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ORIGINAL ARTICLE

Satisfaction with the dentition related to dental functional status and tooth replacement in an adult Bulgarian population: a cross-sectional study

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Abstract
Objectives The purpose of this study is to assess satisfaction with the dentition in general, dental esthetics, and chewing function related to dental functional status and tooth replacement in subjects, dentate in both jaws.
Materials and methods Dentitions of subjects (n=2,437) aged ≥20 years were categorized in a hierarchical functional classification system, with and without tooth replacements, according to four dental conditions: '≥10 teeth in each jaw', 'complete anterior regions', 'sufficient premolar regions' (≥3 occluding pairs), and 'sufficient molar regions' (bilaterally ≥1 occluding pair). Likelihood ratios (LR) were used to express the ability of these conditions to discriminate between satisfied and not satisfied subjects. Odds ratios (OR) were calculated to evaluate associations between satisfaction, the four dental conditions separately, and tooth replacement.
Results In the hierarchical system, subjects having '<10 teeth' were more likely of being not satisfied with their dentitions (LR 4.09), esthetics (LR 3.51), and chewing (LR 5.49). As a separate condition, '≥10 teeth' was significantly associated only with satisfaction with chewing. The conditions 'complete anterior regions' and 'sufficient' premolar and molar regions' were associated with all satisfaction variables (ORs 1.47–2.96, p values ≤0.012). When dental conditions were determined on the basis of natural teeth only, having teeth replaced was positively correlated with satisfaction; when determined on the basis of natural plus replaced teeth, subjects having teeth replaced tended to be less satisfied than their counterparts with natural teeth only.
Conclusions Satisfaction was strongly associated with dental functional status.
Clinical relevance Dental configurations comprising both natural and artificial teeth were less likely to provide the same level of satisfaction as equivalent dental configurations comprising natural teeth only.

Keywords Functional dentition · Tooth replacement · Hierarchical dental functional classification system

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Background

Perceived satisfaction with dental status and oral function is an important aspect of oral health and can be seen as a main goal of oral health care. It has been pointed out that objective clinical indicators represent only one aspect of oral health and that subjective measures of function and well-being should be incorporated when the health of patients or populations is described [1, 2]. Nonetheless,

the few studies on adult oral health in Bulgaria focused mainly on clinical indicators. The scarce available data indicated that dental disease and tooth loss are highly prevalent among the adult population [3, 4]. As public resources for oral health care in Bulgaria are limited [5], management strategies aiming at complete control of disease may be regarded as inappropriate. In some cases, achievement of satisfactory level of oral function may be a more realistic goal for oral health care [6]. Subjective assessment has been advocated as a means of relocating scarce resources towards those patients most likely to benefit from a particular therapy [7].

The impact of tooth loss and tooth replacement on oral health perceptions is of particular interest to prosthodontic care. Studies on self-perception have shown that tooth loss is associated with esthetic, functional, psychological, and social impacts [8–10]. A study on oral health status in older adults in Sri Lanka, however, found only a weak association between tooth loss and oral impacts [11]. It has been suggested that the relationship between objective measures and subjective assessments is influenced by other variables, such as age, gender or social context, and that adverse oral health outcomes do not always result in poor oral health perceptions [11, 12]. With respect to tooth replacement, this implies that replacement of absent teeth is not necessary in all cases [13]. Experience of considerable tooth loss without recourse to a denture, however, has been associated with reduced quality of life [14]. There is some evidence that replacement of missing teeth may have a positive effect on quality of life and satisfaction [15, 16]. It has been stated that satisfaction with dentition and prosthetic rehabilitation might have a positive effect on oral health-related quality of life [17]. Generally, there seems to be consensus that replacement of missing teeth by removable dental prostheses (RDP) does not yield a significant improvement in chewing and may have a negative impact on perceived oral function [6, 18]. In contrast, artificial teeth added by fixed dental prostheses (FDP) are thought to provide similar functionality as natural teeth and are considered more beneficial to patients in terms of quality of life than removable dental prostheses [19, 20]. However, research in this field is not conclusive [15].

The number of present teeth and the number of occluding pairs of teeth, both related to perceived satisfaction with oral function, are often used as clinical indicators to describe oral health of a population [13, 21]. According to a systematic review, sufficient oral functionality depends on the presence of at least 20 teeth with nine to ten occluding pairs, no tooth loss in the anterior region, and the retention of premolars, whereas there may be little increase in satisfaction in subjects who also retain molars [22]. Based on the conclusions of this review, a hierarchical classification system reflecting oral functionality has been recently designed [23, 24]. In this classification system, oral functionality is expressed by (1) number of teeth in upper and lower jaw, (2) completeness of anterior regions, (3) number of premolar occluding pairs, and (4) number of molar occluding pairs. Up to now, this system has been employed in few studies on adult oral health in Vietnam and China [23–27], but has never been used in a Bulgarian population. The aim of this study was to assess perceived satisfaction with the dentition amongst dentate adults in relation to dental condition with and without tooth replacement as determined by the hierarchical dental functional classification system.

Materials and methods

Sample construction

The present study is part of a cross-sectional survey conducted in Bulgaria between October 2006 and January 2010. A quota sampling method was applied to draw subjects aged 20 years and over. Quota units were established with regard to demographic (type of settlement), social (occupational status), and dentition characteristics. Four groups of settlements were defined based on their population size and administrative functions: the capital city, main urban centers, towns, and rural settlements (i.e. small towns and villages). Occupational status was expressed in terms of three groups of occupational categories (‘professionals’, ‘intermediate’, and ‘workers’), whereas retired subjects formed a separate fourth group. Dentitions were classified as complete, interrupted, or shortened on the basis of morphological characteristics. The sample size calculation set a minimum of 2,400 subjects to allow for multiple logistic regressions with at least 12 independent variables, stipulating no less than 120 observations of the least prevalent part of a dichotomous variable at a 5 % prevalence rate. Full details of the sampling process have been published elsewhere [28].

