Validation of Self-reported Oral Health Measures

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Abstract

Objectives: *To assess the validity of self-reported oral disease and health care measures in two populations.* ***Methods:*** *Telephone interviews were conducted among a subsample of participants in the VA Dental Longitudinal Study (VADLS) asking them about periodontal disease status and treatment. Radiographic alveolar bone loss evaluated at all the interproximal sites was used as the standard. A separate study was carried out among first-time patients at the Harvard School of Dental Medicine (HSDM) student clinic. Self-reported measures were obtained by a self-administered questionnaire and compared with clinical and radiograph examinations. The measures used were based on published work that demonstrated good validity of self-reported periodontal measures among health professionals.* ***Results:*** *Among 145 VADLS participants, self-reports of periodontal disease showed a good specificity (59.8%–90.7%), but low sensitivity (17.7%–64.7%). Among 58 HSDM patients, the self-reported numbers of remaining teeth, fillings, root canal therapy, and prosthesis were strongly correlated with clinical records (r=0.74–1.0); self-report was less accurate for measures of periodontal disease (r=0.56) and decayed teeth (r=0.47).* ***Conclusions:*** *Self-reports provide reasonably valid estimates for numbers of remaining teeth, fillings, root canal therapy, and fixed and removable prostheses. However, they appear to be less useful for the assessment of dental caries and periodontal disease in the two populations we have studied. There remains a need and potential to further develop self-report oral health measures that are valid for use in large population studies. Such self-report measures would yield great cost and time savings. [J Public Health Dent 2002;62(2):122-8].*

Key Words: validity, questionnaires, interviews, epidemiologic methods, periodontitis, dental caries, oral health measures, root canal therapy, dental prosthesis.

Self-reported measures such as diet and physical activity have been validated and used routinely in the medical literature (1-6). However, less information is available regarding the validity of self-reported oral health measures. Previous studies showed that the general population could provide accurate estimates of self-reported number of teeth present (7-13) and the presence of dentures (8,11,13,14), but the reporting of replaced teeth was prone to error (14).

There are very few published studies relating subjects' perceived oral health with dentists' ratings (15,16), and with indicators of dentition status and periodontal diseases (17-20). Brunswick and Nikias (15) found a considerable agreement between adolescents' self-rating of teeth and gum conditions and dentists' evaluation of overall oral health. In this study, clinical examination showed gum condition to be worse than that described by self-report. In contrast, a study conducted among dentate elders showed that while 30 percent of the participants rated their oral health identically to the dentist's ratings, half of them rated their oral health lower than the dentist's ratings (16). Gooch et al. (19) demonstrated that self-reported dental health index of pain, worry, and conversation avoidance was related to presence of dental caries and report of toothache. Atchison et al. (16) and Matthias et al. (21) also showed that patient's self-rating of oral health was associated with a variety of clinically evaluated conditions including number of missing teeth and the presence of dental caries.

Studies directly evaluating periodontal disease measures are very limited and inconsistent. Early validation studies of self-reported gingival health suggested that self-report is clearly associated with clinical status; however, in most studies, self-report underestimated the prevalence of gingival disease (17,22,23). Kallio et al. (24) showed that self-reports of "gingivitis" and "bleeding from gums" by adolescents had low levels of agreement with clinical measures. Gilbert and Nuttal (25) tested a battery of questions as predictors of subsequently clinically assessed periodontal status among adult patients. Questions regarding whether patients had been told by a dentist that they had gum disease, whether patients thought they had gum disease, or whether they were aware of being treated for it had high specificity ($\geq$.88), but low sensitivity ($\leq$.32). The results suggest that many patients with periodontal disease appeared to be unaware of their conditions. In our study among health professionals, we found a good validity of self-reported measures with positive and negative predictive values of 76 percent and 74 percent among dentists (26), and 83 percent and 69 percent among other health professionals (27).

