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A new smoking cessation 'cascade' among women with or at risk for HIV infection

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Abstract

Objectives: The aim of this study was to define a smoking cessation ‘cascade’ among USA women with and without HIV and examine differences by sociodemographic characteristics.

Design: An observational cohort study using data from smokers participating in the Women’s Interagency HIV Study between 2014 and 2019.

Methods: We followed 1165 women smokers with and without HIV from their first study visit in 2014 or 2015 until an attempt to quit smoking within approximately 3 years of follow-up,

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initial cessation (i.e. no restarting smoking within approximately 6 months of a quit attempt), and sustained cessation (i.e. no restarting smoking within approximately 12 months of a quit attempt). Using the Aalen-Johansen estimator, we estimated the cumulative probability of achieving each step, accounting for the competing risk of death.

Results: Forty-five percent of smokers attempted to quit, 27% achieved initial cessation, and 14% achieved sustained cessation with no differences by HIV status. Women with some post-high school education were more likely to achieve each step than those with less education. Outcomes did not differ by race. Thirty-six percent [95% confidence interval (95% CI): 31–42] of uninsured women attempted to quit compared with 47% (95% CI: 44–50) with Medicaid and 49% (95% CI: 41–59) with private insurance.

Conclusion: To decrease smoking among USA women with and without HIV, targeted, multistage interventions, and increased insurance coverage are needed to address shortfalls along this cascade.

Keywords

epidemiology; HIV; smoking cessation; tobacco use; women's health

Introduction

Tobacco use remains the leading cause of preventable morbidity and mortality in the United States (USA) [1]. Smoking cessation reduces the risk of cancer, cardiovascular disease, chronic obstructive pulmonary disease, and all-cause mortality [1–3]. However, although cigarette smoking has dramatically declined in the USA over the last decades, people with HIV (PWH) remain disproportionately affected by cigarette smoking and its consequences [4–6].

Over one-third of PWH in the USA report current smoking [4], more than twice the prevalence of smoking in the general population and well above the Healthy People 2020 target of 12% or less adults smoking (since updated to ≤5% in Healthy People 2030) [1,7]. PWH are particularly vulnerable to adverse tobacco-related outcomes. Evidence suggests that cigarette smoking interacts with HIV to increase the risk of pulmonary disease, lung cancer, cardiovascular disease, and pregnancy loss regardless of viral suppression [8–10]. Although AIDS-related mortality has declined in the last two decades with widespread use of antiretroviral therapy, other causes of death (for which smoking is a major risk factor [11]) are now contributing to a substantial proportion of premature mortality among PWH [12].

To reduce the prevalence of smoking, it is critical to understand the process of smoking cessation and the points at which individuals face the greatest barriers. The HIV care continuum [13] and depression treatment cascade [14] are frameworks that were developed to identify issues and opportunities in achieving treatment goals. Here, we analogously define and quantitively describe a smoking cessation cascade among smokers participating in the Women's Interagency HIV Study (WIHS) since implementation of tobacco-related Patient Protection and Affordable Care Act (ACA) policies in 2014. As prior studies have

suggested that PWH may be less likely to quit smoking compared with people in the general population (e.g., [4]), we compare cascades by HIV status. Moreover, we examine differences in the cascade by sociodemographic and healthcare characteristics that the US Surgeon General uses to track smoking trends in the general population [1] and which are theorized to influence health outcomes and health service utilization among vulnerable populations [15].

Materials and methods

Study population

The WIHS, now part of the MACS-WIHS Combined Cohort Study [16], was the largest US interval cohort study of women with or at risk for HIV infection. Described previously [17], the WIHS enrolled 4982 women from 10 sites (Bronx/Manhattan, NY; Brooklyn, NY; Chicago, IL; Los Angeles/Southern CA/Hawaii; San Francisco/Bay Area, CA; Washington, DC; Atlanta, GA; Birmingham, AL/Jackson, MS; Chapel Hill, NC; Miami, FL) over four recruitment waves (1994–1995, 2001–2002, 2011–2012, 2013–2015). Women were followed at study visits approximately every 6 months and contributed sociodemographic, risk behavior, laboratory, physical examination, and clinical event data. The WIHS confirmed deaths through physician review of state death certificates and the National Death Index Plus. Whereas many US clinical cohorts of PWH are predominantly male and disproportionately White, the WIHS included women with HIV (WWH) representative of the racial/ethnic distribution of WWH in the USA. In particular, the WIHS successfully enrolled and followed Black and Hispanic women, who bear a large proportion of the burden of new HIV diagnoses [18] but are less likely to be enrolled in clinical cohorts. Institutional review boards at each site approved the WIHS and all women provided written informed consent to participate.

