Validation of Self-reported Periodontal Measures Among Health Professionals

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Abstract

Objective: *The objective of this study was to determine the validity of self-reported periodontal measures among nondentist health professionals. Valid self-reported measures could provide a time- and cost-efficient alternative for large epidemiologic studies.* ***Methods:*** *A subsample of 212 male nondentists sampled on the basis of their reported periodontal severity from the Health Professional Follow-up Study (HPFS) provided dental radiographs and completed questionnaires assessing self-reported oral health. Alveolar bone loss was evaluated from the radiographs at 32 posterior sites and used as the standard measure of cumulative periodontal disease.* ***Results:*** *The self-reported ordinal periodontal measure had a linear relationship with mean radiographic bone loss (r=.61). The positive and negative predictive values of the dichotomized self-reported periodontal measures were 83 percent and 69 percent. Self-reported history of periodontal surgery was also a good surrogate for bone loss (predictive value positive 78 percent and negative 71 percent).* ***Conclusions:*** *Self-reports can provide discrimination and ranking information of cumulative periodontal disease among health professionals and can be used to provide valid results in etiologic studies in health professionals' populations. [J Public Health Dent 2002;62(2): 115-21]*

Key Words: validity, periodontal disease, periodontal surgery, questionnaire, cost savings, radiographs.

Self-reported measures of oral health could potentially provide an economic alternative to direct clinical examination and enable more large-scale studies related to oral health. As a result, oral health could be included in more studies on overall health status. Valid self-reported measures of periodontal disease and other oral health conditions could reduce the need for clinical exams, thus saving millions of dollars in research funds. The availability of such measures will facilitate incorporation of an important oral health measure in a wide variety of large-scale surveys and other studies of general health status.

As an initial step, we were interested in validating self-reported measures among dentists. Thirty thousand of the 50,000 participants in the ongoing Health Professionals Follow-Up Study (HPFS) study are dentists, whose reports of periodontal disease would seem credible. We have previously evaluated these dentists' self-reports of periodontal disease in a sample of an equal number of dentists with and without self-reported periodontal disease, using radiographs evaluated at 32 posterior sites as the standard (1). The self-reports were found to be in good agreement with the radiographically measured bone loss, with a positive predictive value of 76 percent and a negative predictive value of 74 percent. Our preliminary analysis suggested that the self-reported measures were associated with known determinants of periodontal disease such as age and smoking among nondentists, although less than among dentists. Hence, we think such measures might have potential for use in the nondentists group, as well. In this study we assessed the self-reported measures among nondentist health professionals and evaluated an ordinal measure of periodontitis.

The present study compared self-reported measures of periodontal disease and periodontal surgery against radiographic bone loss among "nondentist" health professionals from the same HPFS population. We also evaluated whether nondentist health professionals were able to report as well as dentists the numbers of remaining teeth, teeth with caries experience, and teeth with root canals. The population in this report consisted of veterinarians, optometrists, osteopaths, pharmacists, and podiatrists. The HPFS population has been under study since 1986 and has also reported its medical conditions and dietary intake, many of which have been validated (2-6). For example, vegetable intake from food frequency questionnaire compared to more elaborate diet records had an average correlation of 0.5, whereas fruits had an average correlation of 0.7 (3). Hence, if these periodontal measures are found also to be valid among nondentist health professionals in this study, a series of important analyses could be pursued that relate periodontal disease to diet and related systemic medical conditions.

Methods

The study was approved by the Institutional Review Board at the Harvard School of Public Health. Participants included a stratified random

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sample of nondentist HPFS participants who responded to the question, "Have you had periodontal disease with bone loss?" in 1996 and had more than 10 teeth. We randomly sampled 100 participants who reported having had (1) none, (2) mild, (3) moderate, or (4) severe periodontal disease with bone loss. No threshold or explanation was provided for these categories because we assumed the nondentists would perceive their periodontal status based on what their dentists may have told them.

