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Oral health-related quality of life among HIV-infected and at-risk women

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Abstract – *Objectives:* Objective measures of dental diseases reflect only their clinical end-point. There is a need to use multidimensional measures of diseases that consider their psychosocial aspects and functional impact. The aim of this study is to compare the oral health-related quality of life (OHRQOL) between a group of HIV-infected women and a similar group of at-risk HIV-uninfected women, and to investigate the role of potential confounding clinical oral health and behavioral factors. *Methods:* Our sample included HIV-infected women (87%) and women at risk for HIV infection (13%) followed up for 5.5 years. OHRQOL was measured using the short version of the Oral Health Impact Profile (OHIP-14), which is a validated and reliable instrument. *Results:* HIV-infected women averaged 10% poorer OHRQOL than HIV-uninfected women; this difference was not apparent after adjusting for the number of study visits attended and significant behavioral and clinical oral health factors. The OHRQOL was inversely related to dental and periodontal diseases and to smoking and freebase cocaine use; these relationships were not confounded by HIV status. *Conclusions:* The study identified specific clinical and behavioral factors where dental professionals can intervene to possibly improve the OHRQOL of HIV-infected or at-risk HIV-uninfected women.

Key words: drug use; epidemiology; HIV; oral health; quality of life

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The impact of oral diseases on patients is typically measured by assessing the diseases' objective clinical end-points without consideration of their psychosocial or emotional impact, or their impact on function (1). Oral health-related qualify of life (OHRQOL) instruments have been developed in an attempt to capture this type of information and have been used in oral health surveys, clinical trials, and dental care programs (1–3). These measures, differing in length, clustering of domains, and scoring methodology (2), have been used to demonstrate cross-cultural consistency (4–6) to investigate different populations including the elderly (5, 7–9), and those with specific problems such as lichen planus (10) or oro-facial pain (11).

Unfortunately, OHRQOL surveys have rarely been conducted on HIV/AIDS patients (12). After a literature search, only two validated OHRQOL instruments that had been utilized with HIV-infected populations were discovered. In both the studies, the focus was on males who acquired the disease through sexual activities with other males or intravenous (IV) drug use. The full version of the Oral Health Impact Profile (OHIP-49) was used with HIV-infected Australians in a cross-sectional design to explore correlations between OHRQOL, dental diseases, and periodontal conditions measured by the number of Decayed, Missed, and Filled Teeth (DMFT) and the Community Periodontal Index (CPI) (13). The Global Oral Health Assessment Index (GOHAI) was used in the national HIV Cost and Services Utilization Study and compared with the subjects' self-ratings on a five-point scale of oral symptoms (12). A third

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study used a nonvalidated instrument with a convenience sample of males who were HIV-infected through sexual activities with other males. The study measured dental indices to assess oral health (pocket depth, DMFS, etc.) and determined that access to dental care improved the quality of life in persons with AIDS (14). Clearly what is lacking is a comprehensive analysis of OHRQOL following over time a diverse group of HIV-infected individuals, including women and minorities, using accepted dental indices and validated surveys.

We investigated the physical, functional, and psychosocial impact of HIV infection from an oral health perspective on women over a 5.5-year period. We hypothesized that HIV-infected women would have poorer OHRQOL compared with a similar sample of at-risk HIV-uninfected women; we further hypothesized that clinical oral health and behavioral factors would explain this difference.

