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Smoking Cessation and Recidivism in the Women's Interagency Human Immunodeficiency Virus Study

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Abstract

Background—Smoking increases the risk of morbidity and mortality and is particularly harmful to HIV-infected people.

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Purpose—To explore smoking trends and longitudinal factors associated with smoking cessation and recidivism among participants in the Women's Interagency HIV Study.

Methods—From 1994 through 2011, 2,961 HIV-infected and 981 HIV-uninfected women were enrolled and underwent semi-annual interviews and specimen collection. Smoking prevalence was evaluated annually and risk factors associated with time to smoking cessation and recidivism were analyzed in 2013 using survival models.

Results—The annual cigarette smoking prevalence declined from 57% in 1995 to 39% in 2011 (p -trend<0.0001). Among smokers, factors significantly associated with a longer time to smoking cessation included less education, alcohol use, having health insurance, >10-year smoking duration, self-reported poor health rating, and having hypertension. Pregnancy in the past 6 months was associated with a shorter time to cessation. Among HIV-infected women, additional risk factors for longer time to cessation included lower household income, use of crack/cocaine/heroin, CD4 cell count < 200, and highly active antiretroviral therapy (HAART) use. Predictors of smoking recidivism included marijuana use, enrollment in 1994–1996, and not living in one's own place. Among HIV-infected women, enrollment in 2001–2002 and crack/cocaine/heroin use were associated with a shorter time to recidivism, whereas older age and HAART use were associated with a longer time to recidivism.

Conclusions—Despite declining rates of cigarette smoking, integrated interventions are needed to help women with and at risk for HIV infection to quit smoking and sustain cessation.

Introduction

The harmful health effects of cigarette smoking include an increased risk of developing cancer, heart disease, infections, and chronic pulmonary disease.^{1,2} Although smokers are also at risk for premature death,³ smoking cessation can reduce and sometimes reverse this excess risk.^{4–6} Smoking can be particularly harmful to HIV-infected individuals, who have an increased risk of mortality, cardiovascular disease, non-AIDS cancers, chronic obstructive lung disease, and pneumonia compared to HIV-infected never smokers.^{7–10}

The use of antiretroviral therapy (ART) to treat HIV infection has dramatically reduced HIV-related morbidity and mortality, resulting in HIV-infected individuals reaching ages at which smoking-related disease rapidly increases.¹¹ The combination of longevity, prolonged immunosuppression, and increasing number of pack-years of smoking puts smokers with HIV/AIDS at a heightened risk for tobacco-related morbidity and mortality.¹⁰ Thus, smoking-cessation programs are extremely important to maintain the health benefits of HIV treatment.

Little is known about smoking cessation among HIV-infected individuals. One large study reported that HIV-infected patients who quit smoking reduced their risk of cardiovascular disease and that this reduction increased with time since cessation of smoking.¹² A smoking-cessation intervention conducted in a Swiss cohort study found that HIV-infected participants who were middle-aged, injection drug users, had psychiatric problems, or high alcohol consumption were less likely to stop smoking.¹³

In the Women's Interagency HIV Study (WIHS), a multicenter cohort study of HIV-1 infection in women conducted at six centers in the U.S, 72% of the HIV-infected and at-risk HIV-uninfected women are current (48%) or former (24%) cigarette smokers, a considerably higher prevalence than the national population rate.¹⁴ A 10-year assessment of smoking cessation in the WIHS found that the odds of tobacco cessation were higher among participants with more years of education and among Hispanic compared with non-Hispanic Black women.¹⁵ Cessation was lower in current or former illicit drug users and women reporting a higher daily number of cigarettes at baseline.¹⁵ This previous WIHS analysis evaluated baseline characteristics as predictors of smoking cessation among women only recruited in the first enrollment wave of the study (1994–1995) and did not include more recently enrolled participants or analyze predictors of recidivism or time-updated factors during study follow-up.

The current study includes participants from all three WIHS enrollment waves (1994–1995, 2001–2002, and 2011) and investigates time-updated factors as predictors. The aims of this investigation were to (1) calculate the annual smoking prevalence from 1994–2011; (2) assess predictors associated with time to self-reported sustained (>12 months) smoking cessation; and (3) measure risk factors associated with time to recidivism (self-reported resumption of smoking) among sustained quitters of smoking. By identifying predictors of smoking cessation and recidivism, these factors can be synthesized with conceptual models to tailor interventions for HIV-infected and at-risk women.

Methods

Study Population

This study included HIV-infected and HIV-uninfected participants in the WIHS. The WIHS methods, baseline characteristics, and participant retention rates have been described previously.^{16–19} To summarize, between October 1994 and November 1995, 2,054 HIV-infected and 569 uninfected women were enrolled (wave 1). A second enrollment wave, between October 2001 and September 2002, added 737 HIV-infected and 406 uninfected women. A third enrollment wave began January 2011, and 170 HIV-infected and six uninfected women enrolled through September 30, 2011. The HIV-infected women in the WIHS cohort reflect the race/ethnicity, HIV exposure groups, and ages of women with HIV/AIDS in the U.S.¹⁷ Study protocols were approved by the IRBs at all sites and informed consent was obtained.