A supplemental questionnaire was sent to these 400 participants to request additional information related to their oral health status and habits, including questions on periodontal surgery and a request for the contact address of their dentists. The supplemental questionnaire also included a question: "Have you ever had periodontal surgery?" A second question asked participants to indicate the type of periodontal surgery they had undergone.

We used radiographic bone loss measurement as the standard because it is one of the most widely accepted measures for periodontal disease (7,8). Also, radiographs were the only measures available in our study. Due to practical and ethical considerations and because bitewings are routinely obtained in clinical practice, participants were not asked to have radiographs taken specifically for this study. We requested preexisting posterior bitewing radiographs closest to 1996 from the participants' dentists. Up to three mailings were sent to nonresponders.

The recorder mounted the selected set of radiographs on standard mounting frames to avoid any confusion related to the orientation of the radiographs. When more than one set of readable radiographs was provided, the set of radiographs, preferably bitewings, closest to 1996 was selected for each participant. Each batch consisted of sets of radiographs for 20 participants to be read independently in a single session by an examiner. The examiners and recorder were blinded to any information about the participant other than the identification numbers. All posterior interproximal sites present (a total of 32 sites) excluding third molars were assessed for each participant.

There were three examiners: a general dentist, a periodontist, and a public health dentist. Two of the three examiners independently evaluated the radiographs for each participant to reduce errors in the standard. As these dentists were likely to have different perspectives due to their different specialties, their errors were less likely to be correlated. After the first examiner had completed one session, the recorder noted the missing teeth on the corresponding forms of the other two examiners to avoid disagreements due to tooth identification. The mounted sets of radiographs within the batch were shuffled prior to each session to assure a random ordering. About 10 percent of radiographs from each batch subsequently were reread to obtain a measure of within-examiner reliability.

Radiographic bone loss was assessed on mesial and distal sites of each tooth. We used methods similar to our previous study among dentists (1). Each site was given a score of 0 to 3 (0=no loss of crestal lamina dura and bone loss ≤2 mm; 1=partial loss of crestal lamina dura and bone loss ≤2 mm; 2=complete loss of crestal lamina dura or bone loss >2 and ≤4 mm; 3=bone loss >4 mm). Radiographs were assessed with the aid of Vernier calipers, a millimeter scale, a magnifying glass, and a viewing box in an area with subdued ambient lighting. The most coronal point of bone was used as the crestal landmark, and in the presence of crowns or restorations, clinical judgment was used to estimate the probable location of the cemento-enamel junction. If the same site was seen on more than one radiograph, the radiograph with the most severe reading was used. Unreadable sites and missing teeth were noted.

We conducted calibration and training sessions using a different set of radiographs, and then proceeded with the readings for this study. The between- and within-examiners percent agreement at the site level for a dichotomized measure (score of 0,1 vs 2,3) during the study, were all equal to or better than the NHANES III reliability of 0.8 (9).

Data Analyses

The distribution of participants with respect to age, smoking, and number of teeth was computed for the validation sample and for the responders who provided x-rays. We compared the self-report of periodontal severity with radiograph findings. We obtained a mean score for each participant by averaging the ordinal scores across all sites and both examiners, then compared the distribution of mean bone loss across the different self-reported responses. We also evaluated the percentage of sites with a score of 2 or more, and with a score of 3 or more. Spearman correlations were computed between an ordinal measure for severity and these measures; we used Spearman to minimize the effect of outliers. In etiologic studies, it is important that measures be able to discriminate individuals into groups, or for continuous measures rank individuals as well. Consistent errors in overestimating or underestimating the actual measures do not impact the associations. Hence, correlations are able to assess the validity of measures for use in etiologic studies.

