# Demonstrating Successful Aging Using the International Collaborative Study for Oral Health Outcomes

**Kathryn A. Atchison, DDS, MPH; Ronald M. Andersen, PhD**

**Abstract**

*As the lifespan increases and people are faced with 15 to 20 years of "old age," we ask what one considers successful aging with respect to oral health. We propose a comprehensive combination of outcome variables, maintenance of teeth, manageable periodontal condition, positive perceived oral health, satisfaction with their access to and receipt of dental services, and minimal functional problems, that together comprise a definition of successful aging. The International Collaborative Study for Oral Health Outcomes provides a data set for exploring the oral health of a diverse sample of older adults in US and international sites using the modified Andersen Behavioral Model. The percent of adults who report no natural teeth ranged from 16 percent in San Antonio to 59 percent in New Zealand. Seventy percent or more of the adults from each site rated their oral health as good/fair or better except in Poland. The current cohort of older adults is faring better on some indicators than others; nevertheless, ethnic minorities and poorer countries still demonstrate inequities. Dentistry must attempt to educate individuals early in their lifespan that a combination of personal oral health practices and current dental techniques offers the potential for successful oral health throughout one's lifetime. [J Public Health Dent 2000;60(4):282-88]*

*Key Words: aging, perceived oral health, geriatric dentistry.*

When we look at a healthy man aged 65 years in 1999, we see a man with an additional 15 years of life before him, of which approximately 13 years will involve independent living, one hopes in "good" health. Similarly, a 65-year-old woman can look forward to 20 more years of life, of which 16 will be independent and in good health. Today's longevity causes us to ponder the implications for oral health. What constitutes "successful aging" for oral health? Are specific groups faring better than others? How can dentistry contribute to successful aging of older adults?

Examples of "social norms" for successful oral health include advertisements that show healthy individuals with full complements of natural, straight, white teeth. Authors of novels or motion pictures use decayed, discolored, crooked teeth as classic descriptors of poorly educated, economically disadvantaged individuals. All seem to promote retention of healthy, esthetic teeth as "successful oral health at any age."

Within the professional dental literature, specified outcome measures have been challenged, rethought, and redefined repeatedly during the past decade. Historical dental literature used epidemiologic measures to describe individual diseases as components of oral health, such as dental decay, periodontal disease, or oral cancer mortality. Coulter et al. (1) argued for a new paradigm for measuring oral health status, one that is comprehensive and considers health rather than disease. More recent literature has accepted such a structure and advanced to the concept of quality of life, while incorporating patient perceptions of oral health and physical and role functioning as critical to understanding the individual's oral condition (2). Yet even these advances probably are not sufficient to allow one to measure an individual's oral health as a component of "successful aging" as opposed to a snapshot of oral health.

The World Health Organization defines health as "a state of complete physical, mental, and social well-being and not only the absence of disease and infirmity" (3). One can argue, however, that the objective of achieving health requires a cooperative effort of the professional and the individual. Thus, to achieve "successful oral health aging," one must have not only acceptable oral health, but also access to professional dental services, as well as a positive feeling about the dental care received.

The objective of this analysis is to propose a model of successful aging for oral health utilizing data from the second International Collaborative Study for Oral Health Outcomes to explore successful aging among a diverse sample. The ICS-II data set was chosen because of the comprehensive model of patient characteristics that directed the data collection and the combination of perceived and evaluated oral health outcome measures incorporating not only oral health, but also access to dental care and satisfaction with dental treatment.