Semiannually, WIHS participants were interviewed, had blood collected, and underwent a physical examination. Among HIV-infected women, blood was tested for CD4+ lymphocyte counts and HIV RNA levels. At each study visit, women were asked detailed information about their smoking history. The selection of factors associated with smoking cessation and recidivism in this investigation were guided by prior studies in the WIHS¹⁵ and other populations of HIV-infected adults.^{13,20} In addition, we included health-related factors that have been shown to be associated with smoking and cessation in women.^{21,22}

Measures

In the survival time analyses, baseline covariates included race/ethnicity, age, number of years of smoking, WIHS locale (California, Illinois, New York, or District of Columbia), enrollment wave, and HIV status (excluding HIV seroconverters). All other covariates for the survival time analyses were time updated and obtained for the 6-month period immediately preceding the visit in which the outcome was ascertained—the first sustained quit visit or last non-quit visit for the time to cessation analyses, and the first recidivism visit or last sustained quit visit for the time to recidivism analyses. This ensured that the predictors preceded the event and were data lagged one semi-annual visit. These covariates included: educational attainment, living situation, employment, household income, place of residence, health insurance status assessed dichotomously as yes or no and as type of health insurance, alcohol and drug use in the past 6 months, the Center for Epidemiological Studies Depression Scale (CES-D) score dichotomized as >22 and yes or no,^{23,24} any hospitalization in the past 6 months, self-reported health rating on a 5-point scale ranging from 1=excellent to 5=poor,²⁵ pregnancy in the past 6 months, child care responsibility in the past 6 months (children aged <18 years in household or care), hypertension (defined as measured systolic blood pressure ≥ 140 , diastolic blood pressure >90 , self-reported hypertension, or self-reported antihypertensive medication use), diabetes (defined as measured fasting glucose ≥ 126 mg/dL, hemoglobin A1C $>6.5\%$, self-reported diabetes, or self-reported use of medications for diabetes), and cervical intraepithelial neoplasia (defined as cytologic or histologic cervical intraepithelial neoplasia-1 or more severe). In regression models that only included HIV-infected women, time-lagged CD4 cell count, HIV viral load, and use of ART were also assessed. In the unadjusted models, we also considered time-updated covariates at the prior 6-month visit (the 6–12-month interval preceding the sustained cessation visit) to see if the factors for initial cessation differed from those for sustained cessation.

The log-normal survival models assumed that the hazard function has a log-normal shape with two parameters (mean and dispersion) that were estimated from the data.²⁶ Covariate effects were shown as a time ratio (TR), rather than a HR, and thus have an interpretation on the time scale. Factors usually termed “risky” or harmful will be associated with $TR > 1$ for the time to cessation analysis but $TR < 1$ for the time to smoking recidivism outcome.

Statistical Analysis

Yearly smoking prevalence was calculated as the number of women who reported smoking cigarettes divided by the number of women interviewed. The prevalence was further stratified by birth cohort and HIV status. The Cochran–Mantel–Haenszel test was used to measure differences across strata. The Cochran–Armitage trend test was used to assess changes in the annual prevalence by calendar year.

Two separate survival analyses were performed: time from baseline smoking to sustained (≥ 12 months) cessation and time from sustained cessation to recidivism (relapse). We defined recidivism as having reported resumption of smoking and a date that they resumed smoking. Time to cessation was calculated from date of the baseline smoking visit to the date of the first sustained quit visit. Women who did not quit were censored at the date of the last follow-up visit. This analysis included all women who reported current cigarette

smoking at their baseline study visit and had at least two follow-up visits. Time to recidivism (first relapse to smoking) was measured among women reporting current cigarette use at study baseline, as the time from first sustained quit visit to the date of first resumption of smoking visit. Participants who did not relapse during follow-up were censored at the date of the last follow-up visit. This analysis included all participants who reported sustained cessation 12 months during WIHS study follow-up and had at least one post-sustained cessation follow-up visit.

Kaplan–Meier survival analyses measured median and mean time to cessation and time to recidivism in years. Factors affecting time to outcome of cessation or recidivism were evaluated using parametric survival models, assuming a log-normal distribution (accelerated failure time).²⁶ In the accelerated failure time model, the effect of a covariate is expressed as either accelerating (shortening) or decelerating (lengthening) time to the event of interest. Covariates with statistical significance at $p<0.05$ in unadjusted models were entered into exploratory multivariate models for the respective outcomes. The final adjusted models were developed using a manual stepwise backward elimination process. Statistical analyses were performed in 2013 using SAS® software, version 9.3 (SAS Institute Inc., Cary NC).

Results

Smoking Prevalence Between 1995 and 2011

The annual cigarette smoking prevalence declined over time in the WIHS, from a high of 57% in 1995 to 39% in 2011 (trend test $p<0.0001$). Differences in annual smoking prevalence were also observed by birth cohort, with both the oldest (birth years 1920–1939) and youngest (birth years 1970–1985) birth cohorts having a lower smoking prevalence than those born between 1940–1969 ($p<0.05$, Figure 1). HIV-infected women had a lower prevalence of smoking compared with HIV-uninfected women ($p<0.05$, Figure 2).

Smoking Cessation

Among the 1,622 WIHS participants who reported smoking cigarettes at their baseline study visit and had complete data on all follow-up study variables, 316 (19.4%) women subsequently reported sustained smoking cessation during study follow-up (median=16.5 years, mean=13.7 years). In adjusted analysis, factors significantly associated with a longer time to cessation ($TR>1$, Table 1) included socioeconomic factors (lower education and having health insurance), behavioral factors (higher number of years smoking cigarettes and alcohol consumption) and biological factors (a fair to poor self-reported health rating and history of hypertension). Having been pregnant in the past 6 months was significantly associated with a shorter time to cessation ($TR<1$). When time-lagged covariates in the 6–12-month period prior to sustained cessation were assessed (data not shown), the results were similar. When health insurance was assessed, either as a dichotomous variable (yes or no) or as a categorical variable (none, public, private, or other), in both instances having health insurance was associated with longer time to cessation.

In adjusted analysis among HIV-infected women only, factors significantly associated with a longer time to cessation ($TR>1$, Table 2) included lower household income, having health

insurance, higher alcohol consumption, use of cocaine/crack/heroin, history of hypertension, use of highly active ART (HAART), and CD4 cell counts <200, whereas having been pregnant in the past 6 months was associated with a shorter time to cessation (TR<1). When time-lagged covariates in the 6–12-month period prior to sustained cessation among the HIV-infected women were assessed (data not shown), the results were similar. Once again, whether health insurance was dichotomized or categorized, having health insurance was associated with a longer time to cessation.