Within the settlements, employed subjects were recruited from factories and institutions, whereas retired subjects were recruited from local health care centers and a home for elderly. Recruitment of participants continued until predetermined conditions for sample size and completion of quota units had been fulfilled. Of all eligible subjects available for examination, 2,644 completed the survey and 313 refused participation. The Ethical Committee of the Medical University-Sofia approved this study (no. 299/15.05.2007). The research was carried out in compliance with the Helsinki Declaration.

Data collection

Verbal consent was obtained from each subject prior to data collection. Data were collected by means of a structured interview, a self-administered questionnaire, and an oral examination. The interview covered a range of areas, including perceived satisfaction with the dentition. Perceived satisfaction with the dentition was defined as a subjective positive evaluation of the dentition in general (i.e. subjective appreciation of one's own teeth as good enough, not causing pain or troubles and performing reasonably well), of dental esthetics (i.e. being pleased with the appearance of the teeth visible during smiling or speaking), and of chewing function (i.e. being pleased with the ability to eat and chew). Dichotomous (yes/no) response format was used to record reported satisfaction. Besides, the interview and the questionnaire contained items regarding a number of demographic (age, gender, and place of residence), socio-cultural (educational attainment, occupational status, and household income), and oral health-related variables (dental attendance and tooth brushing frequency). Educational attainment was determined on the basis of years of formal education completed and classified as lower (≤9 years), middle (>9 years ≤12), or higher (>12 years). Household income was self-rated by the subjects on a five-point scale, and subjects were assigned to three income categories: high (income rated as 'excellent' or 'very good'), medium (income rated as 'good'), or low (income rated as 'fair' or 'poor'). Dental visits were considered as regular if subjects reported visiting a dentist at least once a year, and were considered as irregular if subjects reported less frequent dental visits. Frequency of tooth brushing was scored as follows: two or more times a day; once a day; less than once a day.

Following the interview and the completion of the questionnaire, subjects received an oral examination. Oral examinations were done by one calibrated examiner in natural light using a mirror and a dental probe, with the subject seated in an ordinary chair. A headlight was used when the natural light was felt to be insufficient. Of all variables recorded, only the presence of natural teeth (including third molars), tooth type, number and location of posterior occluding pairs (POPs), and tooth replacement were used in the present study. All pairs of opposing teeth in the premolar region and in the molar region were considered as POPs. A tooth root was defined as missing. A replaced tooth was defined as a missing tooth replaced by a FDP or by a RDP. With respect to the clinical variables involved, inter-observer agreements between the principal investigator and experienced researchers in the field were very good (kappa's ≥0.95).

Hierarchical dental functional classification system

In the classification system, which has been previously described [23, 24], dentitions are classified on the basis of a dichotomized five-level step-by-step branching hierarchy where the criteria applied on the levels are based on conditions that reflect functionality. The conditions used are the number of natural teeth, the tooth types present, and the number of POPs. Levels I (dentition level) and II (jaw level) refer to the number of present teeth per jaw (Table 1). The condition at level I separates edentulous from dentate subjects. The condition at level II categorizes dentate subjects into one of the two branches of the system: the '≥10 teeth branch' for subjects having ≥10 teeth in each jaw and the '<10 teeth branch' for subjects having <10 teeth in at least one jaw (see Fig. 1). Dentitions in each of the two branches are further dichotomized at levels III to V (anterior, premolar, and molar level, respectively), based on number of present teeth and POPs per dental region (Table 1). For practical reasons, categories with relatively low prevalence (the categories not meeting the cutoffs in the '≥10 teeth branch', and the categories meeting the cutoffs in the '<10 teeth branch') were not further dichotomized to the next level (see Fig. 1).

Data analyses

Subjects being edentulous in one or both jaws were excluded from the analyses. For descriptive purposes, subjects' dentate in both jaws were classified on the basis of natural

Table 1 Levels and criteria for dichotomization of the step-by-step branching hierarchy [23]

Level	Meeting criterion		Dichotomy
	Yes	No	
I. Dentition level	≥1 tooth present in each jaw	No teeth present in at least one jaw	≥1 tooth *vs.* no teeth
II. Jaw level	≥10 teeth in each jaw	<10 teeth in at least one jaw	≥10 teeth vs. <10 teeth
III. Anterior level	All 12 anterior teeth present	<12 Anterior teeth	Complete vs. incomplete
IV. Premolar level	3 or 4 occluding pairs of premolars	≤2 occluding pairs of premolars	'Sufficient' vs. 'impaired'
V. Molar level	≥1 occluding pairs of molars at each side of the dentition	No occluding pairs of molars at least at one side of the dentition	'Sufficient' vs. 'impaired'

