

Baseline characteristics of participants in the oral health component of the Women's Interagency HIV Study

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Mulligan R, Phelan JA, Brunelle J, Redford M, Pogoda JM, Nelson E, Seirawan H, Greenspan JS, Navazesh M, Greenspan D, Alves MEAF. Baseline characteristics of participants in the oral health component of the Women's Interagency HIV Study. *Community Dent Oral Epidemiol* 2004; 32: 86–98. © Blackwell Munksgaard, 2004

Abstract – Objectives: This study described baseline sociodemographic and oral health characteristics of a subset of HIV sero-positive and sero-negative women who participated in the oral health component of the Women's Interagency HIV Study (WIHS). **Methods:** In 1995–96, 584 HIV sero-positive and 151 sero-negative women from five WIHS core sites were enrolled in the oral study. Data on oral mucosa, salivary glands, dentition and periodontium, along with demographics, socioeconomics, and behavioral characteristics, were used to characterize this population. **Results:** Mean (SD) age was 37 (8) years for HIV sero-positive and 36 (8) years for sero-negative women; 27% of sero-positive women had CD4 counts ≤ 200 and 34% had viral loads $> 50\,000$ copies/ml. Sero-positive and sero-negative women were similar demographically, as well as on plaque index, gingival bleeding, linear gingival banding, and numbers of DMF teeth and surfaces, but sero-positive women had more abnormal gingival papilla ($P = 0.004$) and fewer teeth ($P = 0.01$). Among sero-positive women, those with < 200 CD4 counts had more DMF teeth ($P = 0.007$), and the number of DMF surfaces increased with decreasing CD4 counts ($P = 0.04$). Sero-positive women who fit the Center for Disease Control (CDC) AIDS criteria were also more likely to have more DMF teeth ($P = 0.004$), DMF surfaces ($P = 0.003$), and decayed and/or filled (DF) root surfaces ($P = 0.0002$) compared to sero-positive women without AIDS. **Conclusions:** Dental and periodontal variables showed little difference between HIV sero-positive and sero-negative women. Among sero-positive women, there were significant differences in coronal and root caries by AIDS diagnostic criteria, but no periodontal indicators by either AIDS diagnostic criteria or CD4 status, were observed.

Key words: caries; CD4 count; demographics; dental; HIV; periodontal disease; WIHS; women

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Submitted 28 January 2003;
accepted 14 August 2003

During the early 1990s, the greatest burden of human immunodeficiency virus (HIV-1) infection in the US shifted from white homosexual/bisexual males to African-American and Latina women (1), which was the result of heterosexual transmission and injectable drug use. In response, the Women's Interagency HIV Study (WIHS) was inaugurated in 1993. The WIHS is a multicenter, nation-wide longitudinal study of HIV sero-positive and at-risk sero-negative women supported by a collaboration of agencies of the National Institutes of Health, and

is the largest US cohort of HIV sero-positive women being studied to date (2).

As part of the WIHS, a comprehensive oral health component was initiated to investigate the relationship between HIV infection and the status and course of oral conditions in women. It has been observed that oral diseases may present differently in immunodeficient than in uncompromised persons (3, 4), with the development of certain oral lesions related to level and duration of HIV sero-positivity (5–10). Few studies have featured HIV-related oral diseases

exclusively in women (11–13) or detailed findings on periodontal disease and caries in HIV-infected populations (14–16), although there is extensive literature on the mucosal lesions of HIV infection (17). Initially, atypical necrotizing gingival and periodontal disease (18, 19) and linear gingival erythema (LGE) were documented as occurring in HIV-infected men (20). The finding of periodontal disease in HIV-infected persons is consistent with the recognition that the occurrence and progression of periodontal diseases are influenced by immunologic factors (21). In contrast to these findings, the presentation of caries in the HIV-infected person is less well understood with some investigators demonstrating increasing (22) and others demonstrating decreasing rates of dental caries (16) when antiretroviral therapy is in use.

It is the purpose of this paper to: (i) characterize baseline demographic, socioeconomic, and behavioral data from the oral subpopulation of the WIHS and compare them to the overall WIHS cohort; (ii) assess group (HIV sero-positive vs. sero-negative) differences on these same factors; (iii) characterize and compare group differences on dental and periodontal variables; and (iv) assess relationships between dental and periodontal variables and indicators of HIV progression (CD4 counts and AIDS diagnoses).

Background on the WIHS core study

The purpose of the core WIHS study is to investigate the impact of HIV infection in women. Primary research objectives are to assess the spectrum and course of clinical manifestations of HIV infection and to investigate the risk factors associated with infections, treatment, endocrine findings, nutrition, health care utilization, socioeconomics, and behavioral risk factors that may be related to the rate and type of HIV disease progression. Methods for the WIHS core study have been presented in detail (2), but will be summarized here to describe the background from which the oral protocol cohorts were derived.

Study participants were recruited from urban HIV primary care clinics, hospital-based programs, research programs, community outreach sites, women's support groups, drug rehabilitation programs, HIV testing sites, and referrals from enrolled participants. Recruitment procedures varied from site to site; however, sero-positive and sero-negative women were recruited from similar sources and matched on demographics and key risk factors such as age, race/ethnicity, education, injection drug use, and number of sexual partners.

To be eligible, a woman had to be at least 13 years old, give informed consent, agree to be tested for HIV, complete the interview in English or Spanish, travel to and from the site/clinic to participate in the baseline visit, and have blood drawn for laboratory testing. Examinations and interviews were scheduled every 6 months. At baseline, there were 2058 sero-positive and 568 sero-negative core participants enrolled at six clinical sites in the US. Age ranged from 16 to 73 years, with mean ages of 36 and 34 years for the sero-positive and sero-negative cohorts, respectively. Any woman enrolled in the WIHS core was eligible to participate in the oral protocol, provided they signed the oral protocol consent form. The aim at each site was to enroll approximately 125–130 sero-positive and 30 sero-negative women in the oral protocol. Incentives such as dental care, transportation, gift packs, product coupons, and vouchers for grocery stores were used to encourage long-term participation.

Methods

Sites

Five of the six core sites – Bronx, NY; Washington, DC; Los Angeles, CA; San Francisco, CA; and Chicago, IL – participated in the oral protocol. Oral visits were scheduled within 2 weeks of core visits so that core visit data could be used in conjunction with oral visit data in analyses. Core visit data included sociodemographics, general health status indicators, medication use, health care access and insurance indicators, primary markers of HIV infection (e.g. CD4 and HIV RNA), HIV risk indicators, and HIV status. All procedures, training, forms, and data collection, editing and analyses have been centralized in a separate data management and analytic coordinating center that has never been one of the examination sites.