To compute predictive values for periodontal surgery and history of periodontal disease, we needed to dichotomize the continuous measure of radiographic bone loss by selecting cutoffs independently of the reported status. There is no universal consensus on classifying a person's periodontal status or classifying someone as a case for surgery. We derived a stringent measure by considering participants as positive if they had two or more sites that both examiners gave a score of 3 or more. We also used the median as the cutoff to derive additional binary standards from the participants' mean bone loss, percent of sites with a score ≥2 and percent of sites with a score ≥3. The self-reported questionnaire measure was tabulated against these dichotomous measures to compute predictive values. We used a refined self-reported measure of periodontal surgery by excluding the 19 participants who had no periodontal surgery other than crown-lengthening procedures.

We were not directly able to validate measures of caries and root canals, since we had very limited full-mouth radiographs; the majority of participants only provided posterior radiographs. Since we expected the dentists would be well able to self-report their caries and root canal status, we compared the nondental health professionals' self-reported distributions of caries, root canals, and

number of remaining teeth against the self-reported distributions for the dentists in this same population.

Results

Of the 400 participants sampled, 309 participants (77%) responded to the supplemental questionnaire. We obtained radiographs for 214 participants (54%); two of the radiographs were unreadable and could not be used. Participants who provided radiographs (responders) were similar to nonresponders (Table 1) with respect to their age, race, smoking, and reported periodontal severity, but were somewhat more likely to have had an annual dental check-up and hence were more likely to be able to provide radiographs. Sixty-eight percent of those who responded to the questionnaire said they had obtained radiographs as part of a routine exam within the last five years. Our previous analysis among dentists (1) suggests that participants who provided radiographs were somewhat older, included more former smokers, had slightly more teeth, and had higher health care utilization rates, compared to the total population of HPFS dentists. The dentists in the published validation study had a mean age of 67 years (SE=0.72) and consisted of 91 percent Caucasians; 53 percent of these dentists were former smokers, 6 percent were current smokers, and 91 percent had 25 or more teeth.

Self-reported Periodontal Disease vs Radiographic Bone Loss. A combination of measurements by two different examiners were used as the radiographic standard. The Spearman correlation coefficient between the two duplicate readings for participants' mean bone loss was 0.93. Our self-reported ordinal measure was measured only once in 1996. Therefore, we were not able to provide reliability measures for that. Figure 1 gives box plots showing that the self-reported categories of none, mild, moderate, and severe disease have a strong linear relationship with the distribution of radiographic bone loss. Mean bone loss scores were 1.25 mm (95% confidence interval [CI]=1.17, 1.33), 1.42 mm (95% CI=1.28, 1.56), 1.67 mm (95% CI=1.55, 1.79), and 2.20 mm (95% CI=2.06, 2.34) for participants who reported none, mild, moderate, and severe periodontal disease, respectively. Spearman correlations of our ordinal self-reported severity measure (0=none, 1=mild, 2=moderate, and 3=severe) with participants' mean bone loss was 0.61, with percent of sites with score of 2 or more was 0.59, and with percent of sites with score of 3 or more was 0.56.

The box plots of mean bone loss for each category of self-reported periodontal surgery, after excluding those with crown-lengthening surgery only (Figure 2), also demonstrated that people with periodontal surgery had a distribution of bone loss substantially higher than that of people who reported no history of periodontal surgery. Participants with history of periodontal surgery had a mean bone loss score of 1.93 mm (95% CI=1.79, 2.07) as compared with a score of 1.40 mm (95% CI=1.32, 1.48) for those who did not. These charts allow visual comparisons of the whole distribution.

Self-reported measures also were compared to bone loss, using cutoffs based on the median for mean bone loss, percent of sites with score of 2 or more, and percent of sites with scores

TABLE 1
Differences in Demographic and Periodontal Status Between Participants Who Provided X-rays and Participants Who Did Not Provide X-rays