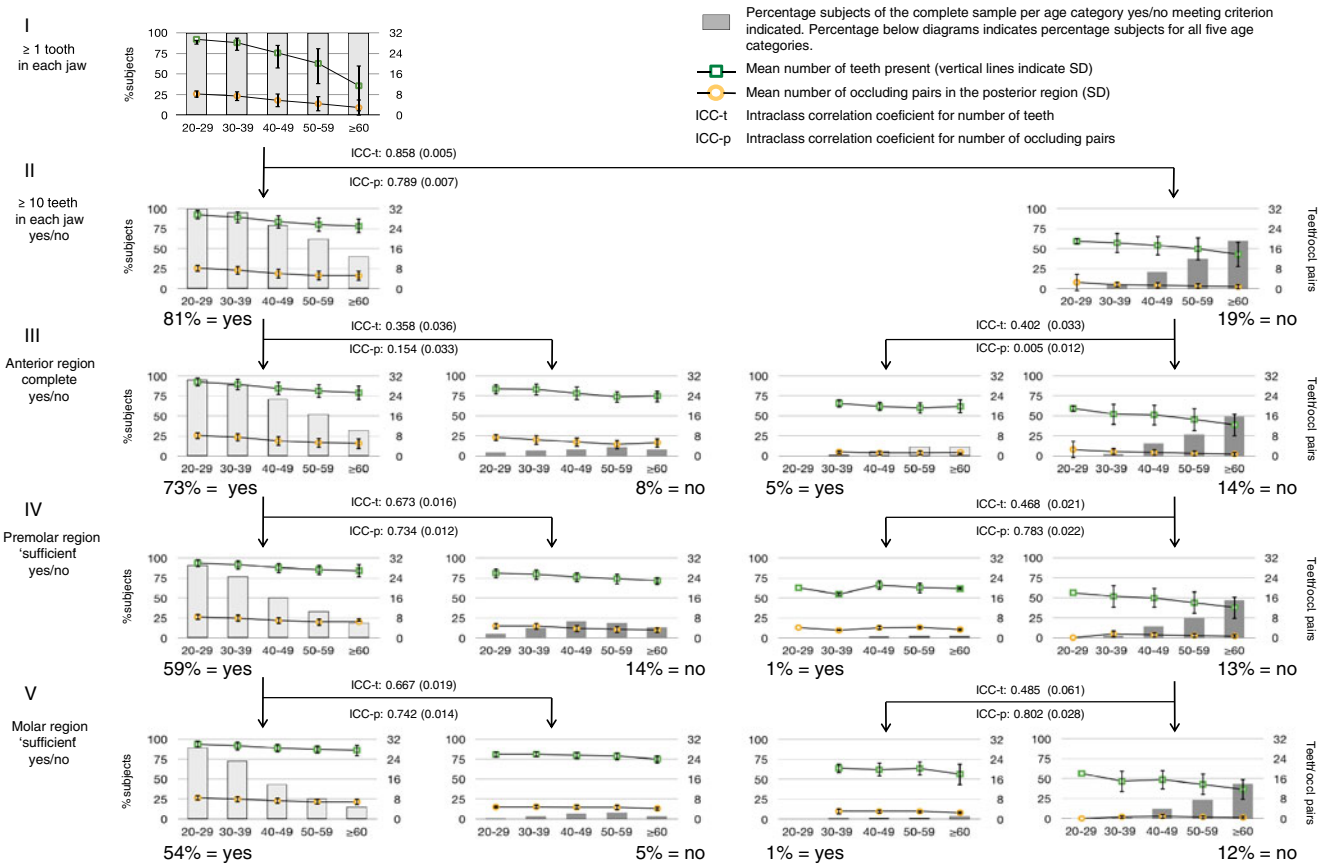

Fig. 1 Percentage of subjects dentate in both jaws (n=2,437), and mean numbers of natural teeth and natural posterior occluding pairs per age group, after classification in Class^{N} according to the step-by-step branching hierarchy dichotomized at five levels: (*I*) ≥1 natural tooth in each jaw, (*II*) ≥10 natural teeth in each jaw, (*III*) anterior region complete, (*IV*) premolar region 'sufficient', (*V*) molar region 'sufficient'

teeth only (Class^{N}), i.e. replaced teeth were not considered. With regard to each level in the branching hierarchy, percentages of subjects meeting or not meeting the classification criteria were calculated. Mean numbers of teeth present and mean numbers of POPs were calculated for five age groups: (1) 20–29, (2) 30–39, (3) 40–49, (4) 50–59, and (5) 60 years and over. Intraclass correlation coefficients (ICCs) were calculated as a measure for the homogeneity of the groups after dichotomization at each level with respect to the number of teeth and the number of POPs. The homogeneity of groups or categories after dichotomization is considered a measure that reflects the significance of the cutoff and the validity of the classification system. A bootstrap resample procedure was used to determine the standard errors for the ICCs.

To analyse reported satisfaction in relation to dental conditions two approaches were used. First, reported satisfaction was related to the hierarchical functional classification system, in which the dental regions are considered in the context of the dentition as a whole. In the second approach, the relationships were analysed for the conditions of the different dental regions separately, i.e. not hierarchically.

In the first approach, likelihood ratios were calculated after dichotomization (meeting versus not meeting the criterion of a dental condition). These likelihood ratios express the extent to which a given condition, for instance having '≥10 teeth in each jaw', discriminates between satisfied and not satisfied subjects. A likelihood ratio of 1 indicates a classification criterion that is not discriminatory. For this analysis, subjects were reclassified on the basis of natural teeth plus teeth replaced regardless the type of tooth replacement (Class^{N+F+R}).

In the second approach, multivariate logistic regression models were used. The three satisfaction items were used as dependent variables in the regression models. The independent variables were the dental conditions corresponding to levels II to V of the hierarchical system ('≥10 teeth in each jaw', 'anterior region complete', 'premolar region sufficient', and 'molar region sufficient'), and the presence of replaced teeth. To assess the associations between replaced teeth and satisfaction, regression models were constructed where subjects were classified on the basis of: (1) natural teeth only (Class^{N}), (2) natural teeth plus teeth replaced by FDP (Class^{N+F}), and (3) natural teeth plus teeth replaced by RDP (Class^{N+R}). The associations between the dependent

and the independent variables were adjusted for a number of background variables: age, gender, place of residence (type of settlement), educational attainment, occupational status, household income, dental attendance, and tooth brushing patterns.

The performance of the multivariate logistic models was expressed as the percentages of subjects being satisfied predicted by (1) the dental conditions only, and (2) all variables. To express the performance of the logistic models, the area under the curve (AUC) statistic is used. An AUC of 0.5 indicates a total absence of model fit; an AUC of 1 indicates that model fit is perfect. Although the models are etiologic by nature and not meant as a predictive tool, the percentages predicted correctly are presented as an additional indication of the model fit. R software version 2.15.0 was used for the statistical analyses.