Smoking Recidivism

Of the 316 participants who reported sustained smoking cessation during follow-up, 273 women had at least one subsequent follow-up visit. Of these 273 women, 145 (53%) reported that they began smoking again during study follow-up, with a median time to recidivism of 6.0 years (mean=7.2 years). In adjusted analysis, marijuana use and enrollment in 1994–1996 were associated with shorter time to cigarette smoking recidivism (TR<1, Table 3). In this same analysis, living in one's own place was significantly associated with longer time to recidivism (TR>1, Table 3). In an adjusted analysis among HIV-infected women only, enrollment in 2001–2002 and crack/cocaine/heroin use were associated with a shorter time to recidivism (TR<1, Table 4), whereas older age and HAART use were associated with a longer time to recidivism (TR>1).

Discussion

One unique finding of our study was that HIV-infected women with CD4+ cell counts <200 had a longer time to smoking cessation than those with counts \geq 500. This may be because women with more severe immune deficiency are less motivated to quit smoking than women with higher CD4+ cell counts, and is in keeping with our finding that women who rated their overall health as poor or fair had a longer time to smoking cessation than women who rated their health as good or excellent. Interventions that increase the motivation to quit smoking can stimulate quit attempts and make them more successful.^{27–29} In addition, HIV-infected women using HAART also had a longer time to quit but had a longer time to recidivism than women not taking HAART. Because HAART use may be confounded by its indications, such as having AIDS-related comorbidities and immunosuppression, that may explain the longer time to cessation among HAART users. On the other hand, the longer time to recidivism may reflect a greater motivation for health improvement among HIV-infected women who are adherent to effective ART and have more access to professional healthcare advice and assistance regarding smoking cessation. Raising the awareness of the health benefits of quitting smoking and sustaining cessation and offering alternative coping strategies, including medications to alleviate withdrawal symptoms,³⁰ are important first steps toward cessation. HIV-infected individuals, especially those with CD4+ cell counts <200 and those prescribed HAART, are likely to have frequent encounters with healthcare professionals, and these providers should take the opportunity to promote smoking cessation among their patients who smoke. Clinicians treating HIV-infected smokers with comorbid medical conditions have an ideal opportunity to teach the patients that they are treating that their health conditions may be exacerbated by smoking and can be ameliorated by quitting.^{27,31–33} One framework for integrating strategies for smoking cessation in the

healthcare setting is based on the principles of asking, assessing, advising, assisting and arranging—the *five A's*.³⁴ This framework complements the motivational approach and has been successfully applied in practice to guide patients through and beyond their quit attempt.³⁵

Several of the factors associated with longer time to smoking cessation and shorter time to recidivism among HIV-infected and at-risk women in this study were similar to those reported in other studies, such as lower educational attainment and income, higher number of years smoked, alcohol and drug use, and not living in one's own place.^{13,36–39} Our study identified factors that may inform the design of programs and interventions to lower smoking rates in HIV-infected and at-risk women. Specifically, interventions that target smoking cessation as soon as possible after initiation, integrate risk reduction for multiple addictions and high-risk behaviors simultaneously, teach coping skills for high-stress situations, and address structural factors such as housing instability and unemployment may be more effective in helping women achieve and sustain smoking cessation.^{38,40}

Among the health conditions included in our analytic models, being pregnant in the past 6 months was associated with a shorter time to sustained cessation. It has been established that pregnant women are more likely to quit smoking^{21,22} and our study provided further evidence to support those findings. We also found that women with hypertension had a longer time to sustained smoking cessation than women without hypertension. Although cigarette smoking may increase the risk of hypertension,^{41,42} we found that hypertension delayed cessation. This suggests that motivating women to quit smoking during pregnancy may be a teachable moment that could be used in other health-related situations such as motivating women with hypertension to quit smoking.

Unexpectedly, women with any type of health insurance had a longer time to cessation than women without insurance. This may be because women without health insurance are more concerned about avoiding behaviors that may increase their risk of ill health. One study that evaluated smoking cessation in subgroups of the insured and uninsured found those with insurance were more likely to use “dependence treatments” for cessation but that the prevalence of quit attempts was similar between the insured and uninsured,⁴³ implying similar motivation to quit in both groups.

The strengths of this study include a large, geographically and ethnically diverse, representative sample of U.S. women with and at risk for HIV. By incorporating the most recent participant data, these longitudinal analyses allowed us to determine the most proximal factors associated with quitting and recidivism. However, this study had several limitations. First, we relied on self-reported cessation and recidivism and did not test for biomarkers of tobacco use. However, our participants had little reason to be untruthful in their responses to the tobacco questions. Second, this cohort is dynamic with individuals entering (three enrollment phases) and leaving (owing to death and loss to study follow-up) during the study period. Therefore, changes in the study population over time may also have contributed to the temporal trends we observed. Third, this study was not guided by conceptual or theoretical frameworks. Instead, we sought to generate hypotheses about the types of interventions that might be targeted for women with and at risk for HIV infection.

The WIHS is an observational cohort study, and although this investigation did not include new policy or counseling interventions, our data suggest that new public health policies and programs tailored to raise awareness and motivate this population of HIV-infected and at-risk women to quit smoking are needed. This is particularly important given the recent finding that HIV-infected smokers lose more years of life to smoking than to HIV infection¹⁰ and because the current smoking rate of 39% among WIHS participants is more than double the national average of 17% for women.⁴⁴ Our results suggest a shift away from the dominant, single-behavior paradigm of treating each health risk behavior as if it were isolated, to a multiple-behavior paradigm that applies innovative integrative models and techniques to impact multiple behaviors.⁴⁵ Programs that treat smoking as well as drug and alcohol addiction and policies that discourage cigarette smoking can further reduce cigarette consumption among these women. Interventions that specifically target recent initiators of cigarette smoking and address perceptions of health and health outcomes, housing needs, and income may have greater success in achieving sustained cessation. Evidence-based smoking cessation approaches for women with and at risk for HIV infection should be individualized and provide continued support to address the syndemic of high levels of stress, drug and alcohol dependency, and comorbidities.⁴⁶ Integrating smoking-cessation interventions into ongoing HIV/AIDS programs, educating HIV-infected persons about the harms of smoking, and teaching coping skills that can help individuals deal with life's challenges without relapsing to smoking may further reduce morbidity and mortality in women and men with HIV infection.