Training

Before clinical examinations began, a collaborative training session was held for principal investigators, oral health examiners (dentists and dental hygienists), coordinators, and data recorders/assistants. Organization and direction for the training session were under the management of the Statistical and Clinical Coordinating Center of the New England Research Institute, with input from project staff of the National Institute of Dental and Craniofacial Research.

Training for the oral interview was carried out through video presentations and role-playing prac-

tice. Strict guidelines for questionnaire administration were provided, and both core and oral protocols followed standardized conventions for instrument design. The primary trainer for most clinical examination components was also the individual who performed the quality control oral examinations. Specialists in salivary gland evaluation and saliva collection, soft tissue lesion diagnosis, and specimen collection and data recording participated actively in the training and calibration sessions. Practice examinations were performed on 75 consenting volunteers. Individual exam results of each examiner/recorder team were compared to that of the gold standard examiner, and feedback was provided. Additional subjects were then examined by each team, until an adequate match rate was achieved. In this way, all examining teams were calibrated to the gold standard examiner and to each other. Training included standardized methods for specimen collection, handling, processing, labeling, storage, and shipping, as well as familiarization with the protocol for obtaining all clinical measurements. Examiner manuals and data collection materials were designed and distributed to all participating sites by the coordinating center. Training in form use was integral to all other parts of training. Interview forms were developed in both Spanish and English. All sites had approval from their respective Institutional Review Boards (IRBs) prior to approaching potential subjects.

Clinical assessments

Prior to oral clinical assessment, a medical evaluation questionnaire was administered to the study participants to determine the need for prophylactic antibiotics, and medication was provided if indicated. The components of the oral protocol examination were: (i) questionnaire on oral health habits; (ii) saliva samples, including whole saliva, both unstimulated (collected by the draining method (23)) and chewing-stimulated (collected by the spitting method), to determine flow rate; (iii) oral mucosal tissue exam (pathologic lesions described using the standardized methods recommended by the USA Oral AIDS Collaborative Group (24) and the European Union Clearinghouse on Oral Problems Related to HIV Infection (25)); (iv) salivary gland examination (visual characteristics and findings upon palpation); (v) smears (putative candida and herpes lesions); (vi) periodontal examination part I (including plaque index, gingival banding score, and papillary assessment score (PAS)); (vii) subgingival plaque sampling for specific periodontal

conditions; (viii) dental caries (including coronal and root caries); (ix) periodontal examination part II (including gingival bleeding and loss of attachment scoring); (x) prosthesis assessment; and (xi) treatment needs assessment and referral.

The soft tissue exam emphasized those lesions thought to be more prevalent in HIV sero-positive individuals and others with lowered immunity (25). The salivary gland examination assessed the parotid, submandibular, and sublingual glands for enlargement, tenderness, and saliva expression upon palpation, using a previously published method (26). Smears were taken from putative candidal and herpetic lesions and sent to the laboratory for confirmation of herpes diagnosis, or to the central repository for future investigations of candidal specimens.

Counts of the number of teeth present in both arches and the number of occluding pairs were recorded. For periodontal examinations, one maxillary and one mandibular quadrant were randomly designated, based on the even or odd sequencing of ID numbers. The quadrants selected remained the same for each subsequent examination. If a participant presented with fewer than 10 teeth, all remaining teeth were evaluated. Plaque assessment was a modification of the Silness and L oe Gingival Plaque Index (27), with the two highest categories of subgingival assessment from the original index collapsed into one group. Gingival banding or LGE recording assessed the presence or absence of a continuous band of erythema at the gingival margin at least 1 mm in width that extended from the mesial to distal line angle of the tooth surface (28, 29). The PAS examined the interdental papillae from both buccal and lingual aspects for signs of erythema, edema, necrosis, cratering, necrosis with exposed bone, and spontaneous bleeding (29). It was possible to record multiple conditions for each site. Subgingival plaque samples were collected from sites that exhibited positive gingival banding scores on facial aspects or for any site that received a PAS of necrosis or exposed alveolar bone. Gingival bleeding and loss of attachment (30) were assessed at four sites per tooth (distal, mid- and mesial-buccal, and mid-lingual) in the randomly designated quadrant selected (31).

Coronal and root caries assessments were performed on all teeth present using the same criteria used in recent national surveys, i.e. criteria derived from Radike, with a coding system modified by the National Institutes of Dental and Craniofacial

Research (NIDCR; 31). Presence of full or partial prostheses and whether they were a source of trauma, irritation, or infection were also recorded. The examination closed with a recording of any treatment needs and discussion of these findings with the participant.

Quality assurance and checking of data collection and entry systems were monitored, and periodic reports were generated. Error correction notices were sent back to individual examiners for resolution. Site visits by the coordinating center and NIDCR project staff were scheduled approximately every other year, at which time, the retraining and recalibration of examiners was performed if necessary. Determination of AIDS status was based on the 1993 CDC revised classification and expanded surveillance case definition for AIDS (33).

Statistical methods

All demographic, HIV-related, and dental health variables were categorical. For each demographic variable, difference by HIV status within the oral study group was tested using logistic regression, with HIV status as the dependent variable and the demographic as the independent variable. Differences in demographics by oral study participation were tested by including study group and a term for the interaction between the demographic and study group as independent variables in each model, where the interaction term tested for difference by study group. Group differences in HIV-related factors and in factors related to dental health were tested by Chi-square tests of association. Differences in dental and periodontal outcomes by HIV status, CD4 levels, and AIDS status were tested using logistic regression for categorical outcomes and non-parametric analysis of covariance (32) for continuous outcomes. For both types of analyses, the dental/periodontal outcome was the dependent variable and HIV, CD4 group (<200, 200–500, >500), or AIDS status (33) was the independent variable. Analyses of covariance used number of teeth or total number of sites evaluated as appropriate covariates. Age was also included as a covariate in analyses of dental outcomes. As number of decayed and/or filled (DF) surfaces and plaque index were categorized for analysis, ordinal logistic regression was used. All significance tests were performed at the 0.05% level using SAS statistical software, Version 8.0 (SAS Institute, Inc., Cary, NC, USA). Subjects with missing values were excluded from relevant analyses.

Results

Recruitment

Five hundred and eighty-four sero-positive and 151 at-risk sero-negative women were enrolled in the oral study of WIHS from April 1995 to August 1996. Age at oral study enrollment ranged from 17 to 61 years, with mean age (SD) of 37 (8) years for sero-positive and 36 (8) years for sero-negative women. Detailed demographics at the time of WIHS enrollment for oral study participants compared to the overall WIHS are shown in Table 1.