This study assessed the validity of

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self-reported oral disease and health care measures among two populations. If self-reports are found to be accurate, it may be possible to obtain usable self-reported oral health data from certain sections of the general population.

Methods

This study was conducted in two different populations: (1) adult men participating in the Veterans Affairs Dental Longitudinal Study (VADLS) and (2) first-time adult patients at the Harvard School of Dental Medicine (HSDM) student's clinic. For the VADLS participants, we compared self-reports of periodontal disease, obtained through a structured telephone interview with radiographic data. For HSDM patients, we examined the validity of self-reported measures including periodontal disease status, numbers of decayed teeth, fillings, remaining teeth, root canal therapy, and various types of prostheses against clinical and radiograph data. The VADLS study protocol has been reviewed and approved by the Human Studies Subcommittee of the VA Boston Healthcare System, and the HSDM study by Harvard Medical School/ HSDM Committee on Human Studies

Data Collection. *VADLS.* The VADLS is a closed-panel cohort study of 1,231 community-dwelling healthy men aged 25 to 85 years residing in the greater Boston metropolitan area at the study baseline. The cohort was assembled to describe age-related changes in the oral cavity and to identify risk factors for oral diseases. The subjects were selected on the basis of good medical health at baseline. As the study aimed to follow subjects throughout their lifespan, their likely geographic stability as related to their employment status was also a selection criterion for those men who were of working age at entry. The cohort is thus of slightly higher socioeconomic status than their age-matched peers in the Boston area. Participants are not VA patients and receive their medical and dental care in the private sector. Ninety-seven percent of the participants were Caucasian and the rest were African-American. Since the study began in 1968, participants have been seen approximately once every three years for comprehensive medical and oral examinations including complete clinical dental and periodontal exams and full-mouth intraoral radiographs.

At each examination cycle, alveolar bone loss was assessed using full-mouth series of intraoral periapical films and the 5-point Schei ruler method (28). The measurement was recorded at the mesial and distal sites of each tooth. The reduction in alveolar bone height from the cemento-enamel junction (CEJ) was measured in 20 percent increments. Alveolar bone loss scores ranged from 0 to 5, with 0 indicating no bone loss and 5 representing bone loss ≥80 percent. A trained and calibrated periodontist carried out all the measurements. Details on training and calibration methods, including reliability of the measurements, have been published elsewhere (29-31). Bone loss measurements exhibited moderate level of agreement. Kappa statistics were .45 for mesial bone loss and .42 for distal bone loss. The percentage of exact agreement was 71 percent and 67 percent for mesial bone loss and distal bone loss, respectively.

Subjects in the present study include VADLS dentate participants who participated in the sixth cycle comprehensive examination (from 1985 to 1988). In 1996 we used a stratified sampling technique to select these participants according to their quartile of alveolar bone loss severity as measured at cycle 6. We oversampled individuals with severe bone loss to ensure sufficient subjects likely to have had a history of periodontal surgery. The initial sample consisted of 50 participants in each of the first, second and third quartiles, and 100 participants in the fourth quartile of bone loss.

Of the 250 participants contacted 155 (62%) agreed to participate. In a structured telephone interview, we asked the participants questions regarding their own periodontal status "Do you have any periodontal/gum disease?" "Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?" "Have you ever been told that you need periodontal or gum treatment?" "Periodontal or gum treatment can include both surgical and nonsurgical therapy such as deep scaling, root planing, or the use of antibiotics; have you ever had any form of periodontal or gum treatment?"

