

# Dynamics of satisfaction with dental appearance among dentate adults: 24-month incidence

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Abstract – Introduction: Dental appearance comprises an important aspect of oral health and oral health-related quality of life (OHRQoL). However, no study has investigated the dynamics of satisfaction with dental appearance and other aspects of oral health using a longitudinal study design. The current study aimed to: (i) quantify longitudinal patterns of change in satisfaction with dental appearance, and (ii) identify the dynamic relationships between the changes in satisfaction with dental appearance and other dimensions of oral health (oral disease/tissue damage and oral disadvantage), taking sociodemographic factors into account. Methods: Data were taken from the Florida Dental Care Study (FDCS), a population-based longitudinal cohort study of oral health and OHRQoL. The sample included at baseline 873 subjects. Patterns of change in satisfaction with dental appearance during 24 months of follow-up were quantified. The dynamic relationships between the changes in satisfaction with dental appearance and other dimensions of oral health were evaluated. Results: During follow-up, 19-22% of the subjects were dissatisfied with dental appearance, depending on the time point of the interview. Onset of a certain oral health problem/condition or constantly having the problem/condition was associated with a lower likelihood of satisfaction improvement and a higher likelihood of deterioration. In comparison, recovery from a certain oral health problem/condition or not having the problem/condition was associated with a higher likelihood of improvement and a lower likelihood of deterioration. Conclusion: Change in satisfaction with dental appearance was substantially influenced by the dynamic changes in other aspects of oral health.

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# Introduction

Just as the definition of health is not merely the lack of disease, the concept of oral health also goes beyond the absence of oral disease. It should encompass physical, psychological, behavioral, and social components. Previous studies have shown that dental appearance comprises an important dimension of oral health and oral healthrelated quality of life (OHRQoL) (1, 2). Not only is dental appearance frequently employed by observers to evaluate a person's social status, personal characteristics, employment prospects, and intellectual competence (3–6), it also can play a critical role in a person's self-image, self-esteem, experiences in social interactions, and self-rated oral and psychological health (7–9). Therefore, having a pleasant dental appearance is a major concern for many people. In some cases, a desire to enhance facial appearance, rather than to improve physical function, is a key motivation for seeking certain types of dental treatment, such as prosthodontic

treatment (10), orthodontic treatment (11), and orthognathic surgery (12).

The literature does not provide consistent guidance about how older adults assess their dental appearance. Although some studies (13, 14) suggest that the expectation level for dental appearance remains low among old people, many researchers agree that appearance and physical attractiveness are of considerable importance to older adults' quality of life (15, 16), especially because an increasing proportion of aged people retain some of their natural teeth for life. Knowledge of satisfaction with dental appearance among middle-aged and older adults is essential to advance our understanding of OHRQoL among these segments of the population.

Previous studies have shown that the perception of dental appearance is associated with certain sociodemographic factors, such as age, gender, and education (13, 14, 17, 18). It is also significantly affected by the presence of some oral health problems/conditions, such as missing teeth, tooth displacement, bad tooth shape, and tooth discoloration (13, 14, 18, 19). However, those oral health problems/conditions included in most of the previous studies were measured using crosssectional study designs. There is a compelling need for identifying, measuring, and understanding health changes, because the ultimate goal of any healthcare intervention is to improve health status at either an individual or a population level. Locker (20) pointed out that there were three distinctive phases involved in the process of probing change in self-perceived oral health status: (i) to describe change; (ii) to identify predictors of change; and (iii) to explain change. Yet, cross-sectional study designs do not enable researchers to carry out comprehensive investigations of the dynamic change in self-perceived dental appearance. Longitudinal study designs are required.

To date, no longitudinal study has been conducted to assess the dynamic relationships between the changes in other oral health parameters and the changes in satisfaction with dental appearance among middle aged and older adults. To aid in identifying key factors that may dynamically affect people's satisfaction with dental appearance over a period of time, we propose a conceptual model shown in Fig. 1, which was adapted with revision from a multidimensional conceptual model of oral health and OHRQoL (21, 22). In the current model (Fig. 1), oral disease/tissue damage and oral disadvantage are two oral health dimensions with direct effects on satisfaction with dental appearance. The relationships between the dimensions in the conceptual model (Fig. 1) and its construct validity and predictive validity have been tested in previous analyses (23–27).