In the oral study, sero-positive women were more likely than sero-negative women to be unemployed ($P = 0.04$), to have health insurance ($P < 0.0001$), to have a primary care physician ($P < 0.0001$), and to have identified HIV risk factors, i.e. IV drug use or heterosexual contact ($P = 0.0001$). Compared to WIHS participants who did not enroll in the oral study, income was lower in sero-positive oral study enrollees and somewhat higher in sero-negative enrollees ($P = 0.03$), and health insurance coverage was less discrepant between sero-positive and sero-negative women in the oral study than it was in the overall WIHS ($P = 0.04$).

Factors specific to the HIV-positive women (CD4, viral load, and antiretroviral medications) were compared between the oral study participants and the overall WIHS, and are presented in Table 2. In the oral cohort, 27% of the sero-positive women had CD4 counts of ≤ 200 and 34% had viral loads of $> 50,000$ copies/ml. Baseline CD4 counts were higher ($P = 0.004$) and the proportion of sero-positive women who had used nucleoside-RTIs was lower ($P = 0.04$) in the oral study than in WIHS participants who were not in the oral study. Only 1% of the oral study population was using highly active antiretroviral therapy (HAART).

Factors related to dental health at the time of oral study enrollment by HIV status are shown in Table 3. HIV sero-positive and sero-negative women were similar in terms of tobacco and alcohol use; however, the sero-positive women were more likely to have seen a dentist in the last 6 months ($P = 0.04$) and were less likely to have recently used illegal drugs than the sero-negative women ($P = 0.03$).

Dental status indicators at the time of oral study enrollment by HIV status are shown in Table 4. Only number of teeth differed by HIV status, with sero-positive women having fewer teeth than sero-negative women ($P = 0.01$). Among HIV-positive women, median numbers of DMF teeth and DMF surfaces

Table 1. Demographic and socioeconomic characteristics at entry into WIHS by HIV status (oral study participants and all WIHS participants)

| Demographic | Oral study | | | | Oral study (<i>P</i> -value) ^a | All WIHS | | | | Comparison (<i>P</i> -value) ^b |
|------------------------------|------------------------|----|------------------------|----|---|-------------------------|----|------------------------|----|---|
| | HIV+ (<i>n</i> = 584) | | HIV- (<i>n</i> = 151) | | | HIV+ (<i>n</i> = 2059) | | HIV- (<i>n</i> = 569) | | |
| | No. | % | No. | % | | No. | % | No. | % | |
| Study site | | | | | | | | | | |
| Bronx | 109 | 18 | 29 | 19 | 0.50 | 420 | 20 | 120 | 21 | 0.97 |
| Brooklyn | 0 | 0 | 0 | 0 | | 311 | 15 | 86 | 15 | |
| Georgetown | 81 | 14 | 29 | 19 | | 296 | 14 | 102 | 18 | |
| Los Angeles | 134 | 23 | 35 | 23 | | 422 | 20 | 112 | 20 | |
| San Francisco | 128 | 22 | 29 | 19 | | 336 | 16 | 90 | 16 | |
| Chicago | 132 | 23 | 29 | 19 | | 274 | 13 | 59 | 10 | |
| Age | | | | | | | | | | |
| <20 | 8 | 1 | 1 | 1 | 0.52 | 15 | 1 | 14 | 2 | 0.07 |
| 20–29 | 106 | 18 | 34 | 23 | | 384 | 19 | 155 | 27 | |
| 30–39 | 254 | 43 | 69 | 46 | | 992 | 48 | 239 | 42 | |
| 40–49 | 187 | 32 | 42 | 28 | | 559 | 27 | 138 | 24 | |
| 50+ | 29 | 5 | 5 | 3 | | 107 | 5 | 23 | 4 | |
| Unknown | 0 | – | 0 | – | | 2 | – | 0 | – | |
| Race/ethnicity | | | | | | | | | | |
| Black | 342 | 59 | 86 | 57 | 0.75 | 1142 | 56 | 302 | 53 | 0.71 |
| Hispanic | 138 | 24 | 41 | 27 | | 484 | 24 | 158 | 28 | |
| White | 91 | 16 | 22 | 15 | | 375 | 18 | 89 | 16 | |
| Other | 13 | 2 | 2 | 1 | | 55 | 3 | 19 | 3 | |
| Unknown | 0 | – | 0 | – | | 3 | – | 1 | – | |
| Education | | | | | | | | | | |
| Did not complete high school | 229 | 39 | 50 | 33 | 0.17 | 767 | 37 | 210 | 37 | 0.13 |
| Completed high school | 355 | 61 | 101 | 67 | | 1290 | 63 | 359 | 63 | |
| Unknown | 0 | – | 0 | – | | 2 | – | 0 | – | |
| Employed | | | | | | | | | | |
| No | 483 | 83 | 113 | 75 | 0.04 | 1627 | 79 | 406 | 71 | 0.85 |
| Yes | 100 | 17 | 37 | 25 | | 424 | 21 | 162 | 29 | |
| Unknown | 1 | – | 1 | – | | 8 | – | 1 | – | |
| Annual household income | | | | | | | | | | |
| \$0–6000 | 193 | 35 | 44 | 31 | 0.38 | 573 | 29 | 183 | 34 | 0.03 |
| \$6001–12000 | 193 | 35 | 53 | 37 | | 687 | 35 | 155 | 29 | |
| \$12001–18000 | 71 | 13 | 13 | 9 | | 242 | 12 | 58 | 11 | |
| \$18000+ | 101 | 18 | 32 | 23 | | 481 | 24 | 139 | 26 | |
| Unknown | 26 | – | 9 | – | | 76 | – | 34 | – | |
| Health insurance | | | | | | | | | | |
| No | 130 | 23 | 60 | 40 | <0.0001 | 359 | 18 | 226 | 40 | 0.04 |
| Yes | 447 | 77 | 90 | 60 | | 1682 | 82 | 335 | 60 | |
| Unknown | 7 | – | 1 | – | | 18 | – | 8 | – | |
| Primary care physician | | | | | | | | | | |
| No | 38 | 7 | 55 | 37 | <0.0001 | 150 | 7 | 184 | 33 | 0.17 |
| Yes | 536 | 93 | 95 | 63 | | 1888 | 93 | 376 | 67 | |
| Unknown | 10 | – | 1 | – | | 21 | – | 9 | – | |
| Dental insurance | | | | | | | | | | |
| No | 409 | 91 | 79 | 88 | 0.26 | 1465 | 87 | 280 | 84 | 0.74 |
| Yes | 38 | 9 | 11 | 12 | | 215 | 13 | 55 | 16 | |
| Unknown | 137 | – | 61 | – | | 379 | – | 234 | – | |
| HIV risk category | | | | | | | | | | |
| IV drug use | 250 | 43 | 55 | 36 | 0.0001 | 694 | 34 | 158 | 28 | 0.62 |
| Heterosexual contacts | 224 | 39 | 45 | 30 | | 849 | 42 | 145 | 26 | |
| Transfusion | 18 | 3 | 4 | 3 | | 81 | 4 | 15 | 3 | |
| Unidentified | 86 | 15 | 47 | 31 | | 413 | 20 | 246 | 44 | |
| Unknown | 6 | – | 0 | – | | 22 | – | 5 | – | |

^aTests of differences between HIV+ and HIV- among oral study participants.