Methods

The WIHS study design

The Women's Interagency HIV Study (WIHS) is a longitudinal, multi-centered study that investigates manifestations of HIV infection in women at six sites throughout the United States: Chicago, Los Angeles, Bronx (NY), Brooklyn (NY), San Francisco and Washington, DC (15, 16). Data collection involves comprehensive structured questionnaires, physical examinations, and biological samplings performed at baseline and biannual follow-up visits. No oral health treatment was rendered during these visits. The participants include HIV-infected and at-risk HIV-uninfected women. The WIHS began in 1993 and by 1995 had enrolled 2058 HIV-infected and 568 HIV-uninfected women. In the study, subjects were enrolled in two waves: (i) at the beginning of the study (visit 1), and (ii) in the autumn of 2001 and the spring of 2002 (visits 15 and 16) to counter attrition. Invitations to participate in the oral substudy were made to all the women who were enrolled in the WIHS on a first-come-first-serve basis until the enrollment goal of each site was achieved for each of the HIV-infected and control groups. All sites had the same enrollment goals. Analysis of the populations by site demonstrated no significant differences in age, race, educational attainment, or employment status (16). At the second enrollment period, the goal was to reconstitute the size of the original study population at each site.

The WIHS oral substudy collected calibrated data on salivary glands, dental caries, and periodontal conditions (e.g. pocket depth and loss of attachment). Strict guidelines for protocol administration were provided, and specialists in all related areas participated actively in the training and calibration sessions where all examiners/recorders were calibrated to the golden standard examiner and to each other. These calibration sessions were held multiple times throughout the period of the study for all the examiners, recorders, and investigators. Training included standardized methods for specimen collection, handling, and processing as well as familiarization with the protocol for obtaining all clinical measurements. Moreover, training for the oral interview was carried out through video presentations and role-playing practice. Interview forms were developed in both Spanish and English (16). The methodology and findings of this substudy are described in detail in previous publications (16–25). Previous work showed that the two groups of women in the oral substudy were comparable in terms of their demographic characteristics. The HIV-infected women were more likely to have health insurance and the services of primary care physicians than HIV-uninfected women (77% versus 60% and 93% versus 63%, respectively), possibly because of the availability of services through the Ryan White Care Act (16).

The WIHS OHRQOL study

Four WIHS sites (excluding Brooklyn, NY and Washington, DC) were included in the OHRQOL study. Data were collected from 689 women during 11 study visits beginning 1998. The participation rates in the OHRQOL study from the oral substudy were 74% among HIV-infected and 62% among HIV-uninfected women. The OHIP instrument was administered by the research assistants in formal research interviews. To ensure standardization of data collection, the research assistants were instructed that the questions were to be read exactly as they were worded, with all the responses being given first before the participant gave her answer (16).

Measurement of OHRQOL and the OHIP instrument

The OHIP (3) provides information about the 'burden of illness' attributed to general oral condi-

tions. Higher scores indicate poorer OHRQOL. The full instrument has 49 weighted items and seven dimensions: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. The shorter version (OHIP-14) was developed from an analysis of South Australian data (3), retaining two questions from each dimension. The OHIP-14 has demonstrated high reliability correlation coefficients of 0.88 for elderly South Australians (9), 0.95 for Japanese elders (5), 0.84 for elderly Canadians (2), and 0.90 for middle-aged Britons (10). Furthermore, the validity of the shortened version has been proven (9, 26). This study used the OHIP-14 instrument to measure the OHRQOL of the participants biannually. The instrument was administered by research staff in formal interviews in either Spanish or English (16).

Statistical analysis

Sociodemographic data, clinical oral health indicators, health behavior risk factors, and primary markers of HIV infection (CD4 count; plasma HIV-RNA) as independent variables were evaluated in relation to the OHIP-14 scores (dependent variable) in linear regression models. The scores were weighted as suggested by the instrument's developers (3). Plaque index was used as a categorical variable with three levels: 0 = no plaque, 1 = film plaque detectable with probe only, 2 = visible plaque. The effect of highly active anti-retroviral therapy regimen (HAART) (27) on the OHIP-14 scores was explored as a time-dependent variable. To accommodate multiple study visits per subject, the correlates of the OHIP-14 scores were tested using mixed-effect models with maximum likelihood estimation and an unstructured covariance structure. As a log transformation of the OHIP-14 scores was used to reduce residual heterogeneity, the regression coefficients were transformed using $(100(e^{\beta}) - 1)$ and interpreted as a percent change in the OHIP-14 score per unit change in the independent variable. A best model was built based on a backward selection procedure ($P < 0.05$ to retain variables). All variables significant at $P < 0.05$ were offered as candidate variables. To adjust for the differential length of follow-up among HIV-infected and -uninfected women in the oral substudy, study visit number was forced into the regression model as a series of indicator variables. The models' assumptions of normality and homoscedastic residuals were visually verified. Chi-square and Wilcoxon rank sum tests were used to test for differences at baseline in the distribution of HIV infection by the site of recruitment or by race, and in the distribution of clinical oral health factors at baseline between the two groups of women. SAS version 9.0 (SAS Institute Inc., Cary, NC, USA) was used to conduct all analyses. As this was a substudy of an existing cohort, the sample size was established by the number of eligible and willing participants in the cohort. The study was approved by each local Institutional Review Board and written consents of the participants were obtained.