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Annual Cigarette Smoking Prevalence in the WIHS, 1994-2011, by Birth Cohort

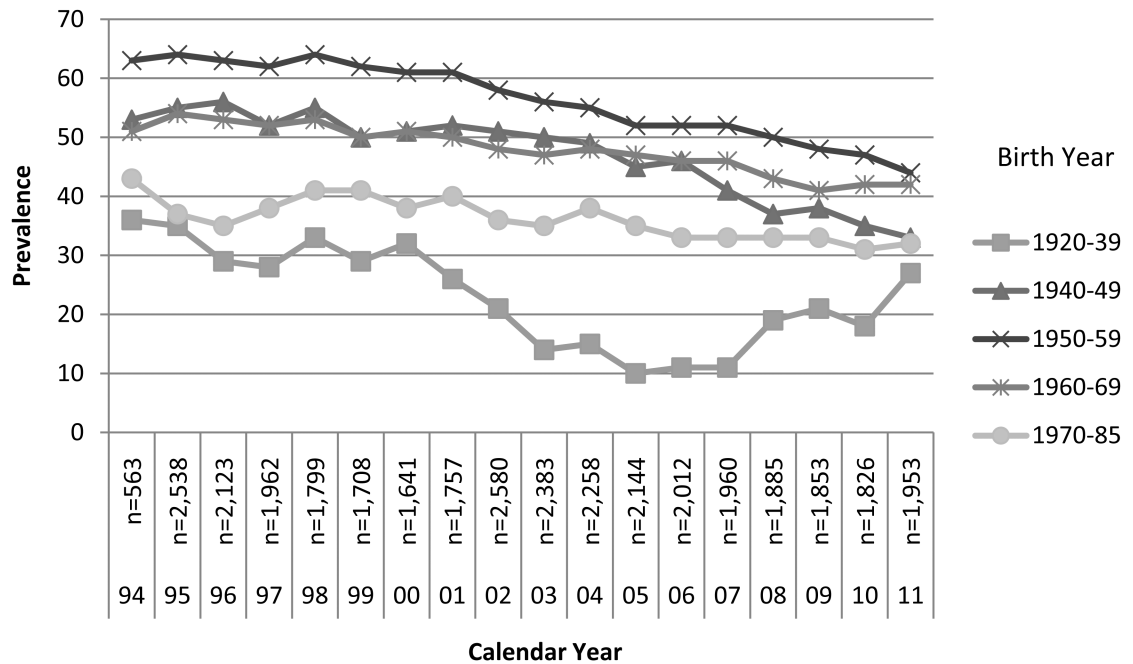


Figure 1. Annual cigarette smoking prevalence in the WIHS, 1994–2011, by birth cohort WIHS, Women's Interagency HIV Study

Annual Cigarette Smoking Prevalence in the WIHS, 1994-2011, by HIV Status

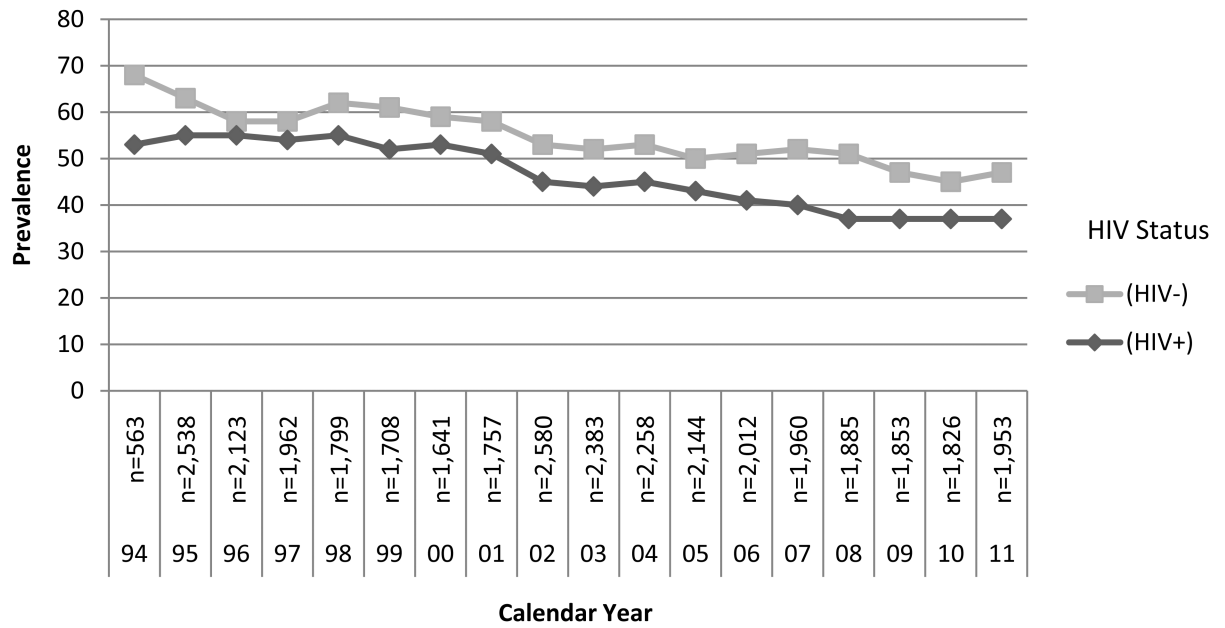


Figure 2. Annual cigarette smoking prevalence in the WIHS, 1994–2011, by HIV status WIHS, Women's Interagency HIV Study

Table 1
Time from baseline smoking to cessation among current and former cigarette smokers