^bTests of differences in HIV+ and HIV- distributions between oral study participants and subjects who did not enroll in the oral study.

Table 2. CD4, viral load, and antiretroviral medications at entry into WIHS (HIV+ oral study participants and all HIV+ WIHS participants)

| HIV-related factors | Oral study (<i>n</i> = 584) | | WIHS (<i>n</i> = 2059) | | % |
|-------------------------------|------------------------------|-----|-------------------------|------------------------------|-------|
| | No. | % | No. | <i>P</i> -value ^a | |
| CD4 count | | | | | |
| ≤200 | 151 | 27 | 446 | 31 | 0.004 |
| 201–500 | 238 | 42 | 631 | 45 | |
| >500 | 175 | 31 | 340 | 24 | |
| Unknown | 20 | – | 58 | – | |
| Viral load (copies/ml) | | | | | |
| ≤4000 | 173 | 31 | 386 | 27 | 0.09 |
| 4001–50000 | 200 | 35 | 496 | 34 | |
| >50000 | 193 | 34 | 561 | 39 | |
| Unknown | 18 | – | 32 | – | |
| Ever Nucleoside-RTIs | | | | | |
| No | 231 | 40 | 512 | 35 | 0.04 |
| Yes | 352 | 60 | 958 | 65 | |
| Unknown | 1 | – | 5 | – | |
| Ever non-nucleoside-RTIs | | | | | |
| No | 574 | 98 | 1459 | 99 | 0.10 |
| Yes | 9 | 2 | 11 | 1 | |
| Unknown | 1 | – | 5 | – | |
| Ever protease inhibitors | | | | | |
| No | 583 | 100 | 1470 | 100 | – |
| Unknown | 1 | – | 5 | – | |
| Highest level of therapy used | | | | | |
| None | 230 | 39 | 512 | 35 | 0.08 |
| Mono | 194 | 33 | 487 | 33 | |
| Combination | 153 | 26 | 461 | 31 | |
| HAART | 6 | 1 | 10 | 1 | |
| Unknown | 1 | – | 5 | – | |

^aTests of differences between oral study participants and subjects who did not enroll in the oral study.

significantly differed by levels of CD4 ($P = 0.03$); in pairwise comparisons, women with CD4 < 200 had more DMF teeth than women with CD4 between 200 and 500 ($P = 0.007$). Further, number of DMF surfaces increased with decreasing CD4 (P -trend = 0.04; Table 5). Compared to other HIV-positive women, those with AIDS-defining conditions had fewer teeth ($P = 0.01$) and more DMF teeth ($P = 0.004$), DMF surfaces ($P = 0.003$), and DF surfaces on roots ($P = 0.0002$; Table 6).

Periodontal status indicators at the time of oral study enrollment by HIV status are shown in Table 7. Sero-positive women had a greater percentage of abnormal papilla than sero-negative women ($P = 0.004$), but were similar to sero-negative women in terms of plaque index, gingival bleeding, and gingival banding. There were no differences in periodontal indicators among HIV-positive women by levels of CD4 (Table 8) or by AIDS status (Table 9).

Discussion

Some baseline descriptive data from the oral component of the WIHS have already been published relative to oral health findings. We have not attempted to review these data here, but instead, we refer to previously published works describing other aspects of the baseline oral findings, such as salivary gland enlargement, tenderness, and absence of saliva upon palpation (34); prevalence of xerostomia and salivary gland hypofunction (35); presence of oral lesions (36); and presence of candidiasis (37).

Unlike previously published reports from the WIHS oral component, this paper describes baseline socioeconomic, demographic, and behavioral characteristics of oral study participants and compares these factors by HIV status. This report also compares, by HIV status, several dental and periodontal health markers including plaque level, gingival

Table 3. Factors related to dental health at time of oral study entry by HIV status

| Dental health factors | HIV+ (<i>n</i> = 584) | | HIV- (<i>n</i> = 151) | | <i>P</i> -value |
|-----------------------------|------------------------|----|------------------------|----|-----------------|
| | No. | % | No. | % | |
| Dental visit last 6 months | | | | | |
| No | 406 | 70 | 121 | 80 | 0.04 |
| Yes | 176 | 30 | 30 | 20 | |
| Unknown | 1 | – | 0 | – | |
| Smoking status | | | | | |
| Never smoked | 135 | 24 | 23 | 16 | 0.09 |
| Ex-smoker | 84 | 15 | 23 | 16 | |
| Current smoker | 347 | 61 | 102 | 69 | |
| Unknown | 18 | – | 3 | – | |
| Years smoked (smokers only) | | | | | |
| ≤10 | 82 | 19 | 37 | 30 | 0.24 |
| 11–20 | 170 | 39 | 43 | 34 | |
| 21–30 | 138 | 32 | 34 | 27 | |
| >30 | 41 | 10 | 11 | 9 | |
| Alcohol use | | | | | |
| Abstainer | 213 | 36 | 52 | 34 | 0.41 |
| Non-abstainer | 206 | 35 | 48 | 32 | |
| Received alcohol treatment | 165 | 28 | 51 | 34 | |
| Illegal drug use | | | | | |
| Never used | 77 | 13 | 10 | 7 | 0.03 |
| Used in the past | 228 | 39 | 54 | 36 | |
| Recently used | 279 | 48 | 87 | 58 | |

linear banding, gingival bleeding, papillary tissue scoring, and number of teeth and dental caries (including coronal and root caries) scored as DMF teeth and DMF surfaces. Additionally, these dental and periodontal variables are described in relationship to CD4 counts and AIDS diagnoses of HIV seropositive women.