Eligibility for analysis was restricted to women reporting current smoking at analysis baseline. Analysis baseline was defined for each woman as her first WIHS study visit on, or after, April 1, 2014. Beginning in 2014, the ACA required most health insurance plans to cover US Food and Drug Administration (FDA)-approved tobacco cessation medications. This guidance applied to state Medicaid programs, alternative benefit plans offered through Medicaid expansion, plans offered through state health insurance marketplaces, and private group and individual plans.

Smoking cessation cascade

We define the smoking cessation cascade as a series of steps necessary to achieve successful smoking cessation. These include making any attempt to quit smoking, achieving initial cessation, and achieving sustained cessation. Similar to the HIV care continuum [13] and depression treatment cascade [14], the smoking cessation cascade is a conceptual, visual model to identify shortfalls at various points along the smoking cessation trajectory.

To characterize the cascade in the WIHS, we used self-reported data on smoking including current smoking status, any smoking since the last visit, any attempt to quit smoking since the last visit, and restarting smoking. Women who reported any attempt to quit smoking

since the last visit (regardless of success or use of a smoking cessation aid) or whose status changed from current to former smoking were classified as having achieved the first step of the cascade. We defined initial smoking cessation (i.e. achieving the second step) as not restarting smoking by the study visit immediately following the quit attempt. This corresponds to approximately less than six months since quit attempt, a period in which susceptibility to relapse is highest [19]. Finally, we defined sustained smoking cessation (i.e. achieving the third step of the cascade) as not restarting smoking by the second WIHS visit following the quit attempt. This corresponds to approximately 6–12 months since quit attempt and is consistent with Centers for Disease Control and Prevention reports in which successful smoking cessation was defined as having quit smoking for 6–12 months [20].

Statistical analyses

We followed women from their analysis baseline visit on, or after, April 1, 2014, until each of the following outcomes (ascertained at semiannual visits): quit attempt within six visits (i.e. approximately 3 years) of analysis baseline, initial smoking cessation within one visit of quit attempt, and sustained smoking cessation within one visit of initial cessation (i.e. two visits of quit attempt). We administratively censored women after eight visits (i.e. approximately 4 years) to ensure that all women were eligible for outcome observation; women enrolled in the last period of the 2013–2015 WIHS recruitment wave had no more than eight completed follow-up visits at the time of analysis.

We estimated the probability of achieving each step of the cascade with the Aalen-Johansen estimator [21], accounting for death as a competing risk. Specifically, we estimated the probability of achieving the first step as the probability of making any attempt to quit, the second step as the joint probability of attempting to quit and achieving initial cessation, and the final step as the joint probability of attempting to quit, achieving initial cessation, and achieving sustained cessation. We additionally estimated ‘cascade transition probabilities’, the proportion of women successfully transitioning to the next step of the cascade (e.g. initial cessation) among those who achieved the prior step (e.g. quit attempt). As transition probabilities were conditional probabilities estimated from models fit among those who achieved the prior step, all individuals included in the sample had remained under follow-up by definition.

To summarize results, we created visual depictions of the smoking cessation cascade. We examined differences in the cascade by HIV serostatus and baseline measures of age (<40, 40–50, >50 years), self-reported race/ethnicity (non-Hispanic Black, non-Hispanic White, Hispanic), level of educational attainment (did not complete high school, completed high school, some post-high school education), and health insurance (no insurance, Medicaid, private insurance, other insurance) by assessing whether point estimates for a given subgroup lay outside the 95% confidence interval (95% CI) of the comparison subgroup [22]. ‘Other’ insurance included those receiving Medicare. When examining cascades by race/ethnicity, we excluded those in other categories (e.g., Native American, Asian) due to small numbers. Before creating cascades by age, race/ethnicity, education, and health insurance, we assessed homogeneity in the proportions of WWH and women without HIV (WWoH) achieving each step of the cascade for each category of the relevant characteristic.