HSDM. Participants were recruited from the HSDM student clinic while they were in the clinic waiting room. The sample included 63 consecutive first-time patients at HSDM aged 18 years or older. These patients were asked for informed consent to participate in the study and to respond to a one-page self-administered questionnaire for the evaluation of their own oral health conditions (Figure 1). Hand-held mirrors were provided to assist participants in answering questions. Participants were subsequently examined by third or fourth year dental students as part of their regular dental visit, like any other new patients at HSDM. Students' clinical as

FIGURE 1
HSDM Study—Questionnaire Items Evaluated

- How many natural teeth do you have in your mouth now? _____
- How many of your permanent teeth in your mouth now:
  have a cavity? _____
  have a filling (silver or white)? _____
  have a crown (cap)? _____
  have root canal therapy? _____
- If you have a bridge in your mouth now:
  how many teeth are involved with the bridge? _____
  how many missing teeth are replaced by the bridge? _____
- How many of your missing teeth:
  are replaced by removable dentures? _____
  are not replaced? _____
- Do you have periodontal disease or gum disease with bone loss?
  yes _____ no _____ don't know _____
- In general, your current periodontal bone loss can be classified as:
  none _____ mild _____ moderate _____
  severe _____ don't know _____

TABLE 1
Sensitivity and Specificity of Self-reported Periodontal Disease Measures Compared to Radiographic Bone Loss in VADLS

Self-report Measure	N*	Sensitivity [Reported+/True+] (%)	Specificity [Reported–/True–] (%)
Threshold 1: At least 2 teeth with bone loss ≥20 percent			
1. Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?	141	32/98 (32.7)	39/43 (90.7)
2. Do you have any periodontal/gum disease?	141	19/98 (19.4)	39/43 (90.7)
3. Have you ever been told that you need periodontal or gum treatment?	145	47/101 (46.5)	34/44 (77.3)
4. Have you ever had any form of periodontal or gum treatment?	144	48/100 (48.0)	32/44 (72.7)
Threshold 2: Median percentage of sites with bone loss ≥20%			
1. Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?	141	23/70 (32.9)	58/71 (81.7)
2. Do you have any periodontal/gum disease?	141	13/70 (18.6)	61/71 (85.9)
3. Have you ever been told that you need periodontal or gum treatment?	145	34/73 (46.6)	49/72 (68.1)
4. Have you ever had any form of periodontal or gum treatment?	144	35/73 (48.0)	46/71 (64.8)
Threshold 3: At least 4 teeth with bone loss ≥40 percent			
1. Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?	141	8/16 (50.0)	97/125 (77.6)
2. Do you have any periodontal/gum disease?	141	3/17 (17.7)	104/124 (83.9)
3. Have you ever been told that you need periodontal or gum treatment?	145	11/17 (64.7)	82/128 (64.1)
4. Have you ever had any form of periodontal or gum treatment?	144	9/17 (52.9)	76/127 (59.8)

* Excluding participants who reported "don't know or don"t remember" to the question.

sessments were reviewed routinely by clinical faculty.

One dentist who was not aware of participants' responses to the questionnaires abstracted relevant data from clinical records. The actual numbers of remaining teeth, decayed teeth, fillings, fixed and removable prostheses, and teeth treated with root canal therapy were obtained from clinical examination charts, while periodontal bone loss was assessed from full-mouth radiographs. The dentist classified periodontal disease severity according to bone reduction from CEJ to alveolar crest at the worst site and assigned a score as follows: 0=none (bone loss ≤1 mm); 1=mild (bone loss >1 mm, but within the coronal third of the root); 2=moderate (within the middle third of the root); and 3=severe (bone loss extending beyond middle third of the root). The mild, moderate, and severe groups were then combined to obtain a binary measure of periodontal disease.

Data Analysis. *VADLS.* Self-reports of periodontal disease status were compared to radiographic alveolar bone loss data obtained from the eighth VADLS cycle of comprehensive oral examinations (from 1992 to 1995). Of 155 people who agreed to participate in the telephone survey, 145 participants had radiographic data available from their most recent VADLS examination. Participants who reported "don't know" or "don't remember" to each question were excluded from the analysis of that specific question. The validity of self-reports is presented as sensitivity and specificity. It was not appropriate to calculate predictive values for this study because we oversampled participants with severe disease. We considered participants to have periodontitis if they had at least two teeth with alveolar bone loss ≥20 percent. We also dichotomized participants by median percentage of sites with bone loss ≥20 percent and by using a stringent threshold of at least 4 teeth with alveolar bone loss ≥40 percent. Additionally, we used independent two-sample *t*-test to compare mean bone loss scores of participants who reported positive with those who reported negative for each self-reported measure.