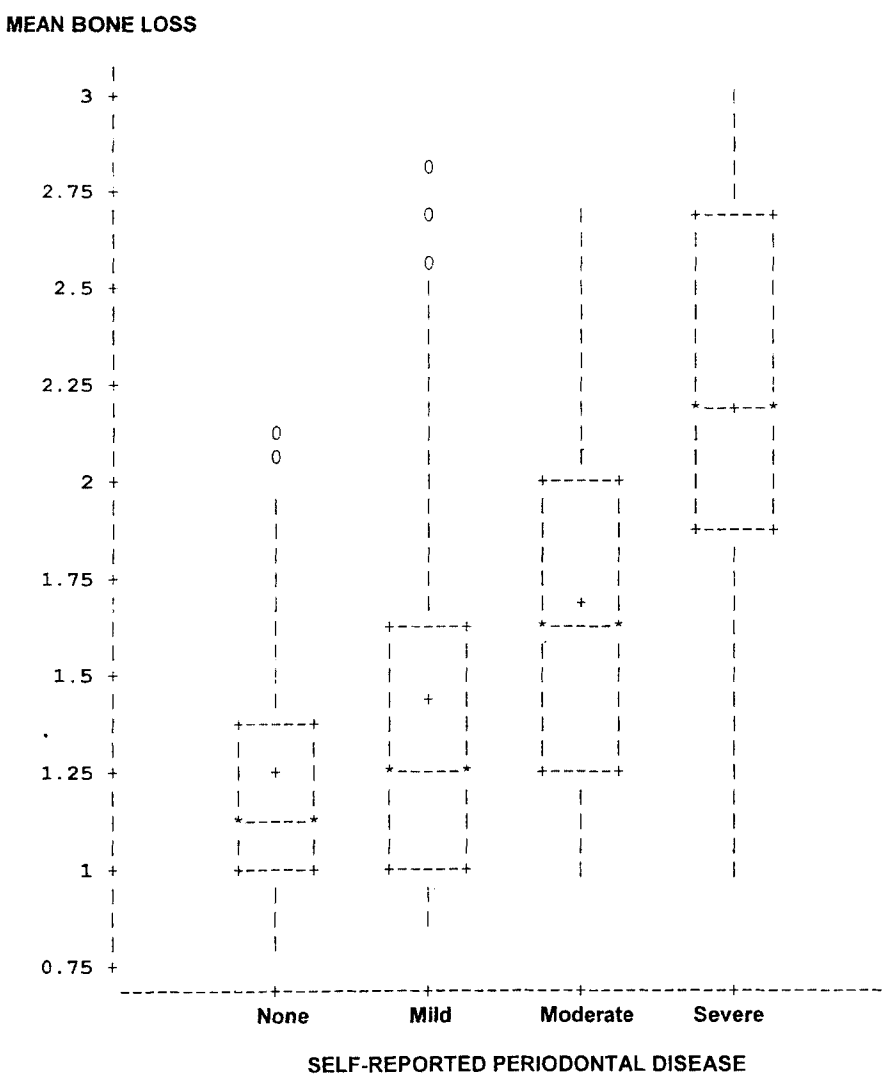
Characteristic	Participants Providing X-rays Number (%) (*N*=212)	Participants Not Providing X-rays Number (%) (*N*=188)
Age in 1996 (mean ± SE)	63±0.62	66.0±0.73
White race	190/205 (92.7)	162/175 (92.6)
Current smokers	19/212 (9.0)	13/188 (6.9)
Self-reported periodontal status		
None	56 (26.4)	44 (23.4)
Mild	57 (26.9)	43 (22.9)
Moderate	51 (24.1)	49 (26.1)
Severe	48 (22.6)	52 (27.7)
Having dental checkups at least once/year	113/202 (55.9)	44/100 (44.0)

TABLE 2
Positive and Negative Predictive Values of Self-reported Periodontal Status and Periodontal Surgery Measure

Self-reported Measure	3 Threshold Levels for Periodontal Disease Positive on Radiographic Standard	Positive Predictive Value*	Negative Predictive Value†
Periodontal surgery	Above median of average bone loss	53/68 (77.9)	78/110 (70.9)
	Above median % of sites with score ≥2	52/68 (76.5)	77/110 (70.0)
	Above median % of sites with score ≥3	47/68 (69.1)	82/110 (74.6)
Periodontal status	Above median of average bone loss	59/71 (83.1)	92/134 (68.7)
	Above median % of sites with score ≥2	57/71 (80.3)	91/134 (67.9)
	Above median % of sites with score ≥3	51/71 (71.8)	99/134 (73.9)

*Positive predictive value=[(true positives)/(true positives+false positives)].
†Negative predictive value=[(true negatives)/(true negatives+false negatives)] x 100%.