When the homogeneity assumption was not supported for at least one step of the cascade (i.e. chi-square test statistic value $P \geq 0.10$), we stratified the cascade by HIV serostatus. All analyses were completed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina, USA).

Results

Among 2552 women participating in the WIHS since implementation of tobacco-related ACA policies in 2014, 1165 (46%) reported smoking since their last study visit and were eligible for analysis. This included 400 (52%) WWoH and 765 (43%) WWH (Supplement; sTable 1, http://links.lww.com/QAD/C327). The median age was 49 [interquartile range (IQR): 42–54]. Seventy-five percent of women were non-Hispanic Black, over 40% had not completed high school, and the majority had Medicaid insurance though nearly 20% were uninsured (sTable 2, http://links.lww.com/QAD/C327). Over follow-up, 45% (95% CI: 42–47) of women made an attempt to quit smoking, 27% (95% CI: 25–30) achieved initial cessation, and 14% (95% CI: 12–16) achieved sustained cessation, with no differences observed by HIV serostatus (Fig. 1, sTable 2, http://links.lww.com/QAD/C327). Among those who attempted to quit, the probability of initial cessation was 0.60 (95% CI: 0.55–0.63). The probability of sustained cessation among those who achieved initial cessation was 0.50 (95% CI: 0.44–0.56).

Age

Among women under 40 years of age, higher proportions of WWoH made an attempt to quit smoking (55%; 95% CI: 47–65), achieved initial cessation (39%; 95% CI: 31–50), and achieved sustained cessation (22%; 95% CI: 15–34) compared with WWH (quit attempt: 46%; 95% CI: 39–54; initial cessation: 28%; 95% CI: 23–35; sustained cessation: 13%; 95% CI: 8–21) (Fig. 2; sTable 3, http://links.lww.com/QAD/C327). The proportions of women achieving each step of the cascade did not vary by age category for WWH. However, for WWoH, a higher proportion of those under 40 achieved each step of the cascade compared with those aged 40–50 or over 50 years. WWoH who were under age 40 had a higher probability of transitioning from a quit attempt to initial cessation (0.71; 95% CI: 0.58–0.83) than WWoH who were 40–50 (0.51; 95% CI: 0.38–0.63) or over 50 (0.56; 95% CI: 0.44–0.68).

Race/ethnicity

The proportions of non-Hispanic White women and non-Hispanic Black women achieving each step of the smoking cessation cascade were similar (Fig. 3; sTable 4, http://links.lww.com/QAD/C327). Higher proportions of Hispanic women quit smoking (50%; 95% CI: 44–57) and achieved sustained cessation (19%; 95% CI: 14–27) than non-Hispanic Black women (quit attempt: 44%, 95% CI: 41–47; sustained cessation: 13%, 95% CI: 11–16).

Education

Figure 4 illustrates increasing proportions of women attempting to quit smoking with increasing levels of educational attainment. Forty percent (95% CI: 36–44) of women who did not complete high school attempted to quit smoking compared with 45% (95% CI:

40–50) of women who completed high school and 52% (95% CI: 47–57) who received some post-high school education (Fig. 4; sTable 4, http://links.lww.com/QAD/C327). However, this monotonic relationship was not observed for initial and sustained cessation. Higher proportions of those with some post-high school education achieved these steps (initial cessation: 32%, 95% CI: 28–38; sustained cessation: 18%, 95% CI: 14–22) compared with those in the other two education categories, yet there were no differences between those who completed and did not complete high school.

Health insurance

Those with no health insurance were least likely to achieve each step of the cascade (Fig. 5; sTable 4, http://links.lww.com/QAD/C327). Only 36% (95% CI: 31–42) of uninsured women attempted to quit smoking compared with 47% (95% CI: 44–50) of those with Medicaid and 49% (95% CI: 41–59) of those with private health insurance; 23% (95% CI: 18–28) achieved initial cessation compared with 28% (95% CI: 25–31) of those with Medicaid and 30% (95% CI: 22–39) of those with private insurance; and 10% (95% CI: 7–16) achieved sustained cessation compared with 15% (95% CI: 12–18) of those with Medicaid and 19% (95% CI: 13–27) of those with private insurance. There were no differences in the proportions of women achieving each step of the cascade across the three other health insurance categories (i.e. Medicaid, private, other).