## Methods

The study uses data from the International Collaborative Study of Oral Health Outcomes (ICS-II), a large-scale research project examining the impact of sociodemographic, environmental, and delivery system factors on the oral health of a diverse sample. While we have relied heavily on the

Send correspondence and reprint requests to Dr. Atchison, UCLA School of Dentistry, 10833 Le Conte Avenue, Room 53-028, Box 951668, Los Angeles, CA 90095-1668. E-mail: kathya@dent.ucla.edu. Dr. Andersen is affiliated with UCLA's School of Public Health. The ICS-II was conducted by the World Health Organization and the Center of Health Administrative Studies, University of Chicago. The study of Age and Ethnic Differences was supported by the Agency for Health Care Policy and Research and the National Institute for Dental Research. Paper presented as part of the satellite symposium "Successful Aging through Oral Health," Vancouver Island, British Columbia, March 14–16, 1999, organized by the Geriatric Oral Research Group of the International Association for Dental Research.

published reports of the ICS-II data, original data analysis also was conducted on the United States sites. The overall methods and results for the ICS-II study are published elsewhere (4-10). We will describe briefly the methods for the ICS-II.

Probability samples were chosen of three age groups: children aged 12–13 years, adults aged 35–44 years, and older adults aged 65–74 years. This analysis deals only with the two groups of adults. Three US research locations and four international research sites were chosen. The three sites chosen in the United States represent five distinct ethnic groups: whites from Baltimore and San Antonio; African-Americans from Baltimore; Hispanics from San Antonio; Navajo from the Indian Health Service (IHS) Shiprock, New Mexico, and Chinle, Arizona, Indian reservations; and Lakota from the Pine Ridge and Rosebud, South Dakota, IHS reservations. The international sites included New Zealand; Lodz, Poland; Erfurt, Germany; and Yamanashi, Japan. Exact sampling frames differed by site and are described in depth elsewhere (5,10).

Social surveys were conducted from 1988 to 1992 using face-to-face interviews regarding oral health and oral health services use for a one-year period. Participants were then invited to have a clinical examination at a later time to gather information on the subject's clinical oral health status. Not all subjects had both a social survey and a clinical examination. Only social survey data will be used for the original analysis in this manuscript.

**Conceptual Model.** A comprehensive approach based on the Andersen model of dental health outcomes was used for variable selection (Figure 1). The model includes predisposing sociodemographics, oral health beliefs, enabling, oral health need, and oral health behavior variables as described earlier (4). Predisposing sociodemographic variables consist of age cohort (35–44 or 65–74 years), ethnic group, sex, years of education, marital status, and perceived general health rating.

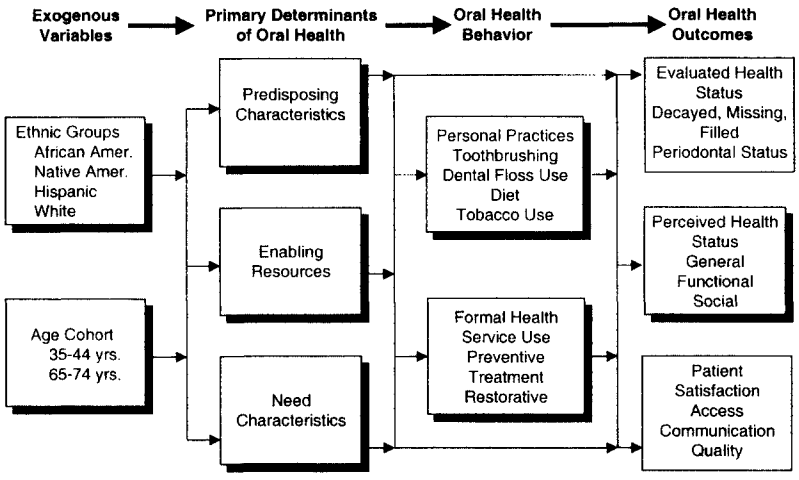
Eighteen oral health belief items included in the ICS-II questionnaire were reduced to five dimensions, plus three additional single items (11). The factors include seriousness of oral health, importance of oral health, benefit of prevention, benefit of plaque control, and efficacy of dentists. Three additional items are: not afraid to go to the dentist, perceiving that dentists are available when I have a dental problem, and being willing to visit the dentist when having a problem, no matter how busy I am. Thus, eight oral health belief variables were used in these analyses.