Results

Of all subjects who completed the survey (n=2,644), 189 were edentulous in upper and/or lower jaw. Of the remaining 2,455 dentate in both jaws subjects, 18 were excluded because of incomplete data sets. This left 2,437 subjects for the current analyses. Distribution of subjects according to demographic, socio-cultural, and oral health-related characteristics is presented in Table 2.

Dental conditions

The hierarchical dental functional classification system describes 87 % of all subjects having teeth in both jaws up to level IV (premolar region) and 72 % up to level V (molar region; Fig. 1). Of all dentate in both jaws subjects, 54 % met all cutoffs up to level V, whereas 12 % met none of the cutoffs. The classification of subjects in the hierarchical system resulted in varying homogeneity of the groups with respect to number of natural teeth present and POPs. Large ICCs, indicating good group homogeneity, were found at level II ('≥10 teeth in each jaw'), whereas low ICCs were found at level III ('anterior region complete') in both the '≥10 teeth branch' and the '<10 teeth branch'.

In the '≥10 teeth branch' (the two left columns in Fig. 1), the lowest mean numbers of teeth (22.9±1.7) and POPs (3.1±1.2) were found in subjects aged 60 years and over who did not meet the criterion for a 'sufficient premolar region' at level IV (Fig. 1). In contrast, the mean number of teeth in subjects who met all criteria up to level V ranged from 30.0±1.6 in the youngest age group to 27.6±2.4 in the oldest age group, providing a mean of 8.5±1.1 and 6.9±1.4 POPs, respectively.

In the '<10 teeth branch' (the two right columns in Fig. 1), the mean number of teeth in those subjects who met none of the criteria (n=291, 12 % of all dentate subjects) ranged between 15.5±3.9 in the 40–49 age group to 11.7±4.2 in the ≥60 age group, providing a mean of 0.9±1.0 and 0.4±0.7 POPs, respectively.

Replaced teeth

Of all dentate in both jaws subjects, 35 % (n=848) presented with one or more teeth replaced. Of them, 83 % (n=708) presented with teeth replaced by FDP, while 16 % (n=140) had teeth replaced by RDP. Of all subjects wearing a RDP, 95 % had <10 natural teeth in upper and/or lower jaw; 36 % had also teeth replaced by fixed dental prosthesis. When classified in $Class^{N}$ on the basis of natural teeth only, 40 % (n=312) of the subjects having teeth replaced did not met the criterion of having '≥10 teeth in each jaw' (Table 3). After reclassification to $Class^{N+F+R}$ on the basis of natural teeth plus teeth replaced, 24 % (n=103, n=33, n=47, and n=20 at dentition, jaw, anterior, and premolar level, respectively) still did not meet the criterion at subsequent functional level in the hierarchical system. Fifty-four percent (n=459) met one or more criteria and were graded to subsequent functional levels, whereas 22 % (n=186) did not change their position in the classification system since they already occupied the highest possible level as determined on the basis of natural teeth only (Table 3).

Reported satisfaction in relation to the dental conditions in the hierarchical functional classification system

Of all dentate in both jaws subjects, only 48 % were satisfied with all three aspects of their perceived oral health and function. Vast majority of all subjects (86 %) reported being satisfied with their chewing function, whereas relatively fewer were satisfied with their dental esthetics (70 %) and with their dentition in general (62 %; Fig. 2, level I, light gray columns). Proportions of subjects satisfied were lower in the '<10 teeth branch' than in the '≥10 teeth branch' at level II. At subsequent levels in both branches, satisfaction rates appeared to be higher among subjects having teeth replaced (black columns) than among their counterparts with natural teeth only (dark gray columns).

Generally, having '<10 teeth in upper and/or lower jaw' was the dental condition that demonstrated the best discriminatory ability with likelihood ratios (LR) ranging between 3.51 for being not satisfied with dental esthetics and 5.49 for being not satisfied with chewing function (Table 4). For the subsequent predictors, the likelihood ratios of being not satisfied were higher if the conditions at preceding levels were met than if the conditions at preceding levels were not met. Of all dental conditions at levels III to V, having 'anterior region incomplete' was the strongest predictor (in terms of its likelihood ratio) of being not satisfied with dental esthetics, both in the '≥10 teeth branch' (LR=2.35) and in the '<10 teeth branch' (LR=1.73). If the condition of

Table 2 Distribution of dentate subjects in the sample (n=2,437) by demographic, socio-cultural, and oral health-related variables

Variables		Number (%)	Variables		Number (%)
Demographic					
Age groups	20–29	463 (19)	Settlement	Capital	378 (15)
	30–39	644 (26)		Urban center	704 (29)
	40–49	594 (24)		Town	685 (28)
	50–59	574 (24)		Rural	670 (28)
	≥60	162 (7)			
Gender	Male	1,477 (61)			
	Female	960 (39)			
Socio-cultural					
Education	High	902 (37)	Occupational status	Professionals	808 (33)
	Middle	1,442 (59)		Intermediate	1,006 (41)
	Low	91 (4)		Workers	540 (22)
	Unknown	2 (0)		Retired	55 (2)
				Unknown	28 (1)
Income	High	212 (8)			
	Middle	968 (40)			
	Low	1,240 (51)			
	Unknown	17 (1)			
Oral health related					
Dental visits	Regular	1,083 (44)	Tooth brushing	≥2 a day	1,353 (56)
	Irregular	1,354 (56)		<2 a day	1,076 (44)
				Unknown	8 (0)
Teeth replaced	No	1,589 (65)			
	Yes	848 (35)			

having '≥10 teeth in each jaw' was met, having 'premolar region impaired' produced highest likelihood ratio of being not satisfied with the dentition in general (LR=2.16), whereas 'molar region impaired' produced highest