Discussion

In this study characterizing the smoking cessation cascade among smokers participating in the WIHS between 2014 and 2019, we found large drop-offs along all steps of the continuum. Less than half of women attempted to quit smoking over approximately 3 years of follow-up, only a quarter achieved initial cessation, and 14% achieved sustained cessation. The vast majority of women remained smokers or restarted smoking within approximately a year of quitting, a period shorter than that needed to confer meaningful reductions in the risks of cardiovascular disease endpoints among PWH [23].

The sizeable drop-offs that occurred along all steps of the cascade highlight the need for multistage interventions in the WIHS and similar US populations of racial and ethnic minority WWH and WWoH. Our findings suggest that multiple challenges interfere with the smoking cessation process. To decrease smoking in such populations, it may be important to consider comprehensive interventions that address multiple steps of the cascade. For example, motivational interviewing based on the Transtheoretical Model of Change combined with the provision of free, evidence-based smoking cessation medication may increase quit attempts, while continued medication management combined with intensive behavioral therapy during the year after quitting may improve initial and sustained cessation [24]. In a systematic review of multicomponent interventions to increase smoking cessation in primary healthcare, interventions that included more components and were longer in duration improved cessation and continuous abstinence from tobacco use [24].

Observed differences in smoking cessation outcomes by age, race/ethnicity, education, and insurance may also be important in guiding future research and intervention planning. As outlined by the Gelberg-Anderson behavioral model [15], these characteristics often

influence health outcomes and health service utilization among vulnerable populations and may lead to different sets of challenges among subgroups. We found that WWoH who were under 40 years old were more likely to quit smoking and achieve initial cessation than older WWoH (despite previous studies suggesting that younger women are less likely to receive interventions) [5,25]. This could be due to a correlation between younger age and fewer years of prior smoking as well as reproductive planning among younger women that might increase motivation to quit smoking and remain abstinent (at least for the period of pregnancy). The worse outcomes experienced among those with less education and no insurance, which has also been observed in the general population, might underscore the need for different strategies to address the unique barriers faced by these individuals.

Whereas previous studies have found lower rates of smoking cessation among non-Hispanic Black individuals compared with non-Hispanic White individuals [26,27], there was no difference in the smoking cessation cascade between non-Hispanic Black and non-Hispanic White women in the WIHS. Race and ethnicity are often imperfect proxies for a complex set of factors that influence smoking behaviors (e.g., socioeconomic status, access to quality care). The distribution of these factors among non-Hispanic Black versus non-Hispanic White individuals in the general population might differ from their distribution among non-Hispanic Black versus non-Hispanic White women in the WIHS. For example, in the general USA population, median household income is lower among non-Hispanic Black versus non-Hispanic White individuals [28], but income was similar for non-Hispanic Black and non-Hispanic White women in the WIHS; about 75% of women in both subgroups had an average annual income of $18 000/year or less. Consequently, in the WIHS, differences in cessation outcomes were more apparent by income level than by race. Those with household incomes more than $18 000/year were more likely to achieve each step of the cascade (sFigure 1, http://links.lww.com/QAD/C321; sTable 5, http://links.lww.com/QAD/C327).

Interestingly, unlike other studies, we did not find differences in any smoking cessation outcome by HIV serostatus. However, prior studies have typically compared smoking cessation among PWH with cessation among the general population [4]. The WIHS enrolled WWoH who are demographically similar to WWH and are at risk for HIV based on sexual behaviors, drug use, and other risk behaviors [17]. Therefore, WWoH in the WIHS are unlike the general population in regards to smoking prevalence and intensity, racial/ethnic distribution, insurance coverage, and other characteristics associated with smoking cessation [1,25,26]. It is possible that these non-HIV-related characteristics, which are better balanced between WWH and WWoH in the WIHS than in other research settings, influence the smoking cessation continuum more than HIV infection itself. Equivalent percentages of WWH and WWoH in our study were long-term, heavy smokers (sTable 2, http://links.lww.com/QAD/C327) who were less likely to achieve successful smoking cessation outcomes than those who smoked fewer cigarettes per day or had been smoking for a shorter duration (sFigures 2, http://links.lww.com/QAD/C322 & 3, http://links.lww.com/QAD/C323; sTable 5, http://links.lww.com/QAD/C327).