The enabling resources include reported income (in quartiles), usual source of dental care, and dental insurance. For IHS respondents, insurance was defined as beyond that provided by IHS, as all individuals were already covered for IHS dental services. Oral need items include the presence of oral pain within the past three months and a symptom inventory, summing the number of positive responses to four questions that asked about gums that hurt, chipped teeth, sore mouth, and bad breath. The oral health behaviors block includes three variables: one or more dental visits, not smoking, and consuming junk foods.

**Optimal Measures of Successful Aging for Oral Health.** We propose a set of indicators of successful aging that take into account dental disease, the individual's perceived oral health and quality of life, and measures of the individual's satisfaction with his or her interaction with the dental system. These indicators should be aspirational; that is, they consider a positive heath state attainable over the course of a lifetime given the knowledge and technology available to the profession and educated public in the late 1990s. These indicators are that an older person should: have some, if not most. natural teeth present; have manageable periodontal health; perceive his or her oral health to be good or excellent; be satisfied with his or her dental care and able to procure dental services when desired or needed; have acceptable physical functioning; and be able to participate in usual social roles.

**Data Analysis.** The object of this analysis is to compare different age groups and different racial/ethnic groups to see how they fare with respect to the indicators proposed above. Comparisons will be made using published data from the ICS-II study and some comparisons from ICS-I studies that took place between 1973 and 1980 (5-9,12). Differences in mean perceived oral health by age and ethnic group are measured using *T*-tests. An original multiple logistic regression analysis is conducted for each of the US sites following the Andersen model to determine the variables associated with the dependent variable, self-reported natural teeth present. For each model the analysis is conducted twice. The analysis is conducted once in the SAS least squares regression program to determine the standardized estimates for the predictors and the adjusted $R^2$ for the overall model (13). The analysis is also conducted in SUDAAN (14) to account for complex and multiple sampling designs in the three research locations and to obtain accurate values and standard errors for the variables significance.

**FIGURE 1**
**ICS-II USA Conceptual Framework (Ref. 4)**



## Results

**Maintenance of Natural Teeth.** As evidence that improvement has been made in "successful aging," one can look for a decrease in the percent of adults who lose all of their natural teeth. Two comparisons can be made regarding the percent of adults who reported having no remaining natural teeth, a comparison of the percent of edentulous 35–44-year-old adults in ICS-I to the percent of edentulous 65–74-year-old adults in ICS-II. This comparison could be considered a rough cohort comparison because ICS-I data was gathered approximately 15 years earlier than the ICS-II data. The cohort comparison will give an estimate of the proportion of adults who lose all of their teeth over the 15-year time frame, where a small increase in the percentage of edentulous 65–74-year-old adults would be an indicator of successful aging. This comparison can be made for four sites: Baltimore, USA; Lodz, Poland; Erfurt, Germany; and New Zealand. Among 35–44-year-olds in Baltimore, 11 percent were edentulous in ICS-I and 23 percent of 65–74-year-olds were edentulous in ICS-II, an increase of 12 percent (Table 1). Only 1 percent of adults was edentulous in the two European countries in ICS-I, increasing to 42 percent in Poland and 29 percent in Germany of the older adults in ICS-II. New Zealand had the largest edentulousness rates in both age groups, with 35û44-year-olds in ICS-I having a rate of 28 percent and ICS-II older adults 59 percent. Poland and Germany seemed to be quite successful with respect to limiting total tooth loss through middle age; however, the relatively large increase by age 65–74 years suggests less than successful aging. While the Baltimore population had larger edentulous rates than Germany and Poland for the middle-aged group, it might be viewed as aging somewhat more successfully because the increase in edentulousness (12%) was the least among all sites. New Zealand was least successful in maintaining teeth for the middle aged group and the incidence of edentulousness increased by 31 percent for 65–74-year-old adults.