These comparisons demonstrate that the seropositive and seronegative cohorts in the oral component of the WIHS are quite similar to each other as they are to the larger WIHS population with regard to basic sociodemographic characteristics, including age, race/ethnicity, and educational attainment. Clearly, the oral subgroup is reflective of the overall

Table 4. Dental status at time of oral study entry by HIV status

| Dental characteristic | HIV+ (<i>n</i> = 584) | HIV- (<i>n</i> = 151) | <i>P</i> -value |
|---|------------------------|------------------------|-----------------|
| No. of edentulous (%) | | | |
| No | 539 (93) | 144 (95) | 0.29 |
| Yes | 41 (7) | 7 (5) | |
| Unknown | 4 | 0 | |
| Median no. of teeth (IQR ^a) | 24 (19–27) | 26 (21–28) | 0.01 |
| Median no. of DMF teeth (IQR) | 14 (9–19) | 13 (8–18) | 0.68 |
| Median no. of DMF surfaces (IQR) | 37 (20–62) | 31 (15–55) | 0.65 |
| Median no. of tooth caries (IQR) | 2 (0–4) | 2 (0–4) | 0.65 |
| Median no. of surface caries (IQR) | 3 (0–6) | 3 (0–6) | 0.63 |
| Median no. of tooth fillings (IQR) | 5 (1–8) | 5 (2–8) | 0.88 |
| Median no. of surface fillings (IQR) | 8 (3–14) | 8 (2–14) | 0.66 |
| No. of DF surfaces – root caries (%) | | | |
| 0 | 349 (65) | 100 (70) | 0.17 |
| 1 | 51 (9) | 14 (10) | |
| 2–4 | 73 (14) | 20 (14) | |
| >4 | 65 (12) | 9 (6) | |
| Unknown | 1 | 1 | |

^aIQR, interquartile range (25th–75th percentiles).

Table 5. Dental status at time of oral study entry by CD4 (HIV+ women only)

| Dental characteristic | CD4 | | | P-value |
|---|----------------|-------------------|----------------|---------|
| | <200 (n = 159) | 200–500 (n = 251) | >500 (n = 159) | |
| No. of edentulous (%) | | | | |
| No | 146 (92) | 233 (94) | 147 (93) | 0.97 |
| Yes | 12 (8) | 16 (6) | 11 (7) | |
| Unknown | 1 | 2 | 1 | |
| Median no. of teeth (IQR ^a) | 24 (18–27) | 24 (19–27) | 24 (19–27) | 0.92 |
| Median no. of DMF teeth (IQR) | 15 (11–20) | 14 (9–19) | 13 (9–18) | 0.03 |
| Median no. of DMF surfaces (IQR) | 41 (24–70) | 37 (17–59) | 35 (19–59) | 0.03 |
| Median no. of tooth caries (IQR) | 2 (0–5) | 2 (0–3) | 2 (0–5) | 0.32 |
| Median no. of surface caries (IQR) | 3 (0–6) | 2 (0–5) | 3 (0–6) | 0.40 |
| Median no. of tooth fillings (IQR) | 5 (2–8) | 5 (1–8) | 4 (1–8) | 0.89 |
| Median no. of surface fillings (IQR) | 9 (2–14) | 8 (3–15) | 8 (3–14) | 0.85 |
| No. of DF surfaces – root caries (%) | | | | |
| 0 | 88 (60) | 164 (71) | 92 (63) | 0.11 |
| 1 | 19 (13) | 20 (9) | 11 (7) | |
| 2–4 | 21 (14) | 22 (9) | 26 (18) | |
| >4 | 19 (13) | 26 (11) | 18 (12) | |
| Unknown | 12 | 19 | 12 | |

^aIQR, interquartile range (25th–75th percentiles).

study population that was designed to represent the general population of women acquiring HIV at the time of study enrollment. In 1996, when the majority of the women were enrolled, 59% of women diagnosed with AIDS in the US were black, 19% were Hispanic, and 21% were white (38). In the seropositive cohort of the WIHS oral component, 59% were black, 24% were Hispanic, and 16% were white. The most recent data demonstrate that the HIV epidemic continues to infect minority women disproportionately, with 2001 statistics estimating

the rates for black and Hispanic women acquiring new HIV-1 infections to be 63 and 17%, respectively, of all affected women (39). Therefore, the heavy enrollment of minority women in the WIHS oral component is appropriate for representing the general population of HIV-infected women in the US.

As income level has been closely linked to oral health status (40), it should be noted that both the HIV seropositive and seronegative groups had similar annual household incomes that were well below the poverty level. Although both groups

Table 6. Dental status at time of oral study entry by AIDS status (HIV+ women only)

| Dental characteristic | AIDS | | P-value |
|---|--------------|---------------|---------|
| | No (n = 332) | Yes (n = 239) | |
| No. of edentulous (%) | | | |
| No | 311 (94) | 220 (92) | 0.56 |
| Yes | 21 (6) | 18 (8) | |
| Unknown | 2 | 2 | |
| Median no. of teeth (IQR ^a) | 24 (20–27) | 23 (18–26) | 0.01 |
| Median no. of DMF teeth (IQR) | 13 (9–18) | 15 (11–21) | 0.004 |
| Median no. of DMF surfaces (IQR) | 34 (17–56) | 43 (24–72) | 0.003 |
| Median no. of tooth caries (IQR) | 2 (0–4) | 2 (1–5) | 0.07 |
| Median no. of surface caries (IQR) | 2 (0–6) | 3 (1–7) | 0.08 |
| Median no. of tooth fillings (IQR) | 5 (1–8) | 4 (2–8) | 0.66 |
| Median no. of surface fillings (IQR) | 8 (3–15) | 8 (3–14) | 0.52 |
| No. of DF surfaces – root caries (%) | | | |
| 0 | 223 (72) | 124 (56) | 0.0002 |
| 1 | 22 (7) | 28 (13) | |
| 2–4 | 38 (12) | 33 (15) | |
| >4 | 27 (9) | 36 (16) | |
| Unknown | 24 | 19 | |

^aIQR, interquartile range (25th–75th percentiles).

Table 7. Periodontal status at time of oral study entry by HIV status

| Periodontal characteristic | HIV+ (<i>n</i> = 584) | HIV- (<i>n</i> = 151) | <i>P</i> -value |
|---|------------------------|------------------------|-----------------|
| No. of plaque index (%) | | | |
| No plaque | 13 (2) | 3 (2) | 0.93 |
| Probe only | 132 (25) | 36 (25) | |
| Visible | 392 (73) | 103 (73) | |
| Unknown | 47 | 9 | |
| Median percentage abnormal papilla (IQR ^a) | 50 (14–86) | 35 (12–68) | 0.004 |
| Median percentage gingival bleeding (IQR ^a) | 13 (2–29) | 12 (2–29) | 0.81 |
| No. of lingual gingival banding (%) | | | |
| No | 516 (96) | 133 (93) | 0.08 |
| Yes | 20 (4) | 10 (7) | |
| Unknown | 3 | 1 | |
| No. of facial gingival banding (%) | | | |
| No | 512 (96) | 139 (97) | 0.73 |
| Yes | 23 (4) | 5 (3) | |
| Unknown | 4 | 0 | |
| No. of anterior gingival banding (%) | | | |
| No | 517 (96) | 135 (94) | 0.18 |
| Yes | 21 (4) | 9 (6) | |
| Unknown | 1 | 0 | |
| No. of posterior gingival banding (%) | | | |
| No | 515 (96) | 134 (93) | 0.15 |
| Yes | 23 (4) | 10 (7) | |
| Unknown | 1 | 0 | |

^aIQR, interquartile range (25th–75th percentiles).