Using data from the Florida Dental Care Study (FDCS), a prospective longitudinal study of oral health and dental care conducted in north Florida, the current study aimed to: (i) quantify longitudinal patterns of change in satisfaction with dental appearance, and (ii) identify the dynamic relationships between the changes in satisfaction with dental appearance and other dimensions of oral health (oral disease/tissue damage and oral disadvantage), taking sociodemographic factors into account.

# Materials and methods

#### Sampling methods

The goal of the FDCS sampling design was to insure that a large number of persons at a hypothesized increased risk for oral health decrements would be included for the sample at baseline. Details of sampling methodology and selection are provided elsewhere (21,28). Briefly, however, a telephonic screening methodology was

*Fig. 1.* Conceptual model specifying relations between explanatory variables and satisfaction with dental appearance. Adapted with revision from the multidimensional conceptual model of oral health (21, 22).



used to identify persons who met eligibility criteria, from which a stratified random sample was selected to participate at baseline. The 873 subjects who participated at baseline resulted in a sample that was representative of the population of interest (28), defined as those who (i) were 45 years old or older, (ii) had a household telephone, (iii) did not reside in an institutional setting, (iv) resided in one of four counties in Florida, (v) could engage in a coherent telephone conversation, and (vi) had at least one tooth (one objective was to investigate tooth loss). Race and Hispanic ethnicity were queried separately; only non-Hispanic African-Americans and non-Hispanic Whites were included. At baseline, this sample had an interval since last dental visit that was similar to National Health Interview Survey (NHIS) data, and conclusions regarding its sociodemographic determinants were the same (28, 29). Additionally, the percentage that had one or more dental visits in the first 2 years of the FDCS, 77%, was very similar to the figure of 75% among the comparable group of NHIS respondents (28, 29). Informed consent was obtained using a protocol approved by the institutional review boards of the University of Alabama at Birmingham and the University of Florida.

## Data collection methods

Sociodemographic

Trained interviewers administered an in-person interview at baseline, which typically lasted about 30 min. Test–retest reliability of the interview questions were estimated afterwards and judged to be satisfactory (28). Immediately following the in-person interview, a clinical dental examination was conducted. Additional telephonic interviews occurred at the 6-, 12-, and 18-month points. At 24 months after baseline, another in-person interview was conducted and was followed immediately by a clinical examination identical to the one conducted at baseline. By 24 months, 764 persons remained in the study, of whom 723 participated in a clinical examination. Possible bias due to subject attrition has been evaluated elsewhere and found to be small (24, 25).

### Measures

Figure 1 was applied to structure our analysis. It specifies the hypothesized relations between satisfaction with dental appearance and other relevant dimensions of oral health and OHRQoL. Table 1 lists the corresponding variables measured at baseline and each 6-month follow-up. The actual wording and response categories of all questionnaire items can be found at the FDCS website at http://nersp.nerdc.ufl.edu/~gilbert/ question.htm.

Because the outcomes of interest in this study were the dynamic changes of satisfaction with dental appearance rather than the actual crosssectional measure of satisfaction at each interview point, and because an important objective of this study was to identify the dynamic relationships between the changes in satisfaction with dental appearance and the changes in other dimensions of oral health and OHRQoL, all original measures of satisfaction with dental appearance, oral disease/tissue damage, and oral disadvantage were recoded into dynamic measures to capture the changes that occurred between two adjacent

characteristics and approach to dental care	Oral disease/tissue damage	Oral disadvantage	Self-rated oral health
Age Gender Area of residence Race Level of formal education Ability to pay an unexpected \$500 dental bill Dental insurance status Typical approach to dental care	Has a sensitive tooth Has a broken filling Has a broken tooth or cap Has cavities Has a painful or abscessed tooth Has infected or sore gums Has bleeding gums Has a loose tooth Has a loose cap or bridge Has teeth that are stained/looked bad Has a problem with bad breath	Avoided laughing or smiling because of mouth problems Avoided talking because of mouth problems Been embarrassed by the appearance or bad health of mouth	Satisfaction with dental appearance

Table 1. Dependent and explanatory variables included in the current study

6-month interview points. We describe next how the dynamic measures were recoded from their original measures.

#### Satisfaction with dental appearance

Cross-sectional measure of satisfaction with dental appearance—Satisfaction with dental appearance was measured at baseline and at each 6-month follow-up interview using a four-point scale that asked subjects to rate their satisfaction as '4 = very satisfied', '3 = satisfied', '2 = dissatisfied', or '1 = very dissatisfied'.