Results

Of the 689 women recruited, 87% ($n = 597$) were HIV-infected, averaging 38.6 years of age (range 19–64). The sample was primarily comprised of ethnic minority women: African-Americans ($n = 364$; 53%), and Hispanic ($n = 226$; 33%). Caucasians made up 12% ($n = 82$) of the sample. There was no statistically significant difference in the prevalence of HIV by race or by site ($P = 0.88$ and 0.73, respectively). The annual income of 67% ($n = 437$) of the women was ≤$12 000 a year. The number of study visits attended per subject (as a measure of participation) ranged from 1 to 11, with a median of five visits. HIV-infected women averaged 5.9 visits, with HIV-uninfected women averaging 1.7 more visits ($P < 0.0001$). At the first measurement of OHRQOL (baseline), all women had an average smoking history of 14.5 years and 54% were current smokers. Methadone, freebase cocaine, and IV drug use in the last 6 months were reported by 1.5%, 15.9%, and 6.7% of all the women, respectively. These characteristics of our subjects did not differ when considering their HIV status except for current smoking (64% among HIV-infected versus 52% among HIV-uninfected, $P = 0.03$).

At baseline, HIV-infected women had higher OHIP-14 scores (meaning poorer OHRQOL) than HIV-uninfected women (median of 28.4 versus 25.0, $P = 0.03$) (Table 1). While the statistically significant difference between the two groups of women was not apparent at the last measurement, HIV-infected women scored on average about 10% significantly higher throughout the study (unadjusted mean difference, $P = 0.007$, Fig. 1). HIV-infected women therefore had consistently poorer OHRQOL. Adjustment for race and income did not affect this relationship between HIV status and

Table 1. OHIP-14 scores at the beginning, during, and end of the study[a] (n = 689)

	HIV-negative median	HIV-positive median
OHIP-14 score at first study measurement (baseline)[c]	25.0	28.4
OHIP-14 mean score of middle study[b] measurements[c]	25.7	27.6
OHIP-14 score at last study measurement[d]	26.6	27.5

[a]Women visits ranged between 1 and 11 visits with a median of 5; and mean values of 5.9 for HIV-positive and 7.6 for HIV-negative women).
[b]Middle study measurements include all measurements except the patients' first and last study visits.
[c]Statistically significant difference at < 0.05 level between HIV-positive and HIV-negative women.
[d]There are no statistically significant differences between the first measurement and the last measurement for either HIV-positive or HIV-negative women.

