups. In the literature, periodontal disease is often considered as a silent disease (11, 30). In contrast, other studies found that periodontal inflammation (6) and mean attachment loss (1, 4) were significantly associated with self-perceived oral health. Moreover, models combining screening questions for periodontitis and risk factors performed well in predicting periodontitis (12, 31). All in all, periodontal problems might indeed be perceived by participants, but to a much lesser extent than caries and prosthetic factors.

In summary, the number of unreplaced teeth was most strongly associated with self-perceived oral health in adults, whereas for older people the presence of a removable denture was the most important factor. In both age groups, periodontal status was not as strongly associated with self-perceived oral health as were caries and prosthetic status, which indicates that periodontal disease severity does not contribute to self-perceived oral health in multivariate models. Awareness of the relative contributions of clinical variables to self-perceived oral health is important for gaining a clearer understanding of the patients' subjective and objective self-perceptions of oral health.

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