HSDM. To determine the validity of self-reports in HSDM study, we computed the sensitivity, specificity, and predictive values for each binary measure including presence of any cavity, filling, root canal therapy, crown, pontic, abutment, removable denture, and periodontal disease. We computed the mean numbers of teeth with aforementioned conditions and compared them with the actual means from clinical records by using paired *t*-tests. Spearman rank correlation analyses were performed to measure the strength of linear relationship between the self-reported and actual means. We also used Spearman rank correlation to compare periodontal disease severity scores from radiographs and from questionnaires.

Results

VADLS. Among 145 participants in the analytic sample, 5.7 percent were current smokers, 98.6 percent were white, and 78.6 percent had education beyond high school. Participants ranged in age from 51 to 86 years (mean=69.4 ±6.3 years) and had 2–30 remaining teeth (mean=20.1±7.3

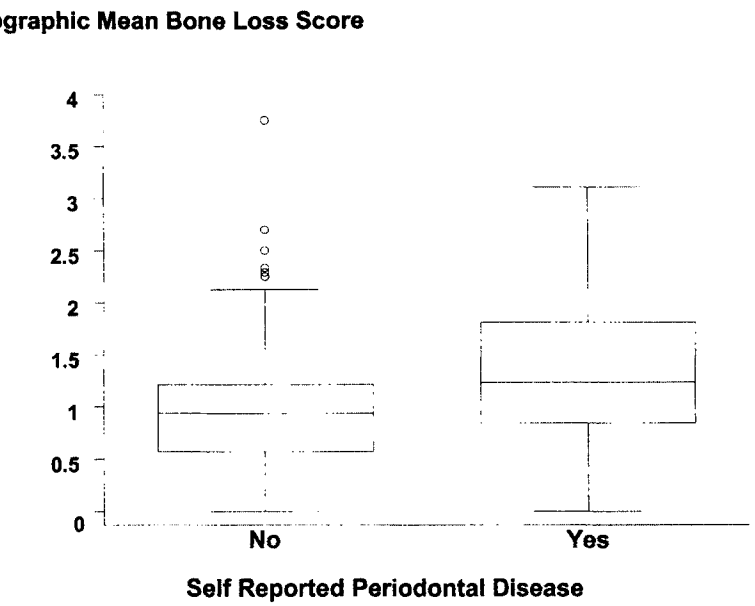
teeth).

Thirty-six participants (24.8%) reported being told by dentists that they had periodontal disease with bone loss, while only 23 participants (15.9%) reported having periodontal disease. Fifty-seven participants (39.3%) were told they needed periodontal treatment. Sixty participants (41.4%) reported receiving some form of periodontal treatment in the past; of these participants, 36.7 percent had scaling or root planing alone; 26.7 percent had a gingivectomy; 6.7 percent received flap or bone surgery; 3.3 percent had grafting; 3.3 percent received antibiotic treatment; and the rest could not remember type of treatment or reported that they were not told by the dentist.

Table 1 shows the sensitivity and specificity of self-reports as compared with three different thresholds of the radiographic alveolar bone loss measure. For each threshold of periodontitis, all four questions had moderate to high specificity ranging from 59.8 percent to 90.7 percent, but low to moderate sensitivity ranging from 17.7 percent to 64.7 percent. Self-reports of periodontal condition (questions 1 and 2) showed higher specificity, but lower sensitivity than self-reports of periodontal treatment (questions 3 and 4).