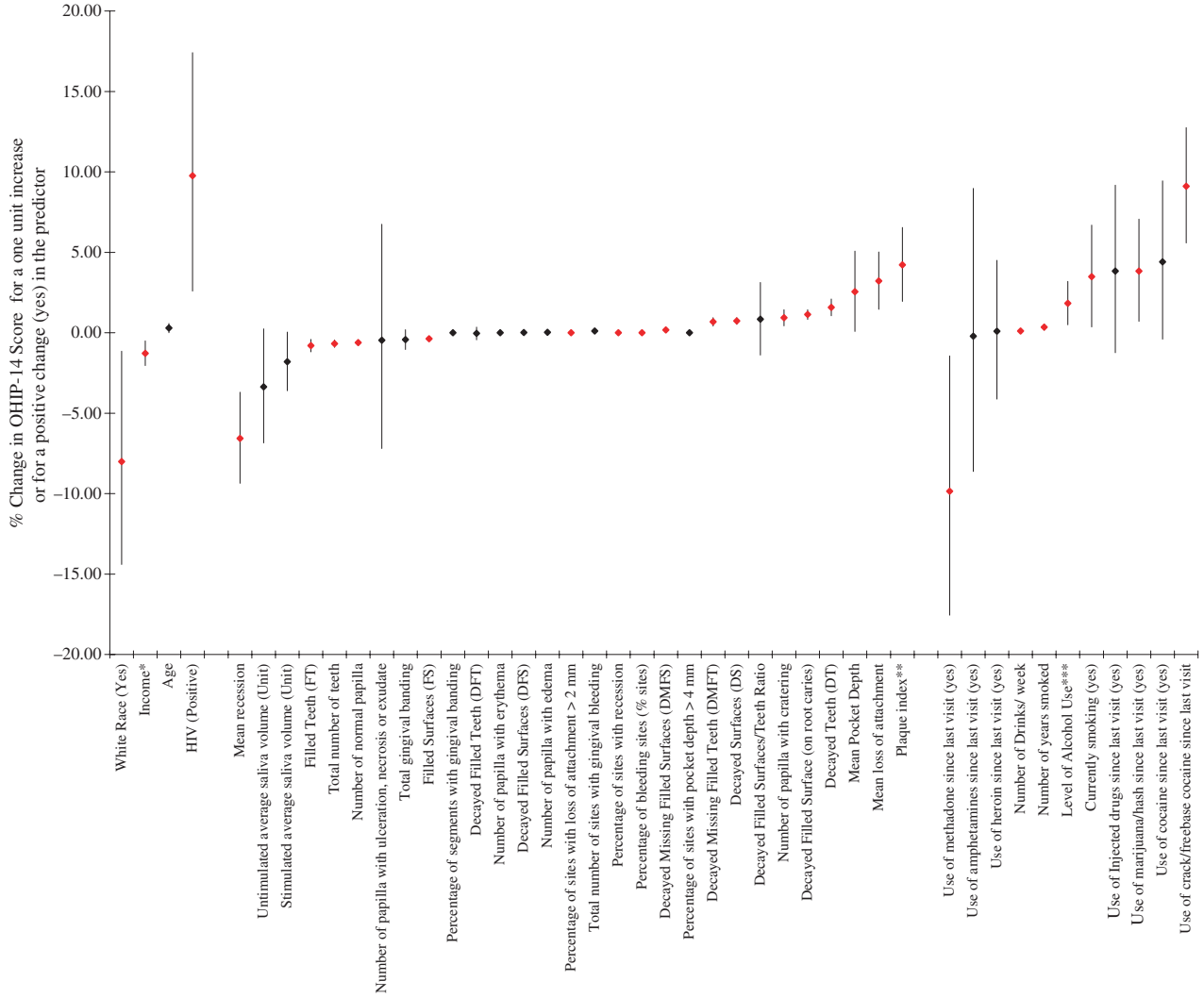

Fig. 1. Univariate modeling of the OHIP-14 scores and the study's demographic, clinical oral health and behavioral factors. Statistics are based on univariate mixed effect linear models. Red points indicate $P < 0.05$. Black points indicate $P \geq 0.05$.
*Income: categorical variable with an increase at each level of $6,000 up to $36,000, then $36,000-$75,000, and $75,000+.
**0= No plaque, 1= Film plaque detectable with probe only, 2= Visible plaque.
***0= Abstainer, 1= Light (<3 drinks/wk), 2= Moderate (3–13 drinks/wk), 3= Heavy (≥14 drinks/wk).