Characteristic	M	Median	Kaplan-Meier n total	n quit	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
HIV status^d						
HIV-uninfected	13.2	N/A	430	84	1.00 (ref)	
HIV-infected	13.6	16.5	1192	232	1.00 (0.74, 1.35)	
State^d						
California	13.4	16.5	521	110	0.82 (0.60, 1.12)	
District of Columbia	11.9	N/A	182	31	1.13 (0.75, 1.71)	
Illinois	13.5	N/A	250	43	1.14 (0.72, 1.82)	
New York	12.4	N/A	669	132	1.00 (ref)	
Age group, years^d						
18–29	13.3	16.5	290	66	1.00 (ref)	
30–39	13.7	N/A	758	144	1.16 (0.84, 1.59)	
40–49	12.4	N/A	505	91	1.21 (0.86, 1.70)	
50	10.6	N/A	69	15	0.86 (0.44, 1.70)	
Enrollment wave^d						
1994–1995	13.7	16.5	1201	235	1.00 (ref)	
2001–2002	8.5	N/A	415	81	0.83 (0.62, 1.13)	
2011	N/A	N/A	6	0	N/A	
Race/ethnicity^d						
African American	13.9	16.5	1060	191	1.00 (ref)	
Latina	7.8	N/A	90	24	0.46 (0.27, 0.78)	
Other	13.3	N/A	233	53	0.76 (0.52, 1.10)	
White	12.3	N/A	239	48	0.78 (0.53, 1.14)	
Living with partner						
Yes	13.0	16.5	424	101	0.78 (0.58, 1.05)	
No	13.5	N/A	1099	215	1.00 (ref)	
Educational attainment						
<High school	14.0	16.5	686	117	1.55 (1.11, 2.15)	1.81 (1.15, 2.85)

Characteristic	M	Median	Kaplan-Meier n total	n quit	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
High school	12.5	N/A	510	101	1.26 (0.90, 1.78)	1.20 (0.75, 1.90)
>High school	12.5	N/A	424	98	1.00 (ref)	1.00 (ref)
Employed						
Yes	11.9	N/A	353	107	0.46 (0.34, 0.62)	
No	14.1	16.5	1260	205	1.00 (ref)	
Yearly household income						
\$12,000	14.0	16.5	998	166	1.80 (1.37, 2.37)	
>\$12,000	12.2	N/A	512	147	1.00 (ref)	
Health insurance						
Yes	13.9	16.5	1434	258	3.03 (2.08, 4.41)	3.16 (1.89, 5.27)
No	7.4	N/A	180	58	1.00 (ref)	1.00 (ref)
Lives in their own place						
Yes	13.6	16.5	1229	256	0.90 (0.65, 1.25)	
No	13.8	N/A	389	60	1.00 (ref)	
Number of years smoked ^a						
<10	12.4	16.5	324	93	1.00 (ref)	1.00 (ref)
10–19	12.4	N/A	593	100	2.24 (1.58, 3.18)	1.98 (1.22, 3.20)
20	13.8	N/A	702	123	2.12 (1.51, 2.97)	1.29 (0.80, 2.08)
Depressive symptoms (CESD)						
<23	13.2	N/A	985	201	1.00 (ref)	
>23	14.2	16.5	469	68	1.15 (0.82, 1.60)	
Alcohol use						
None	13.0	N/A	894	205	1.00 (ref)	1.00 (ref)
1–6 drinks/week	14.0	16.5	497	91	1.41 (1.05, 1.88)	1.89 (1.26, 2.83)
>6 drinks/week or >3 in 1 sitting	7.9	N/A	193	17	2.48 (1.50, 4.12)	3.60 (1.78, 7.28)
Marijuana use						
Yes	12.6	N/A	352	50	1.51 (1.07, 2.13)	
No	13.4	16.5	1238	266	1.00 (ref)	
Crack/cocaine/heroin use						
Yes	13.9	N/A	270	20	2.92 (1.82, 4.69)	

Characteristic	M	Median	Kaplan-Meier n total	n quit	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
No	13.3	16.5	1320	296	1.00 (ref)	
Health rating (self-report)						
Good to excellent	13.4	16.5	757	156	1.00 (ref)	1.00 (ref)
Fair to poor	13.1	N/A	518	56	2.16 (1.43, 3.26)	1.66 (1.11, 2.47)
Hospitalized in past 6 months						
Yes	11.9	N/A	448	61	1.43 (1.03, 1.98)	
No	13.5	16.5	1168	255	1.00 (ref)	
Pregnant in past 6 months						
Yes	7.7	9.2	35	16	0.25 (0.12, 0.54)	0.21 (0.08, 0.59)
No	13.6	16.5	1382	264	1.00 (ref)	1.00 (ref)
Childcare responsibilities						
Yes	13.9	16.5	416	77	1.06 (0.75, 1.49)	
No	13.6	N/A	1070	196	1.00 (ref)	
Hypertension						
Yes	14.7	16.5	606	83	2.48 (1.86, 3.29)	2.28 (1.51, 3.46)
No	12.9	N/A	1015	233	1.00 (ref)	1.00 (ref)
Diabetes						
Yes	12.3	N/A	262	68	0.88 (0.63, 1.25)	
No	13.7	16.5	1357	248	1.00 (ref)	
Cervical intraepithelial neoplasia						
Yes	12.2	N/A	206	25	1.4 (0.89, 2.22)	
No	13.6	16.5	1254	261	1.00 (ref)	

Note: Boldface indicates $p < 0.05$.

^a Baseline covariates.