Table 8. Periodontal status at time of oral study entry by CD4, HIV+ women only

| Periodontal characteristic | CD4 | | | <i>P</i> -value |
|---|------------------------|---------------------------|------------------------|-----------------|
| | <200 (<i>n</i> = 159) | 200–500 (<i>n</i> = 251) | >500 (<i>n</i> = 159) | |
| No. of plaque index (%) | | | | |
| No plaque | 4 (3) | 3 (1) | 6 (4) | 0.19 |
| Probe only | 42 (29) | 59 (25) | 26 (18) | |
| Visible | 99 (68) | 170 (73) | 115 (78) | |
| Unknown | 14 | 19 | 12 | |
| Median percentage abnormal papilla (IQR ^a) | 54 (15–91) | 41 (8–87) | 50 (19–83) | 0.13 |
| Median percentage gingival bleeding (IQR ^a) | 13 (2–31) | 12 (2–29) | 12 (2–28) | 1.00 |
| No. of lingual gingival banding (%) | | | | |
| No | 143 (98) | 220 (95) | 141 (97) | 0.39 |
| Yes | 3 (2) | 11 (5) | 5 (3) | |
| Unknown | 0 | 2 | 1 | |
| No. of facial gingival banding (%) | | | | |
| No | 137 (94) | 224 (97) | 138 (95) | 0.41 |
| Yes | 8 (6) | 7 (3) | 8 (5) | |
| Unknown | 1 | 2 | 1 | |
| No. of anterior gingival banding (%) | | | | |
| No | 140 (96) | 224 (97) | 140 (95) | 0.82 |
| Yes | 6 (4) | 8 (3) | 7 (5) | |
| Unknown | 0 | 1 | 0 | |
| No. of posterior gingival banding (%) | | | | |
| No | 140 (96) | 221 (95) | 142 (97) | 0.81 |
| Yes | 6 (4) | 11 (5) | 5 (3) | |
| Unknown | 0 | 1 | 0 | |

^aIQR, interquartile range (25th–75th percentiles).

Table 9. Periodontal status at time of oral study entry by AIDS status, HIV+ women only

| Periodontal characteristic | AIDS | | P-value |
|---|----------------------|-----------------------|---------|
| | No (<i>n</i> = 332) | Yes (<i>n</i> = 239) | |
| No. of plaque index (%) | | | |
| No plaque | 9 (3) | 4 (2) | 0.72 |
| Probe only | 72 (23) | 57 (26) | |
| Visible | 229 (74) | 158 (72) | |
| Unknown | 24 | 21 | |
| Median percentage abnormal papilla (IQR ^a) | 46 (12–83) | 55 (17–92) | 0.06 |
| Median percentage gingival bleeding (IQR ^a) | 11 (2–28) | 13 (2–33) | 0.48 |
| No. of lingual gingival banding (%) | | | |
| No | 296 (96) | 212 (97) | 0.50 |
| Yes | 13 (4) | 7 (3) | |
| Unknown | 2 | 1 | |
| No. of facial gingival banding (%) | | | |
| No | 300 (97) | 204 (94) | 0.08 |
| Yes | 9 (3) | 14 (6) | |
| Unknown | 2 | 2 | |
| No. of anterior gingival banding (%) | | | |
| No | 300 (97) | 209 (95) | 0.35 |
| Yes | 10 (3) | 11 (5) | |
| Unknown | 1 | 0 | |
| No. of posterior gingival banding (%) | | | |
| No | 298 (96) | 209 (95) | 0.62 |
| Yes | 12 (4) | 11 (5) | |
| Unknown | 1 | 0 | |

^aIQR, interquartile range (25th–75th percentiles).

exhibited substantial degrees of risk behavior activities likely to precede HIV infection (both injection drug use and heterosexual activity), a significantly higher percentage of the sero-positive cohort had identified risk factors compared to the sero-negative cohort ($P = 0.0001$).

Alcohol and smoking are known risk factors for oral disease. A large percentage of both sero-positive and sero-negative oral study subjects were current smokers at baseline. Illegal drug use was a significant factor in the lives of these women, with the sero-negative women putting themselves at greater risk than the sero-positive women (58% vs. 48%). A more detailed analysis on the influence of risk factors such as smoking, alcohol use, and illicit drug use on oral outcomes will be forthcoming.

Detailed information on concomitant medications for HIV-1 infection is also an important component of the WIHS. However, the era of HAART was just beginning during the enrollment period of this study and only 1% of sero-positive study participants were on HAART. Future longitudinal analyses of WIHS data will describe the effects of HAART on intraoral findings.

Our data showed that sero-positive and sero-negative women were well matched on variables such as

age, race/ethnicity, socioeconomic status, education attainment, and behavioral characteristics. There was no significant variability by HIV status on any of the dental variables except for number of teeth. However, among sero-positive women, significant differences by CD4 count on several dental variables were observed. HIV-infected women, who were more compromised (i.e. had a lower CD4 count), had more DMF teeth and DMF surfaces, and this relationship held for those who met the CDC criteria for an AIDS diagnosis. Analysis by AIDS status indicated that this significance was largely because of the caries and missing teeth components of the DMF variables. Our protocol does not include the collection of information that requires subjects to identify reasons for missing teeth; however, given the average age of these participants and the findings from this study, we surmise that extractions and the resulting missing teeth were because of caries rather than periodontal disease.

Although root caries findings were comparable between HIV sero-positive and sero-negative women, sero-positive women with an AIDS-defining condition were at much greater risk for caries than sero-positive women without AIDS. Our findings provide support for investigators who concluded that

HIV-infected individuals may be at a greater risk for caries.

Sero-positive women were more likely than sero-negative women to have had a dental visit in the 6 months prior to their WIHS baseline oral visit; although sero-positive women had fewer teeth than sero-negative women, the two groups were comparable on numbers of fillings and surfaces filled. This may point to a bias in treatment options provided to the women by their dental practitioners. The 30% of sero-positive women who had had a dental visit in the last 6 months was, however, considerably lower than the percentage of people in the general population reporting an annual dental visit in the reference year 1999 (68% of individuals aged 19–44 years, 70% of females, and 46% of those earning less than \$15 000 annually; 41).