Similarly, one can compare the percent of 35–44-year-old adults in ICS-I to the percentage of 35–44-year-old adults in ICS-II who are edentulous. This comparison will estimate any improvement in oral health knowledge or access that resulted during the time lapse. In the three countries with data from both time periods, only one percent of adults reported themselves to have no remaining teeth in ICS-II, suggesting quite successful aging and

**TABLE 1**
**Percent of Edentulous Adults (Ref. 10)**

| | 35–44 Years Old | | 65–74 Years Old |
|---|---|---|---|
| Site | ICS-I | ICS-II | ICS-II |
| Baltimore, MD | 11 | 1 | 23 |
| Indian Health Service | — | 3 | 42 |
| San Antonio, TX | — | 1 | 16 |
| Lodz, Poland | 1 | 1 | 42 |
| Erfurt, Germany | 1 | 1 | 29 |
| New Zealand | 28 | 18 | 59 |

**TABLE 2**
**Multivariate Logistic Regression Analysis: Comprehensive Model of Having One or More Teeth by Research Location for Older Adults (65–74 Years of Age)**

| | Odds Ratios | | |
|---|---|---|---|
| | Baltimore ($n$=708) | IHS ($n$=735) | San Antonio ($n$=405) |
| Predisposing sociodemographics | | | |
| Ethnic group† | –0.39* | –0.38* | –0.23* |
| Sex (male) | 1.08 | 2.10* | –0.98 |
| Years of education | 1.10* | –0.98 | 1.07 |
| Married (yes) | 1.19 | –0.98 | 1.10 |
| Perceived general health‡ | –0.84 | –0.90 | –0.81 |
| Predisposing health beliefs | | | |
| Seriousness of oral disease | –0.90 | –0.92 | 1.42* |
| Benefit of prevention | 1.20 | 1.11 | 1.11 |
| Benefit of plaque control | –0.95 | 1.06 | –0.90 |
| Efficacy of DDS | 1.22 | –0.84 | 1.05 |
| Importance of oral health | –1.00 | 1.11 | 1.11 |
| Not afraid of DDS/pain | –0.86 | –0.71* | –0.65 |
| Not too busy to visit | –0.72 | 1.10 | –0.63 |
| DDS available | 1.59* | –0.86 | –0.79 |
| Enabling resources | | | |
| Income (in sextiles) | 1.07 | 1.40* | 1.11 |
| Usual source (yes) | 1.20* | –0.77 | 2.99* |
| Insurance | 0.74 | –0.99 | –0.86 |
| Oral need | | | |
| Oral pain | –0.93 | 2.65* | –0.50 |
| Number of oral symptoms | 1.74* | 1.50* | 1.80* |
| Oral health behaviors | | | |
| One or more visits | 6.84* | 3.14* | 3.89* |
| Smoke cigarettes | –0.73 | –0.71 | –0.95 |
| Number of junk foods eaten | –0.74* | –0.78* | 1.23 |
| Multiple $R^2$ | 0.32 | 0.24 | 0.27 |

*$P$<.05
†Ethnicity: Baltimore, 1=white, 2=African-American; IHS, 1=Lakota, 2=Navaho; San Antonio, 1=white, 2=Hispanic.
‡General health: 1=excellent to 6=very poor.

substantial improvement for Baltimore where the percent edentulous decreased from 11 percent to 1 percent. The final site, New Zealand, showed improvement from 28 percent in ICS-I to 18 percent in ICS-II, but still has considerable room for improvement compared to the other sites.

Table 2 shows the standardized beta coefficients from the multivariate modeling of individuals who report having some natural teeth for the four blocks of independent variables (predisposing variables, enabling resources, oral need variables, and behaviors) for the three US sites for ICS-II. Baltimore whites, Navajo, and San Antonio whites were more likely to report having one or more natural teeth. Being male was associated with having teeth for the members of the Indian nations and having more years of education was associated with having teeth for Baltimore subjects. Few predisposing health beliefs were significantly associated with having teeth. Enabling variables were associated for each site, income for the Indian nations, and having a usual source of care for the Baltimore and San Antonio subjects. Both oral need variables showed association in at least one site, with a greater number of oral symptoms among those with natural teeth. Among behavioral variables, having one or more recent visits and, in two sites, not eating a lot of junk food were positively associated with having natural teeth.