Table 3 Distribution of subjects having tooth replacement (n=848) in the hierarchical classification system based on natural teeth only (classification in $Class^{N}$) and based on natural teeth plus teeth replaced (reclassification to $Class^{N+F+R}$)

Classification based on natural teeth only Level/criterion met[a] (number of subjects)	Reclassification based on natural teeth plus teeth replaced					Total
	Dentition level ≥1 tooth	Jaw level ≥10 teeth	Anterior level complete	Premolar level 'sufficient'	Molar level 'sufficient'	
Dentition level						
≥1 tooth (n=312)	103	29	36	53	91	312
Jaw level						
≥10 teeth (n=107)	–[a]	33	9	7	58	107
Anterior level						
Complete (n=193)	–[a]	–[a]	47	26	120	193
Premolar level						
'Sufficient' (n=50)	–[a]	–[a]	–[a]	20	30	50
Molar level						
'Sufficient' (n=186)	–[a]	–[a]	–[a]	–[a]	186	186
Total (n=848)	103	62	92	106	485	848

[a] Criteria at preceding levels have been met. For instance, the 107 subjects who have met the criterion of having "≥10 teeth in each jaw" (jaw level, column) have also met the criterion of having "≥1 teeth in each jaw" (dentition level), but have not met the criterion of having "complete anterior region" (anterior level). After reclassification based on natural plus replaced teeth, 33 out of 107 subjects still do not meet the criterion of having "complete anterior region" and remain in the group of ≥10 teeth, while the remaining 74 are reclassified to subsequent functional levels

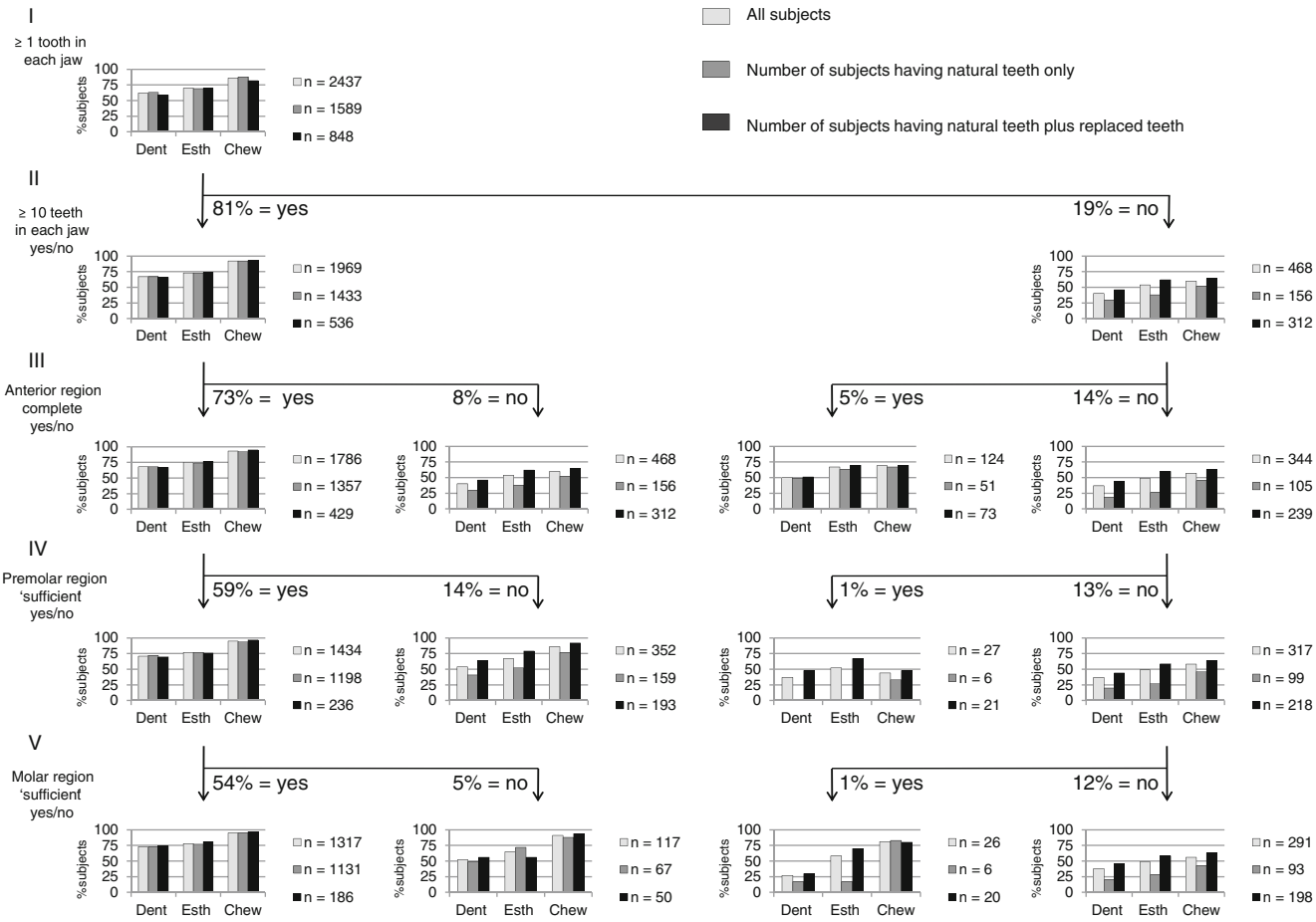

Fig. 2 Percentage (*n*) of subjects satisfied with the dentition in general (*Dent*), with dental esthetics (*Esth*), and with chewing function (*Chew*) at each level of the step-by-step branching hierarchy after classification in Class^{N} (n=2,437) for subjects with and without tooth replacement

likelihood ratio of being not satisfied with chewing function (LR=3.00).