Of the periodontal health indices investigated, sero-positive and sero-negative women were similar in terms of plaque index, gingival bleeding, and linear gingival banding, but sero-positive women had more abnormal gingival papilla ($P = 0.004$). Unlike the dental variables, periodontal variables did not differ by CD4 among sero-positive women. Many of the previously published pathologic periodontal findings have been reported in men (19, 28). Our findings in women are similar to those of Schuman et al. (13), who found no significant differences in percentages of gingival erythema (defined similarly to our gingival banding) between HIV-infected and noninfected women.

One obvious benefit of presenting these baseline data is to set the stage for longitudinal analyses, i.e. the determination of whether the HIV virus is responsible for the decline in oral cavity health, as measured by accepted indices and changes in these clinical parameters over time. Moreover, if changes occur, it will allow us to characterize the nature of any progression for the two main groups. It may also be possible to examine some of the more robust variables for differences in racial groups.

A strength of this study is that it systematically collects data that include markers of HIV-1 infection such as CD4 count and HIV viral load. Some of the previous studies that examined HIV-related oral changes correlated increased oral disease findings with diminishing CD4 counts (28). We expect future examinations of these longitudinal data to answer many of the questions related to the natural history of oral disease in women in conjunction with the progression of HIV infection, thus providing information that has not been available in the literature because of its heavy focus on cross-sectional studies

with a preponderance of male subjects and lack of control groups.

In conclusion, the two cohorts (sero-positive and sero-negative women) in the oral substudy of the WIHS are not easily distinguished by most of the economic, behavioral, and demographic variables collected. Moreover, most of the dental and periodontal health markers reported on herein did not provide substantive group distinction relative to their HIV infection. Distinctions based on CD4 status and/or AIDS diagnosis were observed, and these observations encourage us to continue our investigation into the oral changes of HIV-positive women by examining in detail these particular variables. It will be interesting to see if the findings we have uncovered continue in the longitudinal analyses as the HIV-1 disease progresses, different therapies are introduced, and the immunocompetence of the sero-positive women undergoes change.

Acknowledgments

This study was funded by an NIH cooperative agreement 5U01HD32632 with support from NIDCR. The Oral Substudy of the WIHS includes/d the following:

Clinical sites: New York City/Bronx Consortium, Beth Israel Hospital and Mt. Sinai Medical Center (Charles Barr, DDS; John Kaim RDH; Joan Phelan, DDS); Washington DC Metropolitan Consortium, Howard University Dental School (Peter Tsaknis DDS, Garnett Henley, BS); The Connie Wofsy Study Consortium of Northern California, University of California, San Francisco (Deborah Greenspan, BDS, DSc; John S. Greenspan, BDS, PhD, FRCPath; Laurie A. MacPhail, DMD, PhD); Los Angeles County/Southern California Consortium, University of Southern California School of Dentistry (Roseann Mulligan, DDS, MS; Mahvash Navazesh, DMD; Joyce Galligan, RN, DDS; Nancy Kiehl-Hillman, RDH, MS; Kristi Ellis, RDH; Lupe Arevalo RDH; Sharon Bautista-King; Claudia Vargas); Chicago Consortium, University of Illinois at Chicago (Mario Alves, DDS, MS, DSc); Data Coordinating Center: 1993–97, New England Research Institutes (NERI), Watertown, Massachusetts (Susan Barkan, PhD; Leslie Kalish, ScD; Sonja McKinlay, PhD; Irene Doherty, BS; Kristin Nelson, MS; Eugene Komaroff, PhD); 1998 to present, Johns Hopkins School of Hygiene and Public Health, Baltimore, MD (Alvaro Munoz, PhD; Stephen J. Gange, PhD; Jean Anderson, MD; Lisa P. Jacobson, ScD; Lynn Kirstein, MS; Cynthia Kleeberger, MAS; Patrick Tarwater, PhD; Linda Ahdieh, PhD; Ellen Smit, ScD; Joseph B. Margolick, MD, PhD; Sol Su, ScD); NIH Agency, National Institute of Dental and Craniofacial Research: Bethesda, Maryland: (Maryanne Redford, DDS, MPH; Janet Brunelle, MS). The WIHS is funded by the National Institute of Allergy and Infectious Diseases; the National Institute of Child Health and Human Development; the National Institute of Dental and Craniofacial Research; The National Cancer Institute; the Agency for Health Care Policy and Research; and Centers for Disease Control and

Prevention. The Oral substudy is funded by the National Institute of Dental and Craniofacial Research. Special thanks to Irene Doherty and Kristin Nelson, formerly with NERI, for their expertise, guidance and help particularly with baseline training, start-up and monitoring activities.