Dynamic measures of satisfaction with dental appearance—Dynamic changes in satisfaction were recoded as 'improvement' or 'deterioration'. 'Improvement of satisfaction with dental appearance' was recoded as a dichotomous variable including two categories: '1 = improved' and '0 = other'. 'Improvement' was defined as reporting a higher level of satisfaction with dental appearance at the  $T_X$  interview than at the  $T_{X-1}$  interview (Fig. 2a). Because the higher response scales stand for higher levels of satisfaction with dental appearance, if a higher response scale was reported at the

 $T_X$  interview than at the  $T_{X-1}$  interview ( $S_X > S_{X-1}$ ), it was considered as having improvement, and coded as '1'. Otherwise, it was coded as '0'.

'Deterioration of satisfaction with dental appearance' was also recoded as a dichotomous variable to include two categories: '1 = deteriorated' and '0 = other'. 'Deterioration' was defined as reporting a lower level of satisfaction with dental appearance at the  $T_X$  interview than at the  $T_{X-1}$ interview (Fig. 2 Part A). Because the lower response scales stand for lower levels of satisfaction with dental appearance, if a lower response scale was reported at the  $T_X$  interview than at the  $T_{X-1}$  interview ( $S_X < S_{X-1}$ ), it was considered as having deterioration, and coded as '1'. Otherwise, it was coded as '0'.

#### Oral disease/tissue damage

Cross-sectional measures of oral disease/tissue damage—A broad range of self-reported measures of oral disease/tissue damage (as shown in Table 1) was gathered at baseline and each 6-month follow-up interview during the 24-month period. All measures were dichotomous with '1 = yes (having the problem)' and '0 = no'.

	Curren	nt int	erval	
Interview time	$T_{X-1}$		$T_X{}^a$	
Part A. Coding of changes in satis	faction	with	dental	appearance
Improvement of satisfaction with dental appearance (coded as "1")	$\mathbf{S}_{X-1}$	<	$S_X^{\ b}$	(A higher rating was reported at $T_X$ than $T_{X-1}$ )
Other (coded as "0")	$\mathbf{S}_{X-1}$	≥	$\mathbf{S}_{\mathbf{X}}$	(A lower or equal rating was reported at $T_X$ )
Deterioration of satisfaction with dental appearance (coded as "1")	$S_{X-1}$	>	$S_X$	(A lower rating was reported at $T_X$ than $T_{X-1}$ )
Other (coded as "0")	$\mathbf{S}_{X-1}$	≤	$S_{\rm X}$	(A higher or equal rating was reported at $T_X$ )
Part B. Coding of changes in oral d	lisease/l	tissu	e dama	age and oral disadvantage
Onset of the problem	0		1	(Has the problem at $T_X$ but not $T_{X-1}$ )
Recovery from the problem	1		0	(Has the problem at $T_{X-1}$ but not $T_X$ )
No change/has the problem	1		1	(Has the problem at $T_{X-1}$ and $T_X$ )
No change/does not have the problem	0		0	(Does not have the problem at $T_{X-1}$ and $T_X$ )

 $^aT_{X\cdot 1}$  and  $T_X$  refer to the time of the interviews. For example, if  $T_X$  is the 12-month interview point,  $T_{X\cdot 1}$  connotes the 6-month interview point.  $^bS_{X\cdot 1}$  connotes ratings of satisfaction with dental appearance reported at  $T_{X\cdot 1}$ , and  $S_X$  connotes ratings reported at  $T_X$ .

*Fig. 2.* Coding of changes in dependent and independent variables.

### Dynamic measures of oral disease/tissue

damage—Figure 2b depicts how the dynamic change variables were recoded. Within every 6month interval, changes in individual measures of oral disease/tissue damage could happen in four potential ways: onset of the problem, recovery from the problem, no change but still has the problem, and no change but still does not have the problem. Therefore, each original measure of oral disease/tissue damage was recoded into four mutually exclusive binary variables to reflect the changes between two adjacent interview points: (i) onset (1 = yes and 0 = no), defined as having the problem at the  $T_X$  interview, provided that the participants did not report the problem at the preceding  $T_{x-1}$  interview; (ii) recovery (1 = yes and 0 = no), defined as not having the problem at the  $T_{X}$  interview, provided that the participants reported the problem at the preceding  $T_{X-1}$  interview; (iii) no change/has the problem (1 = yes and 0 = no), defined as having the problem at both the  $T_{X-1}$  and  $T_X$  interviews; and (iv) no change/does not have the problem (1 = yes and 0 = no), defined as not having the problem at both the  $T_{X-1}$  and  $T_X$ interviews.