FIGURE 1
Box Plots of Mean Bone Loss by Self-reported Categories of Periodontal Disease



of 3 or more. For each of these measures, participants were divided into the bottom 50 percent (low bone loss), and top 50 percent (high bone loss). The positive and negative predictive values are presented in Table 2. Comparing periodontal surgery (excluding crown-lengthening surgery) against a binary measure of mean bone loss, the predictive values negative and positive were 71 percent and 78 percent respectively. Using the same standard, for periodontal status the negative predictive value was 69 percent and positive predictive value was 83 percent.

Other Measures. The distribution of number of teeth with root canals among nondentists looks almost identical to that of the dentists, but nondentists report lower caries rates than dentists (Table 3). The periodontal severity distribution among nondentists was similar to that among dentists in the HPFS, except that dentists were more likely to report mild periodontal disease, whereas nondentists were more likely to report none.

Discussion

Health professionals were well able to report their periodontal disease status. Due to the similarity in characteristics among those who did or did not provide radiographs and the fact that most radiographs were obtained routinely, bias from nonresponse seems unlikely. Nondental health professionals were more likely than dentists to say "don't know" to a question on periodontal severity, but those who reported severity were able to distinguish disease severity. The validity among nondentists for the severity measure was very good and did not look appreciably different than for dentists (1), suggesting that nondentist health professionals are also well able to report their periodontal status. Compared to dentists, nondentists seemed more likely to underreport mild periodontal disease as "none." The HPFS binary periodontal measure and periodontal severity correlated well with radiographic bone loss. One would expect that participants can report whether they had periodontal surgery, but it was reassuring to see that the surgery measure also related well with bone loss. History of periodontal surgery is, therefore, a reasonable surrogate for periodontal bone loss.

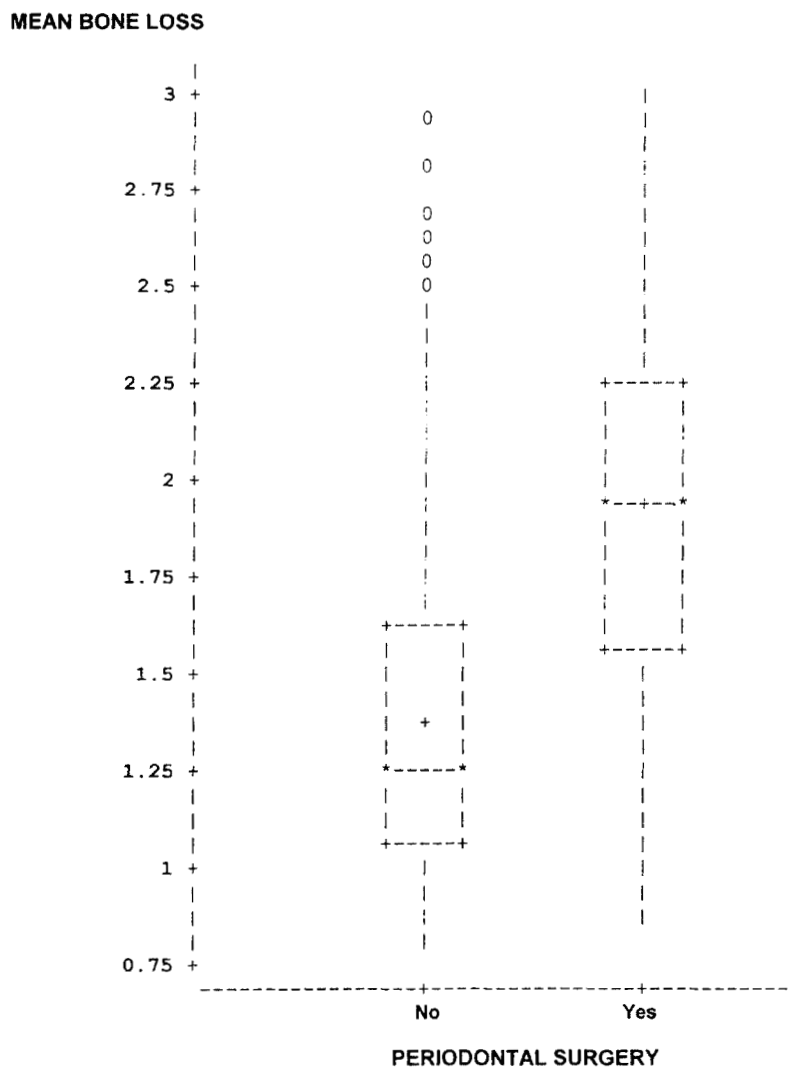
Participants were sampled on the basis of their reported periodontal severity. Hence, participants with periodontal disease, especially severe disease, were oversampled. Sensitivity and specificity were, therefore, not directly obtainable.