CESD, Center for Epidemiological Studies Depression Scale; N/A, not applicable

Table 2

Time from baseline smoking to cessation among current and former HIV-infected cigarette smokers

Characteristic	M	Kaplan-Meier		n quit	Unadjusted log-normal time ratio (95% CI)	Adjusted Log-normal time ratio (95% CI)
		Median	n total			
State ^d						
California	13.8	16.5	370	71	0.93 (0.65, 1.33)	
District of Columbia	11.6	N/A	133	27	0.95 (0.58, 1.57)	
Illinois	12.1	N/A	203	40	0.92 (0.60, 1.42)	
New York	12.4	N/A	486	94	1.00 (ref)	
Age group, years ^d						
18–29	13.9	16.5	173	33	1.00 (ref)	
30–39	13.6	N/A	580	114	0.87 (0.60, 1.28)	
40–49	12.2	N/A	388	74	0.90 (0.61, 1.33)	
50	10.5	N/A	51	11	0.69 (0.32, 1.50)	
Recruitment wave ^d						
1994–1995	13.7	16.5	932	185	1.00 (ref)	
2001–2002	8.1	N/A	254	47	0.92 (0.64, 1.32)	
2011	N/A	N/A	6	0		
Race/ethnicity ^d						
African American	13.7	16.5	800	149	1.00 (ref)	
Latina	5.0	N/A	58	12	0.64 (0.33, 1.24)	
Other	13.4	N/A	162	36	0.86 (0.56, 1.31)	
White	12.4	N/A	172	35	0.88 (0.57, 1.36)	
Living with partner						
Yes	12.8	16.5	307	74	0.72 (0.52, 0.99)	
No	13.6	N/A	816	158	1.00 (ref)	
Educational attainment						
<High school	14.0	16.5	510	84	1.63 (1.13, 2.35)	
High school	12.5	N/A	379	75	1.34 (0.91, 1.96)	
>High school	12.4	N/A	302	73	1.00 (ref)	
Employed						

Characteristic	Kaplan-Meier		Unadjusted log-normal		Adjusted Log-normal	
	M	Median n total	n quit	time ratio (95% CI)	time ratio (95% CI)	time ratio (95% CI)
Yes	11.7	N/A 206	65	0.48 (0.33, 0.69)		
No	14.0	16.5 978	163	1.00 (ref)		
Yearly household income						
\$12,000	14.0	16.5 759	122	1.92 (1.41, 2.62)	1.69 (1.26, 2.26)	1.00 (ref)
>\$12,000	11.8	N/A 354	107	1.00 (ref)		
Health insurance						
Yes	13.8	16.5 1110	204	3.71 (2.19, 6.28)	3.01 (1.85, 4.88)	1.00 (ref)
No	6.9	10.0 75	28	1.00 (ref)		
Lives in their own place						
Yes	13.5	16.5 922	195	0.80 (0.54, 1.18)		
No	14.0	N/A 268	37	1.00 (ref)		
Number of years smoked ^a						
<10	12.9	16.5 202	53	1.00 (ref)		
10–19	12.3	N/A 438	79	1.70 (1.12, 2.57)		
20	13.7	N/A 550	100	1.61 (1.08, 2.39)		
Depressive symptoms (CESD)						
<23	13.0	N/A 697	142	1.00 (ref)		
23	14.0	16.5 356	55	1.03 (0.71, 1.48)		
Alcohol use						
None	13.1	N/A 684	154	1.00 (ref)	1.00 (ref)	
1–6 drinks/week	13.9	16.5 350	67	1.30 (0.94, 1.81)	1.21 (0.90, 1.64)	
>6 drinks/week or >3 in 1 sitting	7.4	N/A 124	9	2.73 (1.45, 5.17)	2.17 (1.18, 3.99)	
Marijuana use						
Yes	12.7	N/A 224	31	1.54 (1.02, 2.31)		
No	13.4	16.5 938	201	1.00 (ref)		
Crack/cocaine/heroin use						
Yes	14.0	N/A 201	13	3.32 (1.92, 5.75)	2.63 (1.59, 4.37)	1.00 (ref)
No	13.3	16.5 961	219	1.00 (ref)		
Health rating (self-report)						
Good to excellent	13.5	16.5 530	107	1.00 (ref)		

Characteristic	M	Median	Kaplan-Meier n total	n quit	Unadjusted log-normal time ratio (95% CI)	Adjusted Log-normal time ratio (95% CI)
Fair to poor	13.0	N/A	381	44	1.73 (1.09, 2.74)	
Hospitalized in past 6 months						
Yes	11.9	N/A	376	50	1.39 (0.98, 1.98)	
No	13.4	16.5	812	182	1.00 (ref)	
Pregnant in past 6 months						
Yes	7.9	11.4	19	9	0.26 (0.10, 0.68)	0.34 (0.15, 0.81)
No	13.5	16.5	1022	199	1.00 (ref)	1.00 (ref)
Childcare responsibilities						
Yes	13.4	16.5	275	59	0.76 (0.51, 1.12)	
No	13.7	N/A	805	136	1.00 (ref)	
Hypertension						
Yes	14.6	16.5	430	63	2.07 (1.51, 2.85)	1.91 (1.40, 2.60)
No	13	N/A	762	169	1.00 (ref)	1.00 (ref)
Diabetes						
Yes	12.2	N/A	183	51	0.78 (0.53, 1.15)	
No	13.8	16.5	1006	181	1.00 (ref)	
Cervical intraepithelial neoplasia						
Yes	12.1	N/A	202	25	1.36 (0.87, 2.12)	
No	13.5	16.5	870	186	1.00 (ref)	
HAART use						
Yes	14.4	N/A	628	103	2.86 (2.17, 3.76)	3.70 (2.76, 4.97)
No	12.4	16.5	564	129	1.00 (ref)	1.00 (ref)
CD4 cell count group						
<200	13.2	N/A	369	38	1.51 (1.00, 2.28)	1.85 (1.25, 2.74)
200–499	11.9	N/A	384	105	0.59 (0.42, 0.84)	0.78 (0.57, 1.07)
500	13.8	16.5	382	85	1.00 (ref)	1.00 (ref)
HIV viral load group, copies						
<4,001	13.9	16.5	652	135	1.00 (ref)	
4,001–50,000	11.9	N/A	197	50	0.46 (0.31, 0.67)	
>50,000	12.8	N/A	276	34	1.01 (0.68, 1.52)	

Note: Boldface indicates $p < 0.005$.