Figure 2 depicts box plots of the distribution of mean bone loss by the level of responses to the question,

FIGURE 2
Box Plots of VADLS Participants' Mean Bone Loss Score by Response to the Question, "Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?" (*N*=141)



"Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?" Men who said yes were more likely to have higher bone loss score than those who said no. A *t*-test comparing mean bone loss scores was significant ($P<.01$). We found similar results for the questions: "Have you ever been told that you need periodontal or gum treatment?" ($P=.01$), and "Have you ever had any form of periodontal or gum treatment?" ($P=.04$). There is no significant difference in mean bone loss score between men who reported to have periodontal disease and those who did not ($P=.40$).

HSDM. In the dental school patient population, a very high response rate (59/63, 93.7%) was achieved: one pa-

TABLE 2
Sensitivity, Specificity, Positive and Negative Predictive Values of Self-reported Oral Health Measures Compared to Clinical Examination Records in HSDM Study

Self-reported Measure	Sensitivity [Reported+/True+] (%)	Specificity [Reported−/True−] (%)	PV+ [True+/Reported+] (%)	PV− [True−/Reported−] (%)
Oral health status				
Presence of untreated dental caries	22/37 (59.5)	18/21 (85.7)	22/25 (88.0)	18/33 (54.5)
Presence of periodontal disease*	11/28 (39.3)	17/17 (100.0)	11/11 (100.0)	17/34 (50.0)
Oral health care				
Presence of filled teeth	47/51 (92.2)	7/7 (100.0)	47/47 (100.0)	7/11 (63.6)
Presence of root canal therapy	18/20 (90.0)	35/38 (92.1)	18/21 (85.7)	35/37 (94.6)
Presence of crown	20/22 (90.0)	34/36 (94.4)	20/22 (90.9)	34/36 (94.4)
Presence of abutment	7/7 (100.0)	51/51 (100.0)	7/7 (100.0)	51/51 (100.0)
Presence of pontic	5/5 (100.0)	51/53 (91.4)	5/7 (71.4)	51/51 (100.0)
Presence of removable prosthesis	4/4 (100.0)	52/54 (93.1)	4/6 (66.7)	52/52 (100.0)

*Excluding 13 patients who responded "don't know."
PV+: positive predictive value.
PV−: negative predictive value.

tient had incomplete data and had to be excluded from analysis. Among 58 patients with complete data, 62.1 percent were male, 63.8 percent had untreated decayed teeth, 87.9 percent had fillings, 34.5 percent experienced root canal therapy, 37.9 percent had fixed prostheses, 6.9 percent had removable dentures, and 3.4 percent were edentulous. Patients were aged 19–78 years with a mean of 40.7 years (SD=16.3).

Table 2 shows the validity parameters of self-reports in the HSDM population using clinical examination as the gold standard. All the binary measures had a high specificity (85.7%–100%), showing that over 86 percent of patients who did not have clinical signs of dental caries and periodontitis also thought they were currently unaffected; those who did not receive restorative, endodontic, or prosthodontic treatment were aware of not being treated for it. Most of the binary measures had a high sensitivity between 90.0 percent and 100.0 percent, except dental caries (moderate sensitivity, 59.5%) and periodontitis (low sensitivity, 39.3%). The positive predictive values of all measures were high, ranging from 66.7 percent to 100.0 percent. Thus, most of patients who reported positive were truly positive according to clinical findings. Self-reports of presence of filled teeth, root canal therapy, and prostheses yielded negative predictive values ranging from 63.6 percent to 100.0 percent. Lower negative predictive values were found for measures of decayed teeth (54.5%) and periodontitis (50.0%).

The self-reported mean numbers of remaining teeth, root canal therapy, and all types of prostheses were similar to the actual means (Table 3). Patients tended to underestimate the numbers of fillings, decayed teeth and unreplaced missing teeth by mean differences of more than 1, but the differences were not statistically significant. The correlation coefficients between the self-reported and actual means were positive and high for most measures ($0.74 \leq r \leq 1.00$), but lower for the numbers of unreplaced missing (r=0.52) and decayed teeth (r=0.47). Scatter plot of self-reported number of teeth against clinical findings is shown in Figure 3. The points below the line indicated underestimation of self-reports, while the points above the line suggested overestimation. Patients could accurately report their number of teeth, although there was a slight tendency toward underreporting.