Since awareness of one's dental status is expected to vary across populations depending on education level, utilization of dental care, and the questions and standards used, validity results may vary across studies. The population in the present study consisted of highly educated health professionals who were expected to have high access to dental care and hence were well aware of and able to report their periodontal status. In our population aged 50 to 90 years, 56 percent had one or more routine visits per year. In the general population, 61 percent of adults aged 25 years and older), and 52 percent of persons aged 65 years and older had routine dental visits in the past year (10), implying there is potential to obtain reasonable self-reported measures from some populations. However, the education level and awareness of the general population would be much lower than among health professionals, and thus the validity is expected to be lower.

Comparisons with Other Studies

Validation studies conducted among other populations showed lower validity. Among nonreferred patients attending Dundee Dental Hospital and School, a self-reported measure of periodontal disease (whether they think they have gum disease) was recently validated. These measures showed low sensitivity and

FIGURE 2
Box Plots of Mean Bone Loss by Self-reported Periodontal Surgery



high specificity against clinical indicators of some 4 mm pocketing (32%, 93%) and some mobility (26%, 91%) (11). Our study among males aged 51 to 86 years who were participants of the VA Longitudinal Dental Study compared telephone interviews on periodontal status and treatment with radiographic bone loss. Self-reports also had low sensitivity (18%–65%) and high specificity (60%–91%) in this population (12). In another study conducted among adult patients at the Harvard School of Dental Medicine student clinic, we validated a self-reported periodontal measure obtained by a self-administered questionnaire against full-mouth radiographs. The results were consistent; self-reports showed a sensitivity of 39 percent and specificity of 100 percent (12).

Self-reports of gingival disease tend to be even less accurate than periodontitis. A study comparing data from self-administered postal questionnaires and clinical examinations indicated marked underreporting of gingival disease among adult dental patients living in a rural community in Norway. Only 25 percent of the subjects with gingivitis reported experiencing "gum disease" (13). Another study assessing the relationship between professionally measured and perceived gingival health in adolescents in Helsinki showed a correlation of 0.28 between self-reported bleeding on probing and percent of sites bleeding on probing (14).

One would expect the participants to know their dental status from what their dentist or dental hygienist tells them. Hence, utilization of dental care also could be an important factor affecting the validity of self-reported measures; we expect populations with low utilization to have low validity.