Reported satisfaction in relation to the separate dental conditions and replaced teeth

The multivariate logistic regression analyses for the separate dental conditions based on natural teeth only (Class^{N}) demonstrated that each of the three dental regions (anterior, premolar, and molar) was significantly associated with each of the dependent variables (Table 5). In contrast, the condition of '≥10 teeth in each jaw' did not reveal significant associations with the dependent variables, except for satisfaction with chewing function. The greatest contributor for satisfaction with dental esthetics in terms of its odds ratio (OR) was the condition of having 'complete anterior regions' (OR=2.84). Of all dental conditions included, having 'premolar region sufficient' revealed the strongest association (OR=2.20) with satisfaction with the dentition in general, whereas the contribution of 'sufficient molar region' was greatest for satisfaction with chewing function (OR=2.52). In this model, having teeth replaced was positively correlated with all satisfaction variables. On the basis of dental conditions only, the percentages of correctly predicted subjects being satisfied ranged from 65.8 % (for satisfaction with the dentition in general) to 84.6 % (for satisfaction with chewing function); AUCs ranged from 0.631 to 0.773, showing a reasonably high level of predictability of the model. The full model, including all background variables, predicted 69.5 % (again for satisfaction with the dentition in general) to 87.2 (again for satisfaction with chewing function) of the subjects being satisfied; AUCs ranged from 0.711 to 0.819.

After reclassification to categories based on natural teeth plus teeth replaced by FDP (Class^{N+F}) or by RDP (Class^{N+R}), the associations between the dental conditions and the dependent variables observed in the regression models for Class^{N} did not change considerably (Tables 6 and 7). The same was true with respect to the fit of the two models. Nevertheless, subjects having teeth replaced by FDP were less likely to be satisfied with their dentitions in genera (OR=0.78) than their counterparts with natural teeth only (Table 6). Subjects having teeth replaced by RDP were less likely to be satisfied with their dentitions in general (OR=0.64) and with their chewing function (OR=0.38) than their counterparts with natural teeth only (Table 7).

Table 4 Likelihood ratios of being not satisfied according to the condition of meeting/not meeting a functional level in the hierarchical classification system at the cutoff for the next level after reclassification to Class^{N+F+R} (n=2,437)

Condition			Predictor	Not satisfied with		
≥10 teeth in each jaw	Anterior region complete	Premolar region "sufficient"		Dentition in general	Dental esthetics	Chewing function
			<10 teeth in either jaw	4.09 (73)	3.51 (102)	5.49 (122)
Yes			Anterior region incomplete	2.02 (67)	2.35 (64)	2.39 (29)
No			Anterior region incomplete	1.65 (31)	1.73 (40)	1.39 (33)
Yes	Yes		Premolar region "impaired"	2.16 (121)	1.99 (102)	2.69 (54)
No	No		Premolar region "impaired"	1.31 (13)	0.73 (12)	1.54 (9)
Yes	Yes	Yes	Molar region "impaired"	1.86 (78)	1.40 (52)	3.00 (34)
No	No	No	Molar region "impaired"	1.13 (42)	1.26 (43)	1.74 (24)

Numbers in parentheses denote the smallest number in the four cells in the respective comparisons

Discussion

For the present survey, a non-probability sampling method was adopted. Consequently, outcomes with respect to the prevalence of dental conditions and tooth replacement cannot be considered representative for the general population. Nevertheless, the sampling strategy and the large sample size ensured broad geographic and socio-economic representation and inclusion of a great variety of dental conditions. Therefore, this sample was considered adequate to study associations between perceived satisfaction, dental conditions, and tooth replacement. The cross-sectional design of the study, however, does not justify causal interpretation of these associations.

In the present study, reported satisfaction was used as a global indicator of dental health and oral function. Although non-validated questions were used to measure satisfaction, the validity of the questions used is implied by the significant and coherent associations observed between perceived satisfaction on the one hand and the dental conditions and tooth replacement on the other. It has been suggested that health perceptions measured by single-item global ratings,

Table 5 Odds ratios [OR; with 95 % confidence interval (95 % CI) and p values] of reported satisfaction in the multivariate logistic regression models* based on the separate dental conditions after classification in Class^{N} (n=2,437)

Condition[a] (level)	Satisfaction					
	Dentition in general		Dental esthetics		Chewing function	
	OR (95 % CI)	p value	OR (95 % CI)	p value	OR (95 % CI)	p value
≥10 teeth in each jaw (II)	1.10 (0.77…1.57)	0.588	0.81 (0.56…1.17)	0.254	1.89 (1.24…2.90)	0.003
Anterior regions complete (III)	2.07 (1.58…2.72)	<0.001	2.84 (2.15…3.76)	<0.001	2.01 (1.43…2.83)	<0.001
Premolar regions "sufficient" (IV)	2.20 (1.71…2.82)	<0.001	1.76 (1.35…2.29)	<0.001	1.81 (1.26…2.60)	0.001
Molar regions "sufficient" (V)	2.02 (1.53…2.66)	<0.001	1.75 (1.31…2.34)	<0.001	2.52 (1.73…3.67)	<0.001
Teeth replaced	1.39 (1.11…1.75)	0.005	1.72 (1.35…2.19)	<0.001	1.90 (1.39…2.60)	<0.001
Dental conditions only						
AUC	0.651		0.631		0.773	
% correctly predicted	65.8		70.2		84.6	
Full model						
AUC	0.711		0.723		0.819	
% correctly predicted	69.5		73.0		87.2	

Model fit expressed by the area under the curve (AUC) statistic and the fraction of subjects correctly predicted by the dental conditions only and by the full model of dental conditions plus background variables. Multivariate logistic regression models adjusted for age, gender, place of residence, education, income, occupation, dental attendance, and tooth brushing