OHIP-14 scores. At baseline, HIV-infected women had significantly more sites with gingival bleeding (median: 6.5 versus 4, $P = 0.004$) and fewer filled teeth (medians: 5 versus 6, $P = 0.008$) than HIV-uninfected women. Salivary measures were not significantly different between the two groups (Table 2), nor were they significantly associated with OHIP-14 scores.

Table 2. Clinical oral health factors at baseline by HIV status[a]

Clinical oral health factors	HIV negative (n = 92) median	HIV positive (n = 597) median
Caries and teeth measures		
Total number of teeth	24.0	23.0
Decayed teeth (DT)	0.0	0.0
Decayed surfaces (DS)	0.0	0.0
Filled teeth (FT)**	6.0	5.0
Filled surfaces (FS)**	11.5	9.0
Decayed filled teeth (DFT)	8.5	8.0
Decayed filled surfaces (DFS)*	19.0	14.0
Decayed filled surfaces (on root caries)	0.0	0.0
Decayed missing filled teeth (DMFT)	14.0	13.0
Decayed missing filled surfaces (DMFS)	41.5	37.0
Number of normal papilla	5.0	5.0
Number of papilla with erythema	3.0	5.0
Number of papilla with edema	1.0	2.0
Number of papilla with ulceration, necrosis or exudate	0.0	0.0
Number of papilla with cratering	0.0	0.0
Periodontal measures		
Plaque index[b,**]	2.0	2.0
Percentage of bleeding sites**	10.7	15.0
Total number of sites with gingival bleeding**	4.0	6.5
Percentage of sites with loss of attachment >2 mm	10.7	16.7
Mean loss of attachment (mm)	1.7	2.1
Percentage of sites with pocket depth >4 mm	0.0	0.0
Mean pocket depth (mm)*	1.7	1.9
Total gingival banding	0.0	0.0
Percentage of segments with gingival banding	0.0	0.0
Percentage of sites with recession	2.3	4.9
Mean recession (mm)	−0.1	−0.1
Salivary measures		
Stimulated average saliva volume (ml/min)	0.7	0.7
Unstimulated average saliva volume (ml/min)*	0.2	0.1

[a]Statistics are based on Wilcoxon rank sum test.
[b]0 = No plaque; 1 = Film plaque detectable with probe only; 2 = Visible plaque.
*$0.01 \le P < 0.05$; **$P < 0.01$.

Using univariate analysis to identify the demographic, oral, and behavioral factors that were related to the OHIP-14 scores, white women had better OHIP-14 scores by 8% compared with nonwhite women ($P = 0.02$); and women earning >$12 000 annually had better OHIP-14 scores by 3% compared with those earning ≤$12 000 ($P = 0.03$). Hispanic and African-American women shared similar OHIP-14 scores ($P = 0.28$). The associations of a one unit or a positive change in clinical oral health or behavioral factors with the OHIP-14 scores were calculated. A 1-mm increase in the mean loss of attachment or mean pocket depth was associated with 3.2% ($P < 0.001$) and 2.6% ($P = 0.04$) poorer OHIP-14 score, respectively. Detectable plaque index also contributed to a 4.2% poorer OHIP-14 score ($P < 0.001$). Behavioral factors associated with the OHIP-14 scores included smoking (current use or history of use), drinking alcohol (number of weekly drinks), and the use of marijuana, freebase cocaine, and/or methadone since the last visit. All, except the use of methadone, were associated with higher OHIP-14 (poorer OHRQOL) scores (Fig. 1).

In multivariate analyses, a model was generated to determine the statistically independent correlates of the relationships between OHIP-14 scores and clinical oral health and behavioral factors. The model included six oral clinical factors: plaque index score, number of papilla with cratering, percentage of bleeding sites, percentage of sites with loss of attachment >2 mm, number of decayed teeth which were positively related to OHIP-14 scores (inversely related to OHRQOL), and total number of teeth where each additional tooth was associated with a 1% (95% CI: 0.7–1.4%) improvement in the OHIP-14 score. The model also included three behavioral factors: number of years smoked, freebase cocaine use, and methadone use (all measured since last visit) (Table 3). When adjusting for these significant clinical and behavioral factors and study visit number, the adjusted regression coefficient for HIV status was 0.05 ($P = 0.14$) and did not appreciably alter the other regression coefficients, indicating that HIV status did not confound the associations of the clinical and behavioral factors with OHIP-14 scores. The multivariate model had an Akaike information criterion of 1423 and a Bayesian information criterion of 1432 compared with 1991 and 2000, respectively, when no variables were inserted in the model.