**Manageable Periodontal Disease.** Another variable deemed an important marker of oral health and successful aging, particularly with recent evidence that periodontal condition is linked with systemic conditions, is having good, or at least manageable, periodontal status. Table 3 shows the periodontal condition for younger and older adults examined for ICS-II in the seven geographic sites (10). Three categories are provided: those who are healthy, those with one or more sites of pocketing of 4–5 mm, and those with one or more sites of pocketing of greater than or equal to 6 mm. Two other categories from the published ICS-II study—bleeding and calculus—were excluded from the model. For younger adults, the percentages with healthy periodontium ranged from 2 percent in Germany to 11 percent in Baltimore. For older adults, between 1 percent and 14 percent of the older adults were rated as healthy. On the other end of the disease spectrum, a minority of adults in both age groups were rated as having more severe periodontal problems—that is, periodontal pockets that were at least 6 mm. For younger adults (35–44 years of age), the percentages ranged from 3 percent in Germany to 28 percent for the Lakota residents of the Indian reservations. For older adults 65–74 years of age, the percentages were similar to the younger age group, ranging from 5 percent in Poland to 25 percent among the Lakota adults. Apart from the Indian nations, the percentage of individuals with severe periodontal pockets was around 10 percent or less in both age groups.

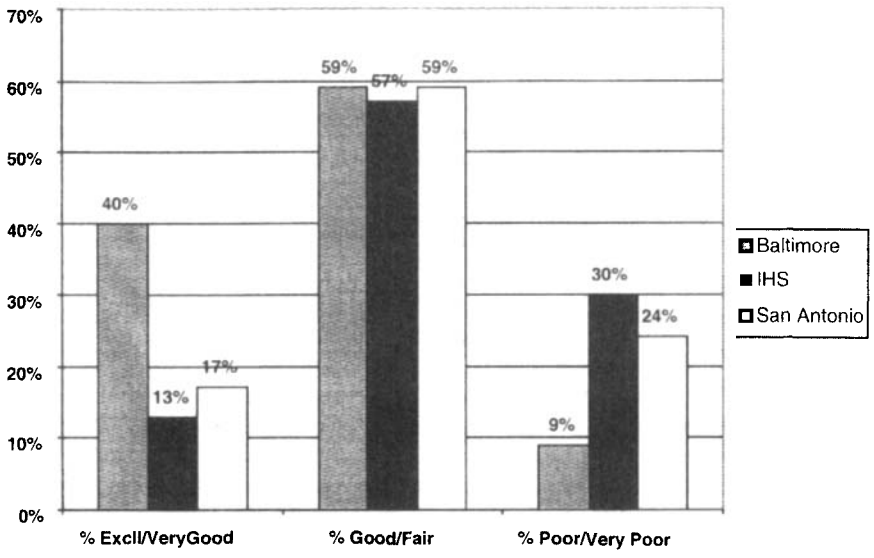
Conclusions about correlates of periodontal problems proved difficult (data not shown). Although the evidence was not consistent across all groups, there was some evidence that men were more likely than women to have deep pocketing (greater than or equal to 6 mm) (10). Increased education was correlated with decreased periodontal problems only in the middle-aged Navajo site; the opposite was found in the older age group in Erfurt, Germany, where higher education was associated with higher proportions of deep pocketing. Among the enabling variables, income differences were not significant in any of the older adult samples and having a usual source of care suffered from a small

**TABLE 3**
**Periodontal Status of Dentate ICS-II Adults Expressed as Percent of Sample* (Ref. 10)**

| | 34–44 Years Old | | | 65–74 Years Old | | |
|---|---|---|---|---|---|---|
| | Healthy | Pocket 4–5 mm | Pocket >6 mm | Healthy | Pocket 4–5 mm | Pocket >6 mm |
| Baltimore, MD | 11 (1) | 17 (3) | 5 (1) | 14 (3) | 26 (3) | 11 (3) |
| Navaho | 6 (1) | 37 (3) | 16 (2) | 1 (1) | 36 (3) | 23 (3) |
| Lakota | 2 (1) | 45 (3) | 28 (3) | 4 (2) | 42 (6) | 25 (5) |
| Erfurt, Germany | 5 (1) | 23 (2) | 3 (1) | 4 (1) | 31 (2) | 6 (1) |
| Lodz, Poland | 9 (2) | 21 (3) | 6 (2) | 14 (2) | 17 (2) | 5 (2) |
| N. Zealand | 11 (2) | 45 (2) | 5 (1) | 11 (3) | 57 (4) | 7 (2) |
| Yamanashi, Japan | 3 (1) | 48 (3) | 8 (1) | — | — | — |

*Numbers in parentheses are standard errors.