### Oral disadvantage

*Cross-sectional measures of oral disadvantage*—Oral disadvantage that is relevant to satisfaction with dental appearance was measured by three questions that asked participants whether they: (i) avoided laughing or smiling because of mouth problems; (ii) avoided talking because of mouth problems; or (iii) had been embarrassed by the appearance or bad health of their mouths. These three measures were also dichotomous with '1 = yes (having the problem)' and '0 = no'.

*Dynamic measures of oral disadvantage*—In a way similar to that illustrated in Fig. 2 Part B, four binary variables were created for each measure of oral disadvantage to capture the change between 6-month intervals: onset, recovery, no change/has the problem, no change/does not have the problem.

# Sociodemographic measures and approach to dental care

Sociodemographic measures and approach to dental care were recorded at baseline. Sociodemographic factors included: age (45–64 years old/65 years old or older), gender (male/female), area of residence (rural/urban), race (non-Hispanic African American/non-Hispanic White), level of formal education (did not graduate high school/graduated high school), ability to pay an unexpected \$500 dental bill (able to pay comfortably/able to pay but with difficulty/not able to pay), and dental insurance status (has dental insurance/no dental insurance). Approach to dental care was measured by asking participants to describe their 'typical approach to dental care' as: (i) 'I never go to a dentist'; (ii) 'I go to a dentist when I have a problem or when I know that I need to get something fixed'; (iii) 'I go to a dentist occasionally, whether or not I have a problem'; or (iv) 'I go to a dentist regularly'. Persons who responded number (i) or (ii) were classified as 'problem-oriented attenders', and those who responded number (iii) or (iv) were classified as 'regular attenders'. A supplemental table of subjects' sociodemographic characteristics is available at the FDCS website at http://nersp.nerdc.ufl.edu/ ~gilbert/supplemental.html.

## Statistical analysis

Data were weighted using the sampling proportions in order to reflect the population in the counties studied and to minimize the variance inflation resulting from sample design effects (28). Except where specified to the contrary, numbers and percentages shown in this report are weighted values.

The person-interval was the unit of analysis. One person participating for one 6-month interval constituted one person-interval. The 873 baseline participants ultimately experienced a total of 3290 person-intervals during the 24 months of follow-up (30). Cross-tabulations were used to describe the prevalence of satisfaction with dental appearance and the patterns of change during the 24 months.

Logistic regressions were conducted to model the probability of improvement of satisfaction with dental appearance and the probability of deterioration of satisfaction with dental appearance, respectively. Generalized estimating equations (GEE) were incorporated into the regressions to account for multiple person-intervals for the same individuals (GENMOD procedure) (31). Because the explanatory variables included multiple measures of oral health and sociodemographic characteristics, a blockwise analytic technique was adopted. In brief, three preliminary logistic regressions fitted with GEE were conducted in parallel to test sociodemographic characteristics, changes of oral disease/tissue damage, and changes of oral disadvantage, respectively. Only those variables that met an inclusion criterion (P < 0.2) in the individual regression analysis were retained in the final regression analysis.

Because we hypothesized that a person's initial satisfaction with dental appearance at the beginning of the interval would affect the probability of change within that interval, we included satisfaction with dental appearance at the  $T_{X-1}$  interview point as a control variable in the final models. Because people who reported 'very satisfied' were not eligible for future improvement, those people were excluded from the regression that modeled improvement. Similarly, people who reported 'very dissatisfied' were excluded from the regression that modeled deterioration.

Based on how the four binary variables were created for each measure of oral diseases/tissue damage and oral disadvantage, we hypothesized that 'no change/has the problem' would be least likely to affect the improvement of satisfaction with dental appearance. Therefore, the 'no change/has the problem' group was used as the reference group in the regression model of improvement. We also hypothesized that 'no change/does not have the problem' would have the least effect on the deterioration of satisfaction with dental appearance. Thus, the 'no change/does not have the problem' group was used as the reference group in the regression model of deterioration. All analyses were conducted in the SAS 9.1 environment (31). All comments about statistical significance in this report refer to probabilities of <0.05.

### Results

# Satisfaction with dental appearance over a 24-month period

Table 2 presents the consecutive prevalence of satisfaction with dental appearance at each of the interviews conducted during 24 months of follow-up. About 24% of subjects reported they were 'dissatisfied' or 'very dissatisfied' with their dental appearance at baseline, and approximately 19–22% reported so at the follow-up interviews.