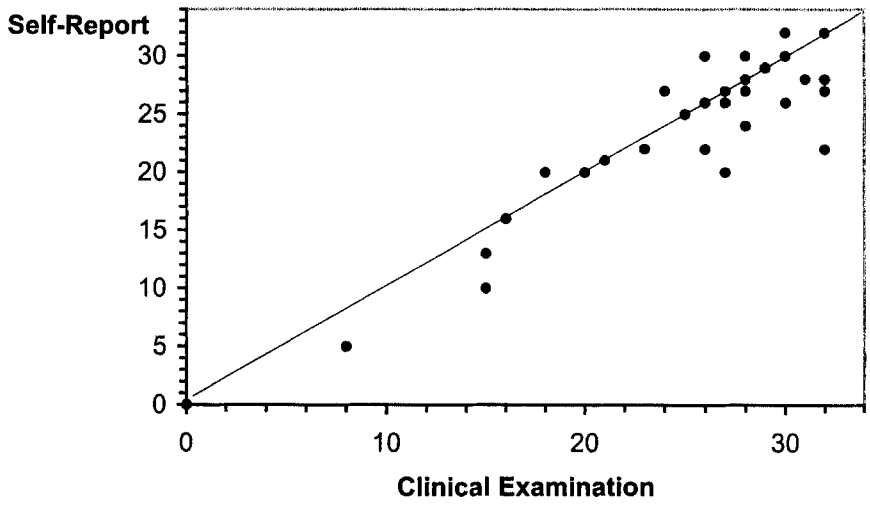
More than 50 percent of the respondents were not able to classify their periodontal disease severity. Among those able to classify, the periodontal severity score obtained from self-report had a reasonable correlation (r=0.56) with the score from radiographs (Table 4).

TABLE 3
Comparison of Self-reported Oral Health Status and Care Measures and Clinical Findings in HSDM Study (*N*=58)

Oral Health Measures	Self-report Mean ± SD	Clinical Exam Mean ± SD	Spearman Correlation
Oral health status Number of decayed teeth	1.4±2.7	2.6±3.2	0.47
Oral health care Number of abutments	0.6±2.1	0.5±1.5	1.00
Number of crowns	1.0±1.9	1.1±1.9	0.91
Number of pontics	0.4±1.5	0.2±0.6	0.89
Number of root canal therapy	0.8±1.5	1.1±2.2	0.83
Number of permanent teeth	25.0±7.3	25.7±6.9	0.78
Number of teeth replaced by dentures	1.2±5.3	1.1±5.2	0.78
Number of fillings*	4.9±4.1	7.0±4.9	0.74
Number of unreplaced missing teeth	0.84±2.07	1.9±3.9	0.52

*Marginally significant difference (t=2.03, P=.05).

FIGURE 3
Self-Reported Number of Teeth and Clinical Findings in HSDM study (*n*=58)



Discussion

First time patients at HSDM were well able to report their own oral health treatment with regard to the numbers of prosthetic appliances, root canal therapy, remaining teeth, and fillings, but were not also able to report their disease status such as dental caries. Douglass et al. (32), in fact, showed that radiographs also do not assess caries well. Our results support previous findings among general population (11,13,14), dental patients (22), and medical patients (8) that people are able to report the presence of removable dentures. We also found that patients can accurately report the presence of fixed prostheses to the

TABLE 4
Comparison of Self-reported Periodontal Disease Severity with Clinical Records in HSDM Study

	Clinical Records				
Self-report	None (0)	Mild (1)	Moderate (2)	Severe (3)	Total
None (0)	10	2	4	1	17
Mild (1)	0	1	0	0	1
Moderate (2)	0	1	1	0	2
Severe (3)	0	1	1	3	5
Total	10	5	6	4	25*

* Excluding 33 patients who responded "don't know."
Note: Percentage of exact agreement = 15/25 = 60.0%.
Percentage of +/- one category = 19/25 = 76.0%.
Spearman correlation coefficient=0.56, P=.003.

level of distinguishing the number of crowns, abutments, and pontics. The agreement between self-reports and clinical findings was lower in a Scandinavian study in which almost 30 percent of the respondents who had a fixed partial denture did not recognize its presence (14).