**FIGURE 2**
**Perceived Oral Health**



sample size.

**Perceptions of Oral Health.** A second type of measure of optimal oral health is the individual's perception of his or her condition. This measure provides an individualized snapshot of the person's oral health compared to his or her personal expectations and other subjective considerations not well understood by the health professional. Figure 2 shows the self-rated oral health for the three US sites. For Baltimore, 40 percent rated their oral health as excellent or very good, while only 9 percent rated their oral health as poor or very poor. In comparison, for adults in the Indian nations, 13 percent rated their oral health as excellent or very good, compared to 30 percent who rated their oral health as poor or very poor. The San Antonio site lies in the middle. Among the non-US sites information was available only for those who rated their oral health as poor/very poor and the percentages showed similar variability. For Germany, 17 percent of the middle-aged adults and 15 percent of the older adults rated their oral health as poor/very poor, compared to 7 percent of the middle aged adults and 4 percent of the older adults of New Zealand and 33 percent of the middle-aged adult and 61 percent of the older adults of Poland (10). Although percentages of those rating their health as excellent/very good are not known for non-US sites, it appears that the people of Poland were substantially more concerned about their oral health than any of the other sites.

A multivariate model comparing predictors of perceived oral health status for the US sites reported by Atchison and Gift (data not shown) demonstrated that ethnicity was a significant predictor in the Baltimore and IHS research locations, with Baltimore whites and Navajo rating their oral health more positively than the Baltimore African-Americans and Lakota (9). Among the remaining predisposing variables, having more education, more positive self-reported general health status, and dentate status categories were predictors of positive perceived oral health. No predictors among the enabling variables were common to all three locations. People with higher incomes within the IHS and the San Antonio locations rated their oral health more positively. In the Baltimore location, having a usual source of care was related to a higher rating of oral health. Having insurance was a significant predictor for the San Antonio location. Both oral need variables were significant predictors of perceived oral health in all three locations. People who reported no oral pain and those with fewer dental symptoms reported their oral health more positively. Among the oral health behaviors variables, adults having one or more dental visits were more likely to positively report their oral health; in the Baltimore location, not smoking was related to a positive report of oral health. The final model explained over 30 percent of the variance in perceived oral health with $R^2$ values ranging from 0.324 for IHS to 0.391 for San Antonio (9).

**Functional and Role Status.** We examined two individual perception items included in ICS-II that represent social or physical functioning: avoiding laughing or smiling and having trouble chewing hard foods (10). Table 4 shows that when adults were asked if they had experienced such impacts, a substantial proportion reported some functional limitations. Differences between the two age cohorts of adults for the social role were not major, but ethnic/racial differences were large. For younger adults the proportion varied from 10 percent for Erfurt, Germany, to 46 percent for the Lakota. For older adults, approximately 9 percent (Baltimore) to 38 percent (Lakota) of the adults reported avoiding laughing or smiling. The numbers were much greater for chewing impairments and varied by both age cohort and ethnic group. The percentage reporting this impact ranged from a low of 6 percent (younger adults in Baltimore) to 62 percent (older adults in Poland).