# Patterns of changes in satisfaction with dental appearance over a 24-month period

Table 3 shows the incidence of change in satisfaction with dental appearance across each 6-month interval. The incidence rates of improvement of satisfaction with dental appearance ranged from 16% to 21%, depending on the interval. The incidence rates of deterioration of satisfaction with dental appearance ranged from 16% to 19%, depending on the interval.

Satisfaction with dental appearance	Baseline interview (n = 873)	6-month interview $(n = 856)$	12-month interview $(n = 829)$	18-month interview ( <i>n</i> = 817)	24-month interview ( <i>n</i> = 788)
Weighted <i>n</i> (%)					
4 = very satisfied	208 (24.0)	207 (24.3)	198 (24.0)	182 (22.4)	186 (23.6)
3 = satisfied	451 (52.1)	457 (53.4)	444 (53.8)	471 (57.8)	454 (57.8)
2 = dissatisfied	158 (18.2)	155 (18.2)	155 (18.9)	129 (15.8)	114 (14.5)
1 = very dissatisfied	50 (5.7)	35 (4.1)	28 (3.4)	33 (4.0)	33 (4.2)

Table 2. Prevalence of satisfaction with dental appearance over a 24-month period

Table 3. Dynamic changes in satisfaction with dental appearance over a 24-month period

Changes in satisfaction with dental appearance over a 24-month period	Interval $1^a$ ( $n = 856$ )	Interval $2^{b}$ ( $n = 829$ )	Interval $3^{c}$ ( $n = 817$ )	Interval $4^d$ ( $n = 788$ )
Weighted <i>n</i> (%)				
Improvement of satisfaction with denta	l appearance			
$\hat{1} = \text{yes}$	179 (21.1)	142 (17.2)	129 (15.9)	148 (19.0)
0 = no	668 (78.9)	683 (82.8)	683 (84.1)	631 (81.0)
Deterioration of satisfaction with dental	appearance			
1 = ves	163 (19.2)	131 (15.9)	138 (17.0)	146 (18.7)
0 = no	685 (80.8)	694 (84.1)	673 (83.0)	633 (81.3)

<sup>a</sup>Interval 1 refers to the interval between baseline and 6 months.

<sup>b</sup>Interval 2 refers to the interval between 6 months and 12 months.

<sup>c</sup>Interval 3 refers to the interval between 12 months and 18 months.

<sup>d</sup>Interval 4 refers to the interval between 18 months and 24 months.

	- 7	
Satisfaction with dental appearance at $T_{X-1}$ (number of person-intervals <sup>b</sup> )	Changes in satisfaction with dental appearance at T <sub>X</sub>	Person-interval (%)
Very satisfied	Improved	Not eligible
(n = 772)	Same	464 (60.1)
	Deteriorated	308 (39.9)
Satisfied	Improved	279 (15.7)
(n = 1776)	Same	1277 (71.9)
	Deteriorated	220 (12.4)
Dissatisfied	Improved	247 (42.8)
(n = 577)	Same	280 (48.5)
	Deteriorated	50 (8.7)
Very dissatisfied	Improved	72 (52.2)
(n = 138)	Same	66 (47.8)
	Deteriorated	Not eligible

Table 4. Changes in satisfaction with dental appearance between  $T_{X\mathchar`l}$  and  $T_X{}^a$ 

<sup>a</sup> $T_{X-1}$  and  $T_X$  refer to the time of the interviews.

<sup>b</sup>Total person-intervals = 3290; missing person-intervals = 27.

Table 4 presents the overall changes in all intervals (intervals between any  $T_{X-1}$  and  $T_X$  interviews), stratified by satisfaction with dental appearance at the beginning of the interval (i.e. at the  $T_{X-1}$  interview). A total of 772 person-intervals reported 'very satisfied' with dental appearance at the  $T_{X-1}$  interview. These person-intervals were not eligible for improvement at the  $T_X$  interview. Among these, nearly 40% reported a deteriorated satisfaction with dental appearance at the  $T_X$ interview. A total of 1776 person-intervals reported 'satisfied' with dental appearance at the  $T_{X-1}$ interview. Among these, nearly 16% reported improved satisfaction with dental appearance at the  $T_X$  interview, while about 12% experienced deterioration. Among 577 person-intervals that reported 'dissatisfied' with dental appearance at the T<sub>X-1</sub> interview, nearly 43% reported improvement and nearly 9% reported deterioration at the  $T_X$  interview. The 138 person-intervals that reported 'very dissatisfied' with dental appearance at the  $T_{X-1}$  interview were not eligible for 'deterioration' at the  $T_X$  interview. Nearly 48% of these reported improved satisfaction with dental appearance at the  $T_X$  interview.