We were not able to directly validate measures of caries, root canal treatment, or number of teeth in the HPFS, because we did not have full-mouth radiographs for most participants. In this study, dentists reported a greater number of teeth present than nondentists. Since we expected the number of teeth to be reported accurately by both groups, we would assume that the caries and periodontal status of dentists may also be slightly better than nondental health professionals. The nondentists reported fewer teeth with caries, even though we may expect they might have more teeth with caries than dentists, suggesting lower validity of the absolute amount of caries. However, the categories are likely to be a reasonable representation of relative levels of low, moderate, or high caries experience among nondentists. It is important to note that radiographs are also likely to underestimate caries. Douglass et al. (15) have shown that the sensitivity of bitewing, panoramic, and periapical radiographs were 57 percent, 55 percent, and 30 percent, respectively, for adult posterior teeth. The distribution of the number of root canal-treated teeth reported by nondentists was very similar to that reported by the dentists. In our study, among first-time participants at Harvard School of Dental Medicine Student Clinic (12), we also found excellent validity of self-reported root canals (positive predictive value=86%; negative predictive value=95%) compared to clinical records. This suggests people can remember root canal treatment and are able to report this very well.

More work is needed before self-reported measures can be used among the general population. Detailed questions and explanations may improve the validity, and different questions and combination of questions need to be validated. Future research should be targeted at evaluating different additional self-reported measures and their combinations in improving the validity for extension to the general population.

In general, when feasible, it would be better to incorporate the best objective measures of oral health rather

TABLE 3
Percent Distribution of Self-reported Oral Health Measures of Dentists and Nondentists

Oral Health Status	Number of Teeth with Caries				
	0	1	2–3	5–9	10+
Nondentist	1	1	13	36	48
Dentist	1	1	7	23	68
	Number of Teeth with Root Canal Treatment				
	0	1	2–3	5–9	10+
Nondentist	41	23	31	5	1
Dentist	40	25	29	5	1
	Number of Teeth				
	0	1–10	11–14	15–24	25+
Nondentist	2	3	4	14	77
Dentist	1	1	2	10	86
	Periodontal Severity				
	None	Mild	Moderate	Severe	Don't Know
Nondentist	53	23	8	2	14
Dentist	52	35	11	2	0

than surrogate measures. It should be noted that clinical measures are also imperfect and have many limitations. There is no agreement among researchers as to the threshold for calling a case positive for periodontal disease. The use of arbitrary thresholds could be biased toward finding a significant association. Another advantage of self-reported measures is that they could assess past history. In many cases, clinical measures may not be feasible, and the alternative would be to exclude oral health measures from the survey or research study. In such cases, the use of valid, self-reported measures of oral health status in surveys would increase our knowledge of oral health status while containing the cost of health assessment surveys. Clearly, questionnaires are far less expensive than epidemiologic surveys requiring oral examinations conducted by a dentist.

If one finds an association using a surrogate measure, then one would expect that the association would be stronger using a perfect measure. Unless the measure is completely useless (predictive values of 0.5 or correlation close to 0) one would see some association with the surrogate measure if one exists with the perfect measure, and the degree of attenuation would decrease with increased validity of the measure. Methods have been developed and are in use to quantify the degree of attenuation by surrogate measures and adjust the relative risks for misclassification (16,17). The degree of attenuation in the relative risk can be calculated from preditive values independently of prevalence, sensitivity, or specificity (16). Therefore, it was not necessary to indirectly calculate sensitivity and specificity in this report. Many measures used routinely in research, such as nutrient intake, are imperfect and vary in their degree of validity. Many clinical measures used in dental research compare well in validity against their counterparts in areas such as nutrition and psychiatry, where correlations of 0.4 (3) have been considered acceptable measures and used in etiologic studies reported in the most prestigious journals (18-20). Validated self-reported measures could facilitate the conduct of large-scale studies of the type needed to evaluate various oral and systemic association and associations between nutrition and oral health that may otherwise be impractical or difficult to finance.

Self-reported oral health measures can provide reasonably valid data on periodontitis and periodontal surgery among health professionals. History of periodontal surgery was a good surrogate for periodontal bone loss in this population. There is a potential for further development of self-reports for use in epidemiologic research as valid, economical, and practical measures for various populations.

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