^aBaseline covariates.

CESD, Center for Epidemiological Studies Depression Scale; HAART, highly active antiretroviral therapy; N/A, not applicable

Table 3

Time from smoking cessation to resumption of smoking among sustained quitters

Characteristic	Kaplan-Meier		Unadjusted log-normal		Adjusted log-normal	
	M	Median n total	n relapse	time ratio (95% CI)	time ratio (95% CI)	time ratio (95% CI)
HIV status ^d						
infected	5.3	3.0 71	45	1.00 (ref)		
HIV-infected	7.5	6.7 202	100	1.31 (0.87, 1.97)		
State ^d						
California	7.1	4.7 91	51	0.87 (0.57, 1.33)		
District of Columbia	3.9	4.0 26	14	0.71 (0.37, 1.38)		
Illinois	7.2	7.7 39	21	1.00 (0.57, 1.75)		
New York	7	6.0 117	59	1.00 (ref)		
Age group, years ^d						
18–29	4.0	2.0 56	35	1.00 (ref)		
30–39	7.1	6.3 123	66	1.73 (1.14, 2.62)		
40–49	7.8	8.0 79	39	1.63 (1.05, 2.55)		
50	4.6	N/A 15	5	2.01 (0.80, 5.07)		
Recruitment wave ^b						
1994–1995	7.7	6.9 206	106	1.00 (ref)		1.00 (ref)
2001–2002	3.7	2 67	39	0.54 (0.36, 0.81)		0.55 (0.37, 0.82)
Race/ethnicity ^d						
African American	7.2	6.9 168	81	1.00 (ref)		
Latina	2.8	2 20	17	0.37 (0.19, 0.72)		
Other	8.1	7.7 46	23	1.20 (0.73, 1.98)		
White	6.7	5.1 39	24	0.84 (0.50, 1.41)		
Living with partner						
Yes	5.3	3.3 74	48	0.82 (0.55, 1.23)		
No	7.1	6.3 180	94	1.00 (ref)		
Educational attainment						
<High school	5.0	4.0 95	52	0.83 (0.57, 1.21)		
High school	7.2	6.0 171	93	1.00 (ref)		

Characteristic	M	Kaplan-Meier		n relapse	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
		Median	n total			
Employed						
Yes	7.4	6	91	50	1.03 (0.70, 1.52)	
No	6.5	4.9	175	95	1.00 (ref)	
Yearly household income						
\$12,000	6.6	4.9	135	79	0.85 (0.59, 1.23)	
>\$12,000	6.9	5.0	118	62	1.00 (ref)	
Health insurance						
Yes	7.2	6	229	120	1.13 (0.77, 2.20)	
No	6	4.0	36	24	1.00 (ref)	
Lives in their own place						
Yes	7.3	2	223	112	2.23 (1.39, 3.57)	2.13 (1.35, 3.36)
No	4.3	2	43	33	1.00 (ref)	1.00 (ref)
Number of years smoked ^a						
<10	6.8	3.0	82	47	1.00 (ref)	
10–19	7.0	6.9	87	46	1.15 (0.72, 1.82)	
20	7.1	6.3	104	52	1.30 (0.83, 2.03)	
Depressive symptoms (CESD)						
<23	7.6	8	184	88	1.00 (ref)	
23	5.1	4	54	36	0.57 (0.35, 0.92)	
Alcohol use						
None	7.5	7	131	61	1.00 (ref)	
1–6 drinks/week	6.3	6	57	33	0.73 (0.46, 1.17)	
>6 drinks/week or >3 in 1 sitting	5.7	4	8	6	0.88 (0.34, 2.26)	
Marijuana use						
Yes	4.6	2	36	28	0.52 (0.31, 0.87)	0.57 (0.35, 0.92)
No	7.2	6.7	230	117	1.00 (ref)	1.00 (ref)
Crack/cocaine/heroin use						
Yes	4.2	3	24	23	0.51 (0.28, 0.92)	
No	7.2	6.3	242	122	1.00 (ref)	
Health rating (self-report)						

Characteristic	M	Kaplan-Meier		n relapse	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
		Median	n total			
Good to excellent	7.5	8	139	69	1.00 (ref)	
Fair to poor	8.1	6.3	58	23	1.06 (0.61, 1.85)	
Hospitalized in past 6 months						
Yes	7	6.3	65	30	1.03 (0.66, 1.62)	
No	7.1	5.1	207	115	1.00 (ref)	
Childcare responsibilities						
Yes	6.5	7.7	75	33	1.20 (0.76, 1.90)	
No	7.3	6.3	162	86	1.00 (ref)	
Hypertension						
Yes	8.2	10.6	105	49	1.47 (1.00, 2.14)	
No	6.3	4	167	96	1.00 (ref)	
Diabetes						
Yes	6.5	4	62	38	0.88 (0.57, 1.34)	
No	7.4	6.9	211	107	1.00 (ref)	
Cervical intraepithelial neoplasia						
Yes	3.3	2.1	23	15	0.73 (0.40, 1.36)	
No	6.8	4.8	216	92	1.00 (ref)	

Note: Boldface indicates $p < 0.05$. Owing to smaller sample size, pregnancy history is not included.

^a Baseline covariates.

^b Follow-up for recidivism was not long enough for women in wave 3 to be included in these analyses. CESD, Center for Epidemiological Studies Depression Scale; N/A, not applicable.