Among HIV-infected women, time on HAART was related to the OHIP-14 scores and each additional month resulted in a 0.07% (95% CI: 0.0004–0.004%) increase in the score ($P = 0.01$). HIV-RNA viral load was not significantly associated with the OHIP-14 scores by itself ($P = 0.26$); however, after controlling for the detection of HIV-RNA viral load, an increase in the CD4 cell counts by 1% was associated with a 2% (95% CI: 0.1–3.7%) reduction in the OHIP-14 score ($P = 0.03$), implying a better OHRQOL outcome.

Table 3. Multivariate modeling between the OHIP-14 scores and clinical oral health and behavioral factors[a]

	Parameter estimate (SE)	% Actual parameter effect 100 × (e(parameter) − 1)	*P*-value
Intercept	3.4 (0.06)	–	<0.0001
Plaque index[b]	0.03 (0.01)	2.6	0.02
Number of papilla with cratering	0.01 (0.003)	1.0	<0.0001
Percentage of bleeding sites	0.1 (0.03)	0.1	0.001
Percentage of sites with loss of attachment >2 mm	0.06 (0.02)	0.1	0.01
Number of teeth with decay	0.01 (0.003)	1.4	<0.0001
Total number of teeth	−0.01 (0.002)	−1.1	<0.0001
Number of years smoked	0.002 (0.001)	0.2	0.04
Freebase cocaine use since last visit	0.06 (0.02)	6.7	0.0003
Methadone use since last visit	−0.1 (0.05)	−10.2	0.03

[a]The model is adjusted for the study visit number as indicator variables.
[b]0 = No plaque; 1 = Film plaque detectable with probe only; 2 = Visible plaque.

Discussion

In the WIHS oral cohort, HIV-infected women had significantly poorer OHRQOL than HIV-uninfected women. The OHRQOL measured repeatedly over 5.5 years showed an overall average difference of 10% between the two groups. This difference was evident even though the groups were similar in their socioeconomic backgrounds and health behavior risk factors. Our subjects had median OHIP-14 scores ranging from 25.0 points for the HIV-negative women to 28.4 for the HIV-positive women. Overall, these scores are higher than other OHIP-14 scores found in patients with phobic dental anxiety (median of 21 points) (28), those with dentofacial deformity (29) and those with xerostomia (30) (both with averages of 15 points). The OHIP-14 scores averaged 24 points among patients with severe periodontal attachment loss (31), and 21 points among patients with Behcet's disease (32). In our study, OHRQOL was also associated with dental and periodontal diseases and behavioral factors in a multivariate model that is adjusted for the study visit number; HIV status was not a significant or confounder factor in this model. Among HIV-infected women, OHRQOL was further compromised among those who were on HAART or had low CD4 cell counts. It may be reasonable to explain the poorer OHRQOL among HIV-infected women compared with the HIV-uninfected women by their poorer clinical oral health conditions. Given the psychological, social, and physical constructs of the OHIP-14, it is also possible that the difference between the two groups was a result of their different perceptions/attitudes toward their own systemic and oral health conditions. These global perceptions/attitudes were not assessed in our study nor was there an attempt to determine their interaction with the women's access to dental care and patterns of health service utilization. Additionally, our sample was a convenience sample with an unbalanced design with respect to HIV status, which may have compromised the study's statistical power.