# *Results for 'improvement of satisfaction with dental appearance'*

Table 5 shows the results from the final logistic regression of 'improvement of satisfaction with dental appearance'. The results point out that

persons who were more satisfied with their dental appearance at the preceding  $(T_{X-1})$  interview were less likely to report improved satisfaction at the following  $(T_X)$  interview (OR = 0.10, P < 0.001). 'Ability to pay' and 'approach to dental care' were the only sociodemographic factors that were significantly associated with improvement in satisfaction. People who reported being able to comfortably pay an unexpected \$500 dental bill and those who were regular dental attenders were more likely to report improved satisfaction than their respective counterparts (OR = 1.70, P = 0.013; OR = 1.51, P = 0.011).

The results suggest that the changes in oral disease/tissue damage affect the likelihood of improvement in satisfaction. Compared with people who reported a broken filling at both the  $T_{X-1}$ and  $T_X$  interviews, those who experienced a new onset of such a problem at the  $T_X$  interview were less likely to experience improved satisfaction with dental appearance (OR = 0.30, P = 0.006). Compared with people who had a broken tooth or cap at both interviews, those who recovered from the problem and those who did not have such a problem at each interview were more likely to report improved satisfaction with dental appearance (OR = 1.77, P = 0.026; OR = 1.60, P = 0.034, respectively). Similarly, people who recovered from the problem of stained or bad-looking teeth and people who did not have such a problem were significantly more likely to report improved satisfaction with dental appearance (OR = 2.16, P = 0.002 and OR = 2.37, P < 0.001, respectively).

Changes in oral disadvantage also were significantly associated with the likelihood of improvement. People who recovered from the problem of being embarrassed by the appearance or bad health of mouth and those who did not have such a problem were more likely to report improved satisfaction (OR = 1.95, P = 0.047 and OR = 1.96, P = 0.021, respectively).

# Results for 'deterioration of satisfaction with dental appearance'

Table 6 shows the results from the final logistic regression of 'deterioration of satisfaction with dental appearance'. Persons who were more satisfied with their dental appearance at the preceding  $(T_{X-1})$  interview were more likely to report deteriorated satisfaction at the following  $(T_X)$  interview (OR = 12.03, *P* < 0.001). People who resided in urban areas were less likely than those living in rural areas to report deteriorated satisfaction with

Table 5.	Logistic	regression	analysis of	'improv	ement of	satisfaction	with d	lental a	ppearance'
	- 0	0							

Covariate	Odds ratio (95% confidence interval)	<i>P</i> -value
-		
Intercept		< 0.001
Satisfaction with dental appearance at the $T_{X-1}$ interview <sup>a</sup>		0.001
Satisfied	0.10 (0.07-0.14)	< 0.001
Dissatisfied/very dissatisfied	-	
Sociodemographic factors		
Able to pay an unexpected \$500 dental bill		
Able to pay comfortably	1.70 (1.12–2.58)	0.013
Able to pay but with difficulty	1.21 (0.85–1.73)	0.279
Not able to pay	-	
Approach to dental care		
Regular attender	1.51 (1.10–2.08)	0.011
Problem-oriented attender	-	
Oral disease/tissue damage		
Has a broken filling		
Onset	0.30 (0.12–0.71)	0.006
Recovery	0.78 (0.34–1.78)	0.559
No change/does not have the problem	0.64 (0.31–1.33)	0.235
No change/has the problem	_	
Has a broken tooth or cap		
Onset	1.53 (0.88–2.65)	0.132
Recovery	1.77 (1.07–2.92)	0.026
No change/does not have the problem	1.60 (1.04–2.48)	0.034
No change/has the problem	_	
Has teeth that were stained or looked bad		
Onset	0.69 (0.41–1.16)	0.161
Recovery	2.16 (1.34–3.49)	0.002
No change/does not have the problem	2.37 (1.58–3.57)	< 0.001
No change/has the problem	_	-
Oral disadvantage		
Been embarrassed by the appearance or bad health of mouth	L	
Onset	0.99 (0.53-1.84)	0.966
Recovery	1.95 (1.01–3.79)	0.047
No change/does not have the problem	1.96 (1.11–3.48)	0.021
No change/has the problem	_	_