Table 4

Time from smoking cessation to resumption of smoking among HIV-infected sustained quitters

Characteristic	Kaplan-Meier		Unadjusted log-normal		Adjusted log-normal	
	M	Median	n total	n relapse	time ratio (95% CI)	time ratio (95% CI)
State ^d						
California	6.9	4.7	57	32	0.73 (0.43, 1.22)	1.00 (ref)
District of Columbia	3.7	2.0	22	12	0.53 (0.26, 1.10)	1.50 (0.90, 2.49)
Illinois	7.4	7.7	36	19	0.90 (0.49, 1.65)	1.88 (1.09, 3.27)
New York	7.8	7.0	87	37	1.00 (ref)	2.08 (0.65, 6.67)
Age group (years) ^d						
18-29	4.4	2.0	28	15	1.00 (ref)	1.00 (ref)
30-39	6.8	6.0	98	54	1.58 (0.92, 2.71)	1.85 (1.05, 3.26)
40-49	8.3	10.6	65	29	1.85 (1.05, 3.26)	1.00 (ref)
50	2.3	N/A	11	2	3.23 (0.89, 11.77)	1.00 (ref)
Recruitment wave ^b						
1994-1995	7.8	7.0	163	80	1.00 (ref)	0.57 (0.34, 0.94)
2001-2002	2.2	3.0	39	20	0.57 (0.34, 0.97)	1.00 (ref)
Race/ethnicity ^d						
African American	7.5	6.9	132	59	1.00 (ref)	0.38 (0.15, 0.93)
Latina	2.0	2.0	10	8	0.38 (0.15, 0.93)	1.26 (0.69, 2.33)
Other	8.6	7.7	31	14	1.26 (0.69, 2.33)	0.74 (0.41, 1.35)
White	6.4	4.9	29	19	0.74 (0.41, 1.35)	1.04 (0.65, 1.67)
Living with partner						
Yes	5.9	6.0	53	31	1.04 (0.65, 1.67)	1.00 (ref)
No	7.1	6.3	136	68	1.00 (ref)	0.90 (0.57, 1.42)
Educational attainment						
<High school	5.3	6.7	67	34	0.90 (0.57, 1.42)	1.00 (ref)
High school	7.4	6.3	129	66	1.00 (ref)	0.76 (0.48, 1.21)
Employed						
Yes	7.1	3.0	57	33	0.76 (0.48, 1.21)	1.00 (ref)
No	7.1	6.3	139	67	1.00 (ref)	

Characteristic	M	Kaplan-Meier		n relapse	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
		Median	n total			
Yearly household income						
\$12,000	7.0	6.0	103	56	0.83 (0.49, 1.41)	
>\$12,000	6.4	7.7	42	21	1.00 (ref)	
Health insurance						
Yes	7.4	6.3	177	87	1.23 (0.60, 2.53)	
No	6.4	5.4	18	12	1.00 (ref)	
Lives in their own place						
Yes	7.4	6.9	168	81	1.79 (0.98, 3.24)	
No	5.2	2.0	28	19	1.00 (ref)	
Number of years smoked ^a						
<10	6.7	3.0	47	26	1.00 (ref)	
10–19	7.2	7.0	68	35	1.19 (0.67, 2.10)	
20	7.6	7.7	87	39	1.38 (0.80, 2.39)	
Depressive symptoms (CESD)						
<23	7.7	8.7	135	61	1.00 (ref)	
23	5.5	4.0	41	25	0.63 (0.35, 1.11)	
Alcohol use						
None	7.5	7	131	61	1.00 (ref)	
1–6 drinks/week	6.3	6	57	33	0.73 (0.46, 1.17)	
>6 drinks/week or >3 in 1 sitting	5.7	4	8	6	0.88 (0.34, 2.26)	
Marijuana use						
Yes	4.7	2.5	24	18	0.53 (0.29, 0.99)	
No	7.4	7.0	172	82	1.00 (ref)	
Crack/cocaine/heroin use						
Yes	4.2	3.0	20	19	0.49 (0.25, 0.94)	0.49 (0.26, 0.93)
No	7.5	7.7	176	81	1.00 (ref)	1.00 (ref)
Health rating (self-report)						
Good to excellent	7.5	7.7	102	50	1.00 (ref)	
Fair to poor	8.3	6.9	49	18	1.16 (0.63, 2.16)	
Hospitalized in past 6 months						

Characteristic	M	Kaplan-Meier		n relapse	Unadjusted log-normal time ratio (95% CI)	Adjusted log-normal time ratio (95% CI)
		Median	n total			
Yes	6.9	6.3	58	26	1.00 (0.61, 1.65)	
No	7.5	6.7	143	74	1.00 (ref)	
Childcare responsibilities						
Yes	6.3	7.7	55	24	1.00 (0.59, 1.71)	
No	7.8	6.7	121	58	1.00 (ref)	
Hypertension						
Yes	8.4	10.6	83	37	1.35 (0.87, 2.10)	
No	6.6	6.0	118	63	1.00 (ref)	
Diabetes						
Yes	6.8	4.7	47	27	0.90 (0.55, 1.48)	
No	7.6	7.7	155	73	1.00 (ref)	
Cervical intraepithelial neoplasia						
Yes	3.2	2.1	21	14	0.60 (0.31, 1.16)	
No	7.4	6.3	155	80	1.00 (ref)	
HAART use						
Yes	8.4	10.6	125	51	2.37 (1.55, 3.62)	2.21 (1.46, 3.36)
No	4.9	3.0	76	49	1.00 (ref)	1.00 (ref)
CD4 cell count group						
<200	4.6	5.1	39	21	0.74 (0.40, 1.37)	
200–499	6.7	4.8	82	47	0.76 (0.46, 1.25)	
500	8.5	14.1	69	30	1.00 (ref)	
HIV viral load group						
<4,001	8.2	9.0	135	64	1.00 (ref)	
4,001–50,000	4.1	3.3	36	26	0.49 (0.29, 0.84)	
>50,000	3.9	4.4	16	7	0.72 (0.30, 1.71)	

Note: Boldface indicates $p < 0.05$. Owing to smaller sample size, pregnancy history is not included.

^a Baseline covariates.

^b Follow-up for recidivism was not long enough for women in wave 3 to be included in these analyses.

CESD, Center for Epidemiological Studies Depression Scale; HAART, highly active antiretroviral therapy; N/A, not applicable