**Consumer Satisfaction.** A third measure of successful aging for oral health is being satisfied with one's dental services. Table 5 compares the mean consumer satisfaction ratings for the 11-item measure (ranging from 11 to 44) reported by Reifel et al. for older adults from the six US ethnic groups (7). It shows that whites from San Antonio and Baltimore and African-Americans from Baltimore reported the greatest satisfaction with their dental services. The two white groups were generally the most satisfied with their dental care. Comparable data were not available for the international sites. Using multivariate analysis, the predictors of consumer satisfaction for older adults when controlling for other independent variables varied by site (data not shown) (7). Being female, having higher education, higher perceived general health, and having teeth were associated with greater consumer satisfaction in one or more site. At least one oral health belief variable was a significant predictor of satisfaction for each ethnic group except whites from San Antonio. Belief in the efficacy of the dentist was the most common pre-

**TABLE 4**
**Proportion of Older Adults Reporting a Functional Impact by Site 4 (Ref. 10)**

| Functional Impact | Baltimore, MD | Navaho | Lakota | Erfurt, Germany | Lodz, Poland | New Zealand |
|---|---|---|---|---|---|---|
| Avoid laughing/smiling | | | | | | |
| Aged 35–44 years | 13 | 34 | 46 | 10 | 11 | 11 |
| Aged 65–74 years | 9 | 26 | 38 | 7 | 12 | 6 |
| Unable to chew hard foods | | | | | | |
| Aged 35–44 years | 6 | 14 | 25 | 7 | 25 | 11 |
| Aged 65–74 years | 13 | 45 | 47 | 34 | 62 | 24 |

dictor of higher satisfaction. Enabling characteristics were not significant predictors of satisfaction for most ethnic minority groups except for the Indian nations. Oral need, behaviors, and self-reported oral health were, likewise, not significant predictors in most sites for older adults.

## Discussion

We have proposed a conceptualization for successful oral health aging that goes beyond current individual measures of oral health status. We have proposed that successful oral health combines good oral health status, positive perceived oral health, good functional health, and satisfaction with access to care and satisfaction with dental services. This conceptualization is in keeping with Field and Lohr's (15) view that outcome measures should be broad and encapsulate multiple aspects of the individual's encounter with treatment and health. It is also responsive to the WHO's definition of health.

Using this conceptualization, we found a variety of indicators within the comprehensive model used by the ICS-II study that begin to answer the questions "Are older adults aging successfully?" and "Are specific groups faring better than others?" We have summarized the ICS-II findings in Table 6 to demonstrate successful aging over the numerous categories suggested.

We found that the majority of adults do maintain some natural teeth to older age. Only in the IHS sites, Poland and New Zealand had a substantial percentage of older adults lost all of their teeth. This finding suggests that maintenance of teeth has become a mainstream goal of successful aging. We noted ethnic differences in maintenance of teeth between those with some enabling resources compared to those with fewer resources, which demonstrated that some groups are aging more successfully than others. New Zealand, in particular, demonstrated improvement since ICS-I, but remained far below the other geographic sites.

Periodontal status demonstrates little change between younger and older adults for the most serious category, and, apart from the Indian nations, fewer than 10 percent of older adults have indicators of severe periodontal problems. Little consistency was found among predictors of periodontal disease from which to draw conclusions regarding specific groups that might be faring worse than others. Of course, these data are only from individuals who have retained some natural teeth, so they do not totally reflect the oral health decrement attributable to periodontal disease. Nonetheless, we conclude that among dentate adults, periodontal disease appears manageable for all groups except the Indian groups.

Approximately 70 percent of the adults reported their oral health to be at least good/fair, excepting Poland. Differences do exist among ethnic groups in the US sites that are not obvious in the summary table, with minority individuals in the US perceiving their oral health to be poorer—an indicator that majority status adults may be aging more successfully. Those with some natural teeth report more of these tooth-based oral symptoms and report their oral health to be worse. One must learn more about older persons' expectations to understand exactly how perceptions fit into the model of successful aging.

The proportion of adults who report problems with laughing/smiling or chewing varied by problem, by age cohort, and by site. A greater proportion of older adults reported physical functioning problems (chewing) than social role problems. Finally, adults of both ages in the US sites are moderately satisfied with the dental care they receive and their access to it, although members of the Indian nations were the least satisfied.