<sup>a</sup>Person-intervals that reported 'very satisfied' at the  $T_{X-1}$  interview were excluded because they were not eligible for improvement at the  $T_X$  interview.

dental appearance (OR = 0.69, P = 0.002). Compared with people who did not have the problem of stained or bad-looking teeth at both the  $T_{X-1}$  and T<sub>X</sub> interviews, those who reported an onset of such a problem at the  $T_X$  interview and those who constantly had the problem were more likely to experience deteriorated satisfaction with dental appearance (OR = 2.39, P < 0.001 and OR = 2.24, P < 0.002, respectively). Compared with people who did not have the problem of avoiding laughing and smiling all the time, those who reported an onset of the problem at the  $T_{\boldsymbol{X}}$  interview and those who constantly had the problem were more likely to report deteriorated satisfaction (OR = 2.25, P = 0.015 and OR = 3.06, P = 0.009, respectively). People who recovered from the problem of avoiding talking were significantly less likely to report deteriorated satisfaction than those who did not have the problem (OR = 0.49, P = 0.045). People who experienced an onset of the problem of being embarrassed by the appearance or bad health of mouth and those who reported the problem at both interviews were more likely to report deteriorated satisfaction (OR = 4.22, P < 0.001 and OR = 10.39, P < 0.001, respectively).

### Discussion

Dissatisfaction with dental appearance was common. Approximately 24% of subjects reported being 'dissatisfied' or 'very dissatisfied' with their dental appearance at baseline. During the 24 months of follow-up, from 19% to 22% of the subjects were 'dissatisfied' or 'very dissatisfied' with dental appearance, depending on the time

#### Meng et al.

Table 6	Lociatio	magnesian	amalaria	<b>_</b> f	(deterioretion	~ 6	anticfaction.		dontal		,
Table 0.	LUgistic	regression	ana1y 515 (	01	ueterioration	01	Satisfaction	vv 1t11	uemai	appearance	

	Odds ratio	
Covariate	(95% confidence interval)	<i>P</i> -value
Intercept		< 0.001
Satisfaction with dental appearance at the $T_{X-1}$ interview <sup>a</sup>		
Satisfied/very satisfied	12.03 (7.82–18.51)	< 0.001
Dissatisfied	_	
Sociodemographic factors		
Area of residence		
Urban	0.69 (0.54–0.87)	0.002
Rural	_	
Oral disease/tissue damage		
Has teeth that were stained or looked bad		
Onset	2.39 (1.60–3.56)	< 0.001
Recovery	0.98 (0.66–1.46)	0.925
No change/has the problem	2.24 (1.35–3.73)	0.002
No change/does not have the problem	-	
Oral disadvantage		
Avoided laughing or smiling because of mouth problems		
Onset	2.25 (1.17-4.30)	0.015
Recovery	1.36 (0.77–2.39)	0.285
No change/has the problem	3.06 (1.33–7.05)	0.009
No change/does not have the problem	-	
Avoided talking because of mouth problems		
Onset	0.59 (0.27–1.26)	0.172
Recovery	0.49 (0.25–0.98)	0.045
No change/has the problem	0.75 (0.28–2.02)	0.573
No change/does not have the problem	-	
Been embarrassed by the appearance or bad health of mouth		
Onset	4.22 (2.31–7.71)	< 0.001
Recovery	1.12 (0.55–2.29)	0.749
No change/has the problem	10.39 (4.02–26.80)	< 0.001
No change/does not have the problem	-	

<sup>a</sup>Person-intervals that reported 'very dissatisfied' at the  $T_{X-1}$  interview were excluded because they were not eligible for deterioration at the  $T_X$  interview.

point of the interview. We also observed in this study that people's satisfaction with dental appearance was dynamic. The 6-month incidence of improvement was similar to the magnitude of deterioration during the 24 months of follow-up, ranging from 16% to 21% at different intervals. It is difficult to compare results across different studies because different measures of self-perceived dental appearance have been adopted. For example, a question on the Oral Health Impact Profile (OHIP) asks 'how often have you felt uncomfortable about the appearance of your teeth, mouth, or denture?' (32) and a question on the Geriatric Oral Health Assessment Index (GOHAI) queries 'How often were you pleased or happy with the looks of your teeth and gums, or dentures?' (33). If we treated the OHIP answers 'very often/fairly often/ occasionally' and the GOHAI answers 'sometimes/seldom/never' as proxies for being dissatisfied with dental appearance, then the prevalence of dissatisfaction in the current study would be similar to but slightly lower than those findings (23% and 28%, respectively) (32, 33).