References

- Cohen M. Natural history of HIV infection in women. *Obstet Gynecol Clin North Am* 1997;24:743–58.
- Barkan SE, Melnick SL, Preston-Martin S, Weber K, Kalish LA, Miotti P, et al. The women's interagency HIV study. *Epidemiology* 1998;9:117–25.
- Scully C, Porter SR. Oral mucosal disease: a decade of new entities, aetiologies and associations. *Int Dent J* 1994;44:33–43.
- Narani N, Epstein JB. Classifications of oral lesions in HIV infection. *J Clin Periodontol* 2001;28:137–45.
- Baqui A, Meiller T, Jabra-Rizk M, Zhang M, Kelley J, Falkler W. Association of HIV viral load with oral diseases. *Oral Dis* 1999;5:294–8.
- Patton LL, Shugars DC. Immunologic and viral markers of HIV-1 disease progression: implications for dentistry. *J Am Dent Assoc* 1999;130:1313–22.
- Wanzala P, Manji F, Pindborg JJ, Plummer F. Low prevalence of oral mucosal lesions in HIV-1 seropositive African women. *J Oral Pathol Med* 1989;18:416–8.
- Hilton JF, Donegan E, Katz MH, Canchola AJ, Fusaro RE, Greenspan D, et al. Development of oral lesions in human immunodeficiency virus-infected transfusion recipients and hemophiliacs. *Am J Epidemiol* 1997;145:164–74.
- Lifson AR, Hilton JF, Westenhouse JL, Canchola AJ, Samuel MC, Katz MH, et al. Time from HIV seroconversion to oral candidiasis or hairy leukoplakia among homosexual and bisexual men enrolled in three prospective cohorts. *AIDS* 1994;8:73–9.
- Begg MD, Lamster IB, Panageas KS, Mitchell-Lewis D, Phelan JA, Grbic JT. A prospective study of oral lesions and their predictive value for progression of HIV disease. *Oral Dis* 1997;3:176–83.
- Shiboski CH, Hilton JF, Neuhaus JM, Canchola A, Greenspan D. Human immunodeficiency virus-related oral manifestations and gender. A longitudinal analysis (The University of California, San Francisco Oral AIDS Center Epidemiology Collaborative Group). *Arch Intern Med* 1996;156:2249–54.
- Ramirez-Amador V, Esquivel-Pedraza L, Sierra-Madero J, Ponce-de-Leon S, Ponce-de-Leon S. Oral manifestations of HIV infection by gender and transmission category in Mexico City. *J Oral Pathol Med* 1998;27:135–40.
- Schuman P, Ohmit SE, Sobel JD, Mayer KH, Greene V, Rompalo A, et al. Oral lesions among women living with or at risk for HIV infection (HIV Epidemiol Research Study (HERS) Group). *Am J Med* 1998;104:559–64.
- Brown JB, Rosenstein D, Mullooly J, O'Keeffe Rosetti M, Robinson S, Chiodo G. Impact of intensified dental care on outcomes in human immunodeficiency virus infection. *AIDS Patient Care Stds* 2002;16:479–86.
- McKaig RG, Thomas JC, Patton LL, Strauss RP, Slade GD, Beck JD. Prevalence of HIV-associated periodontitis and chronic periodontitis in a southeastern US study group. *J Public Health Dent* 1998;58:294–300.
- Bretz WA, Flaitz C, Moretti A, Corby P, Schneider LG, Nichols CM. Medication usage and dental caries outcome-related variables in HIV/AIDS patients. *AIDS Patient Care Stds* 2000;14:549–54.
- Greenspan D, Greenspan JS. HIV-related oral disease. *Lancet* 1996;348:729–33.
- Glick M, Muzyka BC, Salkin LM, Lurie D. Necrotizing ulcerative periodontitis: a marker for immune deterioration and a predictor for the diagnosis of AIDS. *J Periodontol* 1994;65:393–7.
- Robinson P. Periodontal disease and HIV infection. A review of the literature. *J Clin Periodontol* 1992;19:609–14.
- Grbic JT, Mitchell-Lewis DA, Fine JB, Phelan JA, Bucklan RS, Zambon JJ, et al. The relationship of candidiasis to linear gingival erythema in HIV-infected homosexual men and parenteral drug users. *J Periodontol* 1995;66:30–7.
- Oringer RJ. Research, Science, and Therapy Committee of the American Academy of Periodontology. Modulation of the host response in periodontal therapy. *J Periodontol* 2002;73:460–70.
- Glick M, Berthold P, Danik J. Severe caries and the use of protease inhibitors. *J Dent Res* 1998;77:84.
- Navazesh M, Christensen CM. A comparison of whole mouth resting and stimulated salivary measurement procedures. *J Dent Res* 1982;61:1158–62.
- Greenspan JS, Barr CE, Sciubba JJ, Winkler JR. Oral manifestations of HIV infection. Definitions, diagnostic criteria, and principles of therapy (The USA Oral AIDS Collaborative Group). *Oral Surg Oral Med Oral Pathol* 1992;73:142–4.
- EEC. Clearinghouse on oral problems related to HIV infection and WHO Collaborating Centre on oral manifestations of the human immunodeficiency virus (an update of the classification and diagnostic criteria of oral lesions in HIV infection). *J Oral Pathol Med* 1991;20:97–100.
- Navazesh M, Christensen C, Brightman V. Clinical criteria for the diagnosis of salivary gland hypofunction. *J Dent Res* 1992;71:1363–9.
- Silness P, Loe H. Periodontal disease in pregnancy. Part II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* 1964;22:121–35.
- Swango PA, Kleinman DV, Konzelman JL. HIV and periodontal health. A study of military personnel with HIV. *J Am Dent Assoc* 1991;122:49–54.
- Tomar SL, Swango PA, Kleinman DV, Burt BA. Loss of periodontal attachment in HIV-seropositive military personnel. *J Periodontol* 1995;66:421–8.
- Ramfjord SP. Indices for prevalence and incidence of periodontal disease. *J Periodontol* 1959;30:51–9.
- NIH (National Institutes of Health). Epidemiology and oral disease prevention program. Oral health surveys of the NIDR. diagnostic criteria and procedures. NIH publication; 1991. p. 91–2870.
- Centers for Disease Control and Prevention. MMWR recommendations and reports. Revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults (1996 December 18). 1993. p. 41 (RR-17). [online accessed 2003 May] available from <http://www.cdc.gov/mmwr/preview/mmwrhtml/00018871.htm>.

33. Conover WJ, Iman RL. Analysis of covariance using the rank transformation. *Biometrics* 1982;38:715–24.
34. Mulligan R, Navazesh M, Komaroff E, Greenspan D, Redford M, Alves M, et al. Salivary gland disease in human immunodeficiency virus-positive women from the WIHS study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2000;89:702–9.
35. Navazesh M, Mulligan R, Komaroff E, Redford M, Greenspan D, Phelan J. The prevalence of xerostomia and salivary gland hypofunction in a cohort of HIV-positive and at-risk women. *J Dent Res* 2000;79:1502–7.
36. Greenspan D, Komaroff E, Redford M, Phelan JA, Navazesh M, Alves ME, et al. Oral mucosal lesions and HIV viral load in the Women’s Interagency HIV Study (WIHS). *J Acquir Immune Defic Syndr* 2000;25:44–50.
37. MacPhail LA, Komaroff E, Alves ME, Navazesh M, Phelan JA, Redford M. Differences in risk factors among clinical types of oral candidiasis in the Women’s Interagency HIV Study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2002;93:45–55.
38. Centers for Disease Control and Prevention. HIV/AIDS surveillance report. U.S. HIV and AIDS cases reported through December 1996, Vol. 8, No. 2 (year-end edition); 1996. p. 12. [Online accessed 2003 April]. Available from <http://www.cdc.gov/hiv/stats/hiv-sur82.pdf>.
39. Centers for Disease Control and Prevention. HIV/AIDS surveillance report. U.S. HIV and AIDS cases reported through December 2001, Vol. 13, No. 2 (year-end edition). 2001. p. 12. [Online accessed 2003 April]. Available from <http://www.cdc.gov/hiv/stats/hasr1302.pdf>.
40. Heslin KC, Cunningham WE, Marcus M, Coulter I, Freed J, Der-Martirosian C, et al. A comparison of unmet needs for dental and medical care among persons with HIV infection receiving care in the United States. *J Public Health Dent* 2001;61:14–21.
41. CDC National Oral Health Surveillance System. Percentage of people who visited the dentist or a dental clinic within the past year for any reason. Behavior Risk Factor Surveillance 1999. Online accessed. Available from <http://www2.cdc.gov/nohss/DisplayV.asp?nKey=343>.