Our study is the first to use a cascade framework to assess smoking cessation outcomes in the modern ACA era among WWH and WWoH, overall and by sociodemographic characteristics. Although the 2020 Report of the Surgeon General monitors national

trends in smoking among numerous subgroups, it does not include information related to populations with or at risk for HIV infection [1]. Previous studies of smoking cessation among PWH have primarily used data from periods before 2014 [4,29–32] (the time at which ACA policies were implemented to improve health insurance coverage of smoking cessation aids) [33], used cross-sectional analytic designs and report measures of annual prevalence [4,29,30], and/or failed to account for death as a competing risk in longitudinal analyses [32]. In this study, we anchored the follow-up period for analysis to the calendar time during which access to evidence-based smoking cessation interventions should have improved. Moreover, we followed women longitudinally (accounting for death as a competing risk) to overcome challenges with cross-sectional designs; namely, that changes in the prevalence of smoking may be influenced by a combination of factors including changes in the characteristics of the analytic sample across study years, changes in the incidence of smoking, changes in the incidence of smoking cessation, and deaths.

Another unique strength of our study is that we adapted the traditional framework for visual depictions of cascades by explicitly incorporating transition probabilities, a measure that offers a more nuanced understanding of the shortfalls along the cascade and the points at which interventions are most needed. For example, when considering transition probabilities in addition to the proportion of women achieving each step of the cascade, it is possible to see that the worse outcomes we observed among those with no health insurance may largely be influenced by the lower probability of attempting to quit. Among the 36% of women without insurance who attempted to quit smoking, the probability of transitioning to initial cessation did not differ from those with insurance, nor was there a difference in the probability of transitioning from initial to sustained cessation. Thus, understanding and addressing the unique barriers to quitting among those without insurance is likely a priority. Provision of universal health insurance, Medicaid expansion, and/or improved health insurance coverage (or free availability) of smoking cessation aids might help increase quit attempts.

Our cascade framework can be expanded to identify and address potential barriers in smoking cessation among subgroups defined by other clinical, psychosocial, and substance use related factors. Examining differences in outcomes by these characteristics might provide further insight for optimal intervention strategies, especially considering supplementary analyses suggested worse smoking cessation outcomes among those who consumed alcohol and had a history of injection drug use (sFigures 4, http://links.lww.com/QAD/C324 & 5, http://links.lww.com/QAD/C325; sTable 5, http://links.lww.com/QAD/C327).

Our findings should be interpreted in light of the following limitations. First, as smoking was self-reported, results may overestimate quitting and cessation if women falsely indicated that they quit and remained abstinent. Consequently, our study represents the smoking cessation cascade among *women who report current smoking*. Second, 95% CIs for some point estimates, particularly sustained cessation, were wide. Given that so few women achieved this step, further studies with larger sample sizes may be needed to determine whether meaningful differences in success at this stage exist between groups. Third, when comparing the cascade by health insurance, we used insurance type at analysis baseline

(classified according to a hierarchy scheme outlined in a Kaiser Issue Brief [34] and applied in previous WIHS papers [35]). Future work may examine the impact of changes in insurance type, or insurance interruptions, on particular points in the cascade. Fourth, although we focused on the period during which policy changes should have improved access to FDA-approved smoking cessation aids, coverage varies widely by state. Policy implementation may have had less impact on smokers in Southern states that opted out of Medicaid expansion [36]. In fact, we observed that women participating at Southern WIHS sites were less likely to make quit attempts and achieve sustained cessation than women at non-Southern sites (sFigure 6, http://links.lww.com/QAD/C326). Finally, there was limited information on receipt and use of evidence-based smoking cessation strategies in the WIHS. Documented use of pharmacological aids was low which made meaningful comparisons between groups difficult; only one-fifth of women reported ever using nicotine replacement therapy and a mere 5% reported use of varenicline (sTable 6, http://links.lww.com/QAD/C327). Yet, the limited use of evidence-based cessation strategies in the WIHS might highlight a gap in need that can be addressed to improve cessation outcomes.