To our knowledge, this is the literature's first report of longitudinal data on how changes in other aspects of oral health are associated with changes in satisfaction with dental appearance. In this study, the modified multidimensional concept model of oral health and OHRQoL was applied to guide the analysis. Our results show that this model identified well the key predicting factors in each dimension. Changes in oral disease/tissue damage and oral disadvantage were significantly associated with change in satisfaction with dental appearance. As a general rule, onset of a certain oral health problem or constantly having the problem was associated with a lower likelihood of satisfaction improvement and a higher likelihood of deterioration. In comparison, recovery from a certain oral health problem or not having the problem was associated with a higher likelihood of experiencing improvement and a lower

likelihood of reporting deterioration. Previous cross-sectional studies (13, 14, 34, 35) found that tooth discoloration negatively affects people's perception of dental appearance. In this longitudinal study, dynamic changes of the problem of stained teeth were also found to be significantly associated with both positive and negative changes in satisfaction with dental appearance. The correlations noted in this study are consistent with the notion that tooth color is of considerable importance in dental esthetics.

People's ability to pay for unexpected dental care and dental care attendance type have been commonly reported as being associated with oral health outcomes (27, 36). Our results show that ability to pay a dental bill comfortably and being a regular dental care attender significantly predicted a higher likelihood of improvement. We also found that urban residents had a lower risk for decline in satisfaction with dental appearance than rural residents. Studies using national survey data have documented that rural residents on average had less adequate dental care utilization and poorer oral health status than their urban counterparts (37, 38).

Several methodologic issues merit further discussion. A limitation of this study is that only baseline sociodemographic characteristics were included in the analysis. Some sociodemographic circumstances, such as income, insurance status, typical approach to dental care, and residence area, are changeable over time. Accounting for change in such sociodemographic factors may better predict the change in satisfaction with dental appearance. Additionally, various measures have been used to assess the self-perceived dental appearance, but the field provides no clear definition of the underlying concepts. In this study, a single-item assessment was used to evaluate people's global satisfaction with dental appearance. The advantages of using this single-item measure are that it evaluates the overall satisfaction level and is easy to administer. Nevertheless, a single-item global assessment may under-represent complex underlying dimensions. For example, satisfaction with dental appearance seems to be an outcome of a complex self-evaluation process, which is not only determined by physical esthetics and oral health indicators, but which is also influenced by personal expectations, importance assigned to dental appearance, and other psychosocial traits.

Change in satisfaction with dental appearance was measured in this study by comparing responses made during interviews separated by six months in time, which may be less sensitive to frequent within-subject changes. In addition, ceiling and floor effects may be a relevant methodologic issue (20, 39, 40). Ceiling effects exist when a score reaches a maximum extreme, while floor effects exist when a score reaches a minimum extreme. Therefore, improvement change for people who reported 'very satisfied' with dental appearance, and deterioration change for those who reported 'very dissatisfied', could not be detected. In both situations, there was only one direction in which subsequent measurements can change - to the middle. Table 4 demonstrates that people who reported extreme scores at the preceding  $(T_{X-1})$  interview were more likely to experience change in the opposite direction at the following  $(T_{\chi})$  interview than those who reported middle scores. This trend is also implied by the logistic regression results (Tables 5 and 6). Although the main focus of the current study was to investigate the relationship between changes in other selfreported oral health parameters and change in satisfaction with dental appearance, it is possible that bias was introduced because relevant factors were not measured.

Because of the introduction of preventive dentistry and improved dental awareness in the general public, the overall prevalence of tooth loss and complete edentulism has been steadily declining over the past decades in the United States, with more people retaining at least some of their natural teeth for life (41). Dental appearance may be a more important component of oral health in future generations. Therefore, how to improve or maintain people's dental appearance may be an increasing challenge to dental professionals in the future. A previous study has shown that dental professional evaluations of dental appearance may not be concordant with patients' subjective perceptions (18). Given this discordance, knowing how satisfaction with dental appearance changes over time and the factors associated with these changes may help health professionals improve patients' satisfaction with dental appearance.

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#### Dynamics of dental appearance satisfaction

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