[a] Reference=condition not present

Table 6 Odds ratios [OR; with 95 % confidence interval (95 % CI) and *p* values] of reported satisfaction in the multivariate logistic regression models based on the separate dental conditions after reclassification to Class^{N+F} (*n*=2,437)

Condition[a] (level)	Satisfaction					
	Dentition in general		Dental esthetics		Chewing function	
	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value
≥10 teeth in each jaw (II)	0.92 (0.60…1.39)	0.675	0.88 (0.58…1.34)	0.560	1.11 (0.70…1.77)	0.660
Anterior regions complete (III)	2.41 (1.77…3.29)	<0.001	2.63 (1.93…3.58)	<0.001	2.06 (1.43…2.97)	<0.001
Premolar regions "sufficient" (IV)	2.04 (1.55…2.69)	<0.001	1.95 (1.46…2.60)	<0.001	1.84 (1.28…2.66)	0.001
Molar regions "sufficient" (V)	1.97 (1.48…2.61)	<0.001	1.47 (1.09…1.98)	0.012	2.93 (2.04…4.21)	<0.001
Teeth replaced	0.78 (0.63…0.97)	0.024	0.88 (0.71…1.10)	0.277	1.06 (0.79…1.42)	0.710
Dental conditions only						
AUC	0.641		0.632		0.767	
% correctly predicted	66.2		70.5		85.5	
Full model						
AUC	0.705		0.720		0.812	
% correctly predicted	68.9		73.6		87.2	

Model fit expressed by the area under the curve (AUC) statistic and the fraction of subjects correctly predicted by the dental conditions only and by the full model of dental conditions plus background variables. Multivariate logistic regression models adjusted for age, gender, place of residence, education, income, occupation, dental attendance, and tooth brushing

[a] Reference=condition not present

such as expression of satisfaction or dissatisfaction, integrate several health concepts including biological and psychological states, symptoms and physical, psychological, and social functioning [29]. Single-item global indicators are important determinants of the use of health services and are often used as a 'gold standard' to test the validity of oral health-related quality of life measures [30, 31]. Nevertheless, satisfaction is a complex construct, and there seems to be a lack of consensus on a number of methodological issues, such as selecting an appropriate definition for a given context and development of valid measures of satisfaction [32, 33]. In contrast, several validated questionnaires have

Table 7 Odds ratios [OR; with 95 % confidence interval (95 % CI) and *p* values] of reported satisfaction in the multivariate logistic regression models based on the separate dental conditions after reclassification to Class^{N+R} (*n*=2,437)

Condition[a] (level)	Satisfaction					
	Dentition in general		Dental esthetics		Chewing function	
	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value	OR (95 % CI)	*p* value
≥10 teeth in each jaw (II)	1.29 (0.91…1.84)	0.154	0.97 (0.67…1.39)	0.854	1.66 (1.11…2.49)	0.014
Anterior regions complete (III)	2.02 (1.55…2.63)	<0.001	2.96 (2.27…3.87)	<0.001	1.91 (1.38…2.63)	<0.001
Premolar regions "sufficient" (IV)	2.09 (1.65…2.65)	<0.001	1.63 (1.27…2.10)	<0.001	1.83 (1.31…2.56)	<0.001
Molar regions "sufficient" (V)	1.89 (1.44…2.46)	<0.001	1.58 (1.20…2.09)	0.001	2.11 (1.49…2.98)	<0.001
Teeth replaced	0.64 (0.43…0.96)	0.033	0.89 (0.59…1.36)	0.600	0.38 (0.24…0.60)	<0.001
Dental conditions only						
AUC	0.657		0.643		0.757	
% correctly predicted	67.0		72.0		86.1	
Full model						
AUC	0.715		0.727		0.815	
% correctly predicted	69.8		73.7		86.9	

Model fit expressed by the area under the curve (AUC) statistic and the fraction of subjects correctly predicted by the dental conditions only and by the full model of dental conditions plus background variables. Multivariate logistic regression models adjusted for age, gender, place of residence, education, income, occupation, dental attendance, and tooth brushing

[a] Reference = condition not present

been provided to measure oral health-related quality of life [34]. Even though satisfaction and quality of life are related constructs, they represent different patient-based outcomes, measurement models, and aims, and so "… one type of outcome cannot (and should not) be seen as a surrogate for another" [35]. Whether one is satisfied or not with his or her oral health may determine the extent to which functional and psychosocial events are perceived as oral health impacts [30]. It should be noted that judgments of satisfaction are inherently an evaluation process and have a large cognitive component. Consequently, they are amenable to influences of psychosocial conditions and somatization disorders [36]. The scope of the present study, however, remains restricted to associations between perceived satisfaction and selected dental factors.

The present study demonstrated significant associations between reported satisfaction, tooth replacement, and dental condition as determined by a hierarchical dental functional classification system. The ability of the classification system to display functionality of dentitions on population level has been previously evaluated in studies in Vietnam and China [23, 24]. In the present study, intraclass correlation coefficients were calculated as a measure for the homogeneity of the groups in the classification system after dichotomization at each level. Overall, the correlation coefficients, comparable to those reported for a Vietnamese and a Chinese population, indicated satisfactory homogeneity of the groups. Therefore, the classification system was considered as appropriate to describe the dental functional status of the study population.