Number of teeth was shown to be validly reported in several populations. Douglass et al. (10) conducted a study among community-dwelling adults aged 70+ in New England and found no significant differences between self-report and examination data, nor any systematic under- or overreporting of teeth. A study in adult Finnish immigrants in Sweden also found no systematic error in reporting of remaining teeth (7). Three other Scandinavian studies reported a slight tendency toward overreporting (8,14,22), while one study showed a tendency toward underreporting (9). Our results showed a high validity and slight tendency toward underestimation, if any. The degree of underestimation was greater for the number of unreplaced missing teeth and decayed teeth.

Both VADLS and HSDM studies showed low sensitivity and high specificity of the binary periodontal disease measures, consistent with Gilbert's study (25). The low sensitivity indicates that many patients who had periodontitis, by our case definitions, were unaware of their periodontal condition. The tradeoff between sensitivity and specificity values varies according to the threshold of the standard. One of the reasons for low sensitivity in the HSDM study may be because of the liberal criteria used by the dentist for classifying a person as having periodontal disease (having at least one site with CEJ-crestal distance over 1 mm). Another reason for the low validity may be because the periodontal questions asked about current periodontal status, whereas the bone loss measures were cumulative measures. More than half the HSDM participants reported "don't know" for the periodontal severity measure. However, among those who reported periodontal severity the self-report showed a reasonable validity.

Validity of self-reported periodontal measures is less satisfactory in the VADLS population. VADLS participants are older and may have less accurate recall than younger and middle-aged adults. Questions on periodontal treatment had a higher sensitivity and lower specificity as compared with questions on disease condition, which may be expected as people would be unaware of disease until diagnosed and/or treated, but would be aware of treatment. We used alveolar radiographic bone loss as the criterion standard. Some types of periodontal surgery such as gingivectomy and soft tissue grafting involve only soft tissues and are not necessarily related to bone loss. We reanalyzed the data excluding 13 patients who reported having gingivectomy or grafting alone (data not shown), but the results were not substantially different.

Of all the six periodontal measures tested in the two studies, the VADLS's question "Do you have any periodontal/ gum disease?" demonstrated the lowest validity. This question included double conditions: periodontitis and gingivitis. As a result, participants who had a "yes" response did not necessarily have periodontal bone loss that was measured on radiographs (the standard measure). Five other questions appear to be reasonable estimates of periodontal disease and deserve to be included in future studies of self-reported periodontal measures, either as a single measure or part of a composite instrument.

Our study populations may not be representative of the general population, as the HSDM population consisted of individuals utilizing dental care. The VADLS population is a volunteer cohort taking part in a long-term study of aging and health. One would expect such men to be more health conscious than their age-matched peers in the general population. Having received repeated oral examinations over a period of almost 20 years also possibly raised their awareness of oral health. In addition, based on the selection criteria for their entry into the VADLS in the 1960s, the participants also were of somewhat higher socioeconomic status than the general population. Thus, the validity of such self-reports may be expected to be even lower among the general population and in groups with less access to care.

The results do suggest sufficient validity to stimulate the development and validation of more elaborate questions or combination of questions for use in etiologic studies. The validated self-reported measures could easily be incorporated in large cohort studies where clinical examinations may not be feasible.

The specific periodontal measures we evaluated here do not show adequate validity for adoption in epidemiologic studies, except among special populations such as health professionals (26). Our data indicate that participants are well able to report numbers of prosthetic appliances, root canal therapy, remaining teeth, and fillings. Hence, these measures can be used in etiologic studies.

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