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

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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 $\leq$200 and 34% had viral loads >50 000 copies/ml. Sero-positive and sero-negative women were similar demographically, as well as on plaque index, gingival bleeding, linear gingival banding, and numbers of DMF teeth and surfaces, but sero-positive women had more abnormal gingival papilla ($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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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 Löe 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 nonparametric 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 (P-value)[a]	All WIHS				Comparison (P-value)[b]
	HIV+ ($n=584$)		HIV− ($n=151$)			HIV+ ($n=2059$)		HIV− ($n=569$)		
	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	–	

[a]Tests of differences between HIV+ and HIV− among oral study participants.
[b]Tests 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)

	Oral study ($n = 584$)		WIHS ($n = 2059$)		
HIV-related factors	No.	%	No.	P-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	–	

[a]Tests 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+ ($n=584$) No.	%	HIV− ($n=151$) No.	%	*P*-value
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 sero-negative 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+ ($n=584$)	HIV− ($n=151$)	*P*-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	

[a]IQR, interquartile range (25th−75th percentiles).

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

Dental characteristic	CD4 <200 ($n=159$)	200–500 ($n=251$)	>500 ($n=159$)	P-value
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	

[a]IQR, 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 sero-positive 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 sero-positive and sero-negative 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 No ($n=332$)	Yes ($n=239$)	P-value
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	

[a]IQR, interquartile range (25th–75th percentiles).

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

Periodontal characteristic	HIV+ ($n=584$)	HIV− ($n=151$)	P-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	

[a]IQR, interquartile range (25th–75th percentiles).

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

	CD4			
Periodontal characteristic	<200 ($n=159$)	200–500 ($n=251$)	>500 ($n=159$)	P-value
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	

[a]IQR, 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 ($n = 332$)	Yes ($n = 239$)	
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	

[a]IQR, 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.

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