The majority of subjects in the sample reported being satisfied with their dentitions, dental esthetics, and chewing function. Nevertheless, half of the respondents were not satisfied with at least one aspect of their oral health. Significant relationships were found between perceived satisfaction and the dental functional status. The use of two approaches for statistical analyses allowed the contribution of each dental condition and of tooth replacement to be studied in different contexts. In the first approach, the dental conditions were considered within the frame of the hierarchical classification system. Of all dental conditions, having '<10 teeth in upper or lower jaw' best discriminated between satisfied and not satisfied subjects, especially with respect to chewing function. In the second approach, however, in which multivariate regression models were constructed to analyse the relationship between reported satisfaction and the separate dental conditions, having '≥10 teeth in each jaw' did not show significant associations with the dependent variables, except for satisfaction with chewing function in $Class^{N}$ and in $Class^{N+R}$ (Tables 5 and 7). In the presence of other dental conditions and a number of background variables in the regression models, it appeared that having more or less than ten teeth in each jaw is of greater importance for satisfaction with chewing than for satisfaction with the dentition and with dental esthetics. These results support the finding that 20 "well-distributed" teeth are sufficient to maintain a satisfactory chewing ability [37].

In a recent systematic review, it was concluded that tooth loss is associated with impairment of oral health-related quality of life and that the severity of the impairment is affected by location and distribution of tooth loss [10]. In the present study, the separate dental conditions at dental region level (i.e. anterior, premolar, and molar region) demonstrated significant relationships with all dependent variables. The results suggested that subjects having "complete anterior region" and "sufficient" premolar and molar regions are most likely to be satisfied with their dentitions and oral function. This is in line with the finding that subjects with more premolar and molar pairs are the ones most satisfied with their teeth [38]. Nevertheless, since different tooth types have different functions, it can be expected that they also have different impact on perceived satisfaction. In the present study, the molar region emerged as a strong determinant of satisfaction with chewing function, but seemed to be relatively less important for satisfaction with the dentition in general and with dental esthetics than the other two dental regions. Bearing in mind the low rates of being not satisfied with chewing function among the study participants, it may be suggested that the contribution of the molar region to perceived satisfaction is of limited extent compared to the contribution of the anterior and the premolar region. This is in line with the proposition that molars have a relatively small impact on oral functions and quality of life [6, 39].

In this study, the vast majority of subjects having teeth replaced presented with FDP. This is in line with a recent study on laboratory production of prosthetic restorations in Bulgaria where it was concluded that the production of FDPs noticeably outnumbers the production of RDPs [40]. In the present study, satisfaction rates seemed to be higher among subjects having tooth replacement. The multivariate regression models based on dental configurations of natural teeth only ($Class^{N}$) demonstrated that subjects having teeth replaced are more likely to be satisfied than their counterparts without tooth replacement (Table 5). There is some evidence in the literature that tooth replacement may have a positive effect on quality of life and satisfaction [15, 16]. However, when the participants in the present study were reclassified on the basis of natural teeth plus teeth replaced by fixed or removable dentures, it became evident that subjects having teeth replaced tend to be less satisfied than subjects with corresponding dental configurations comprising natural teeth only. It appeared that dental configurations comprising both natural and artificial teeth do not provide

the same level of subjective satisfaction as equivalent dental configurations comprising natural teeth only. A study on the effect of treatment with FDP and RDP demonstrated that improvement in quality of life for a patient group does not reach the level of a control group [16]. In contrast, another study showed improvement of the quality of life in patients treated with RDP and FDP to a level similar of that of a control group already wearing a dental prosthesis [41]. Comparison between these previous studies and the present study, however, cannot be conclusive due to differences in the study design and the study populations. In the present study, a strong negative correlation was found between having teeth replaced by RDP and satisfaction with chewing function, which was not demonstrated for FDP (Tables 6 and 7). This corroborates the suggestion that artificial teeth added by removable dentures are not equivalent to natural teeth in terms of masticatory potential [42].

In the present study, the vast majority of subjects reported being satisfied with their chewing function. Although significant association was found between dental functional status and satisfaction with chewing, it should be recognized that being not satisfied with chewing might be due to signs and symptoms of temporomandibular disorders (TMD). It has been suggested that chewing ability is correlated with dysfunction of TMD patients [43]. The present paper is focusing on the relationship between satisfaction with chewing function and dental (occlusal) conditions. Several studies reported lack of evidence with respect to associations between occlusal factors (such as missing posterior teeth) and TMD problems [44–46]. In contrast, some studies associated higher risk for TMD problems with dentitions with asymmetric occlusal support [47, 48]. Based on these considerations, it was expected that TMD patients would be more or less equally distributed among the subjects as categorized by the hierarchical classification system and thus not biasing the results.

The feasibility of the hierarchical dental functional classification system has been previously demonstrated with respect to chewing ability and oral health-related quality of life in two Asian populations [25–27]. This study is the first to suggest that the ability of the classification system to display functionality is independent from the cultural context of the study participants. This study also demonstrates the capability of the classification system to discriminate between satisfied and not satisfied subjects. The dental conditions of the functional classification system predicted 66 % of the subjects correctly with respect to satisfaction with the dentition in general, 71 % with respect to satisfaction with dental esthetics, and 85 % with respect to satisfaction with chewing function. The present findings contribute to the feasibility of the hierarchical dental functional classification system and add to the validity demonstrated in the previous studies. Further investigation is needed to determine whether low levels of perceived satisfaction are paralleled by impairment of oral health-related quality of life.

Conclusions

Within the limitations of this study, it can be concluded that the dental condition in the hierarchical dental functional classification system that best discriminates between satisfied and not satisfied subjects is the presence of at least ten teeth in each jaw. Nevertheless, the separate dental conditions at anterior, premolar, and molar levels emerged as stronger correlates of perceived satisfaction than the condition of having more or less than ten teeth. Dental configurations comprising both natural and artificial teeth were less likely to provide the same level of satisfaction as equivalent dental configurations comprising natural teeth only. The present findings support the World Health Organization goal for oral health care, i.e. the retention throughout life of a natural functional dentition not requiring recourse to prosthesis.

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Conflict of interest The authors declare that they have no conflict of interest.

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