Comparing the summary scores in Table 6, Baltimore and Germany appear to have the most positive high marks, thus appearing to age most successfully using these indicators of oral health and access to and satisfaction with dental care. The Indian Nation sites demonstrated the lowest combination of marks, suggesting the greatest problem in successfully maintaining good oral health as they age.

**TABLE 5**
**Comparison of Mean Consumer Satisfaction Scores, Aged 65–74 Years (Ref. 8)**

| Ethnic Group | Mean | Sample Size | Bonferroni Grouping* |
|---|---|---|---|
| White (Baltimore): A | 37.98 | 477 | A B E F |
| African-American (Baltimore): B | 37.22 | 91 | A B F |
| Navajo: C | 32.07 | 202 | C |
| Lakota: D | 34.36 | 134 | D F |
| White (San Antonio): E | 39.09 | 124 | A E |
| Hispanic (San Antonio): F | 36.32 | 128 | A B D F |

*Means with same letter are not significantly different.

**TABLE 6**
**Comparison of Successful Aging Indicator by Sample**

| Indicator | Sample | | | | | |
|---|---|---|---|---|---|---|
| | Baltimore | IHS | San Antonio | Poland | Germany | New Zealand |
| Tooth loss | high | poor | high | poor | mod. | poor |
| Periodontal status | mod. | poor | — | high | high | high |
| Perceived oral health | high | mod. | mod | poor | mod. | mod.–high |
| Physical/social function | high | mod. | — | poor | mod. | high |
| Consumer satisfaction | mod.–high | low | mod.–high | — | — | — |

What do we learn from this model? We learned that this combination of measures of successful aging did, in general, demonstrate differences in age and ethnic status. Ethnic minorities and poorer countries demonstrated less success in aging on these indicators, as evidenced by the Indian nations of the United States and Poland. Ensuring good oral health for socioeconomically disadvantaged individuals is a long-standing problem and solutions are not clear. It was not clear that education or income were driving factors; nevertheless, some combination of factors results in decreased oral health and satisfaction with access to and results of dental services.

How can dentistry promote successful aging for oral health? Given the knowledge and technology available to dental health professionals, we believe it is possible for most adults to maintain at least some of their natural teeth and keep them in manageable periodontal health. However, this goal will involve education of both professionals and consumers. Individuals must be educated about the technological and biological expectations for oral health, personal responsibility, and the need for prevention. Likewise, health professionals must be educated about ways to educate individuals to maintain oral health. The contribution of health beliefs and oral health behaviors was not strong for any of these outcome measures, so one questions the best manner for using education to attain these goals; nonetheless, education must be one component. Attainment of goals also will require a redistribution of professional resources to educate all people about the opportunities available from dental health professionals and to provide dental health professionals in underserved areas. Public health dentistry must take a proactive role in spearheading these initiatives.

We propose that a new "Tooth Fairy" is needed. Although somewhat tongue-in-cheek, the Tooth Fairy represents a mascot for the dental profession. It helps young people accept the changes to their oral health through a tumultuous time of growth and development. Yet, implicitly, it rewards the individual for loss of teeth. The Tooth Fairy for the 21st century should be a comprehensive mascot who educates people of all social and ethnic backgrounds about the opportunities for maintaining good oral health across the lifespan, beginning with protection of primary teeth from early childhood caries to the ingrained sense that maintenance of teeth is a goal for all ages. While we stress that a new goal should be developed socializing all people in industrialized and developing countries that oral health is a positive goal for all people, we must be careful to assist those individuals who feel that, because of past lack of services or access inequities, good oral health is not a possibility for them. We must also alter the delivery system to provide services to older adults in all settings so keeping teeth becomes an asset, not a problem.

Finally, we need to learn more about the needs and desires of individuals who are faring less well than others. Is it a function of individual priorities and the need to achieve basic needs that supersede disease-free teeth? Clearly, we understand more about oral diseases than we do about differences in perceptions and values among people of different ages and ethnic groups. Answering such questions will help us develop more successful oral health promotion interventions that level the playing field for all people.

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