Our study demonstrated that certain behavioral risk factors, specifically smoking and freebase cocaine use, were associated with a poorer OHRQOL. In contrast, the national HIV Cost and Services Utilization Study found that intravenous drug users demonstrated the poorest OHRQOL of all HIV exposure groups (12). Although IV drug use was not a significant risk factor in our study, interestingly, methadone usage had a positive association with OHRQOL. Methadone, a long-acting opioid analgesic often used as part of a medically supported rehabilitation program (33), acts by blocking the euphoria of heroin and eliminating heroin-seeking behavior (34) and results in the user becoming involved in rehabilitation or everyday activities. We speculate that the more positive OHRQOL among the WIHS women who used methadone was a result of such programs.

As our HIV-infected group showed poorer oral disease at baseline than the uninfected group, our data are contrary to those obtained from an Australian study of HIV-infected males, who demonstrated similar or better oral health outcomes than the comparison group of general dental patients (13). This study, which employed the DMFT and CPI indices, suggested that these indices might not be sensitive enough to capture

the presence of disease in the HIV-infected and recommended the usage of DMFS and attachment loss indices. These are two of the indices that we used and were found to significantly correlate with the OHRQOL. However, we disagree on the importance of DMFS, because the number of teeth with active decay was a more important correlate of OHRQOL than overall caries experience.

A major confounder when assessing the impact of systemic conditions on oral diseases is the population's access to dental care, which can be a substantial impediment to oral health especially in persons with AIDS (14). Costs of dental care have been shown to be the primary barrier to accessing treatment in other HIV-infected populations (35), although baseline data from the WIHS oral protocol showed that HIV-infected women were more likely to have visited a dental clinic for care within the last 6 months than the HIV-uninfected women (16). A more recent analysis of a subset of the WIHS women showed as well that HIV-infected women reported higher dental care utilization (compared with HIV-uninfected women), resulting in fewer unmet dental needs (36). The protocol for the WIHS oral substudy called for examination of the women by a dentist or dental hygienist at each biannual visit, with feedback provided about their oral conditions and dental needs but no actual dental care delivery. For treatment, the women needed to go elsewhere. Anecdotally, we know that many of the study women became dental patients at their WIHS-host facility. It is likely that more of the HIV-infected women (compared with those uninfected) became dental patients at the affiliated dental school clinics, for their dental problems where funding was made available to provide free/low-cost dental care for HIV-infected patients by the Ryan White Dental Reimbursement Programs. Therefore, the poorer OHRQOL among the WIHS HIV-infected women (compared to the HIV-uninfected) in spite of their self-reported higher dental visitation rate, may either be an artifact of the HIV-infected women's care-seeking behavior or a confirmation of their overall higher oral health need for oral health treatment. This is consistent with the higher rates of salivary hypofunction and/or complaints of dry mouth by those on HAART medications (17), as well as the higher prevalence of mucosal lesions (24) and caries (20) described for the WIHS HIV-infected women (compared with the HIV-uninfected).

Oral diseases have their greatest burden on disadvantaged and socially marginalized populations (37), and oral health disparity among members of minority communities compared with the general population has been clearly demonstrated as has been their relative lack of access to dental care (38, 39). In our study, we found that minority women had poorer OHRQOL than did white women. Similarly, we confirmed that certain HIV-infected populations are disproportionately affected by greater need and less available oral health care. These include women, African-Americans, the less educated, those with lower income or no insurance, and nongay persons or IV drug users (40).

In conclusion, the study identified specific clinical and behavioral factors where dental professionals can intervene to possibly improve the OHRQOL of HIV-infected or at-risk HIV-uninfected women; for example by reducing levels of plaque and discouraging cocaine use. Our results might be generalizable to similar populations of vulnerable HIV-infected women. Women in our sample, because of their HIV status, benefited from a public healthcare program (including oral health care). It is more likely that women who do not benefit from such programs will endure poorer levels of OHRQOL compared with the general population. To further advance our understanding of this disparity in OHRQOL, there is need for a more comprehensive study of OHRQOL that measures simultaneous opportunistic infections and oral lesions as well as the subjects' oral health perspectives and psychosocial aspects of life.

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