Conclusion

Smoking cessation is paramount to reduce morbidity and mortality in the USA and is particularly important among PWH. The cascade framework outlined and applied in this study provides succinct, visual, and numerical representations of the smoking cessation continuum, facilitates identification of points of vulnerability, and enables comparisons by subgroups that may be important in guiding future research and designing targeted interventions. Substantial shortfalls observed across all points of the cascade highlight opportunities for comprehensive, multistage smoking cessation interventions among USA women with or at risk for HIV infection.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Conflicts of interest

D.W. has engaged in unrelated consulting work for PRI Healthcare Solutions on behalf of Sanofi-Pasteur. T.T.B. has served as a consultant to Merck, ViiV Healthcare, Gilead, Janssen, and Theratechnologies. PCT's institution has received funding for her research from Merck. A.A.A. has received personal fees for consulting from Merck, Viiv, and Gilead and her institution has received funding for her research from Merck and Gilead. T.L.B., A.E., J.K.E., L.C.Z., S.R.C., C.R., I.O., S.G.K., D.K.P., D.L.J., G.D., M.H.C., T.N.T., and K.A. have nothing to disclose.

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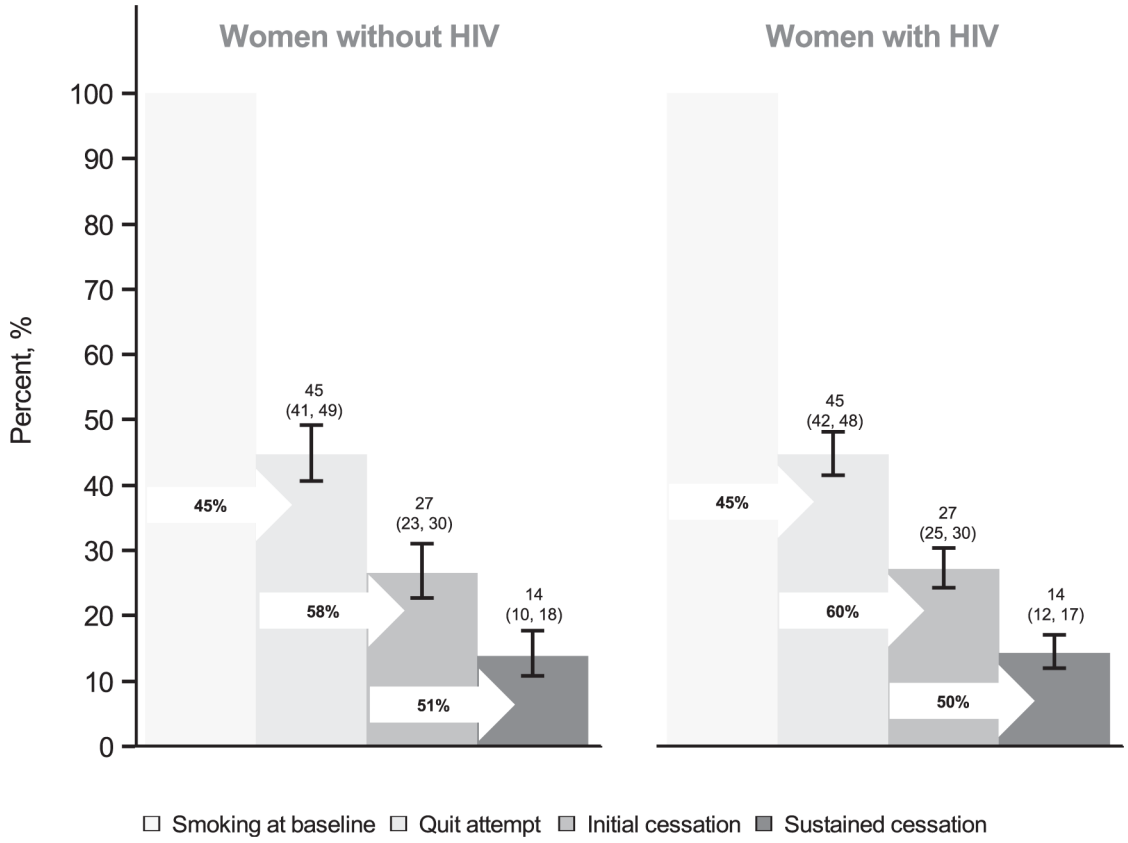

Fig. 1. Smoking cessation cascade among 1165 women smokers participating in the Women's Interagency HIV Study between 2014 and 2019 by HIV serostatus.

(Women without HIV: $n = 400$; Women with HIV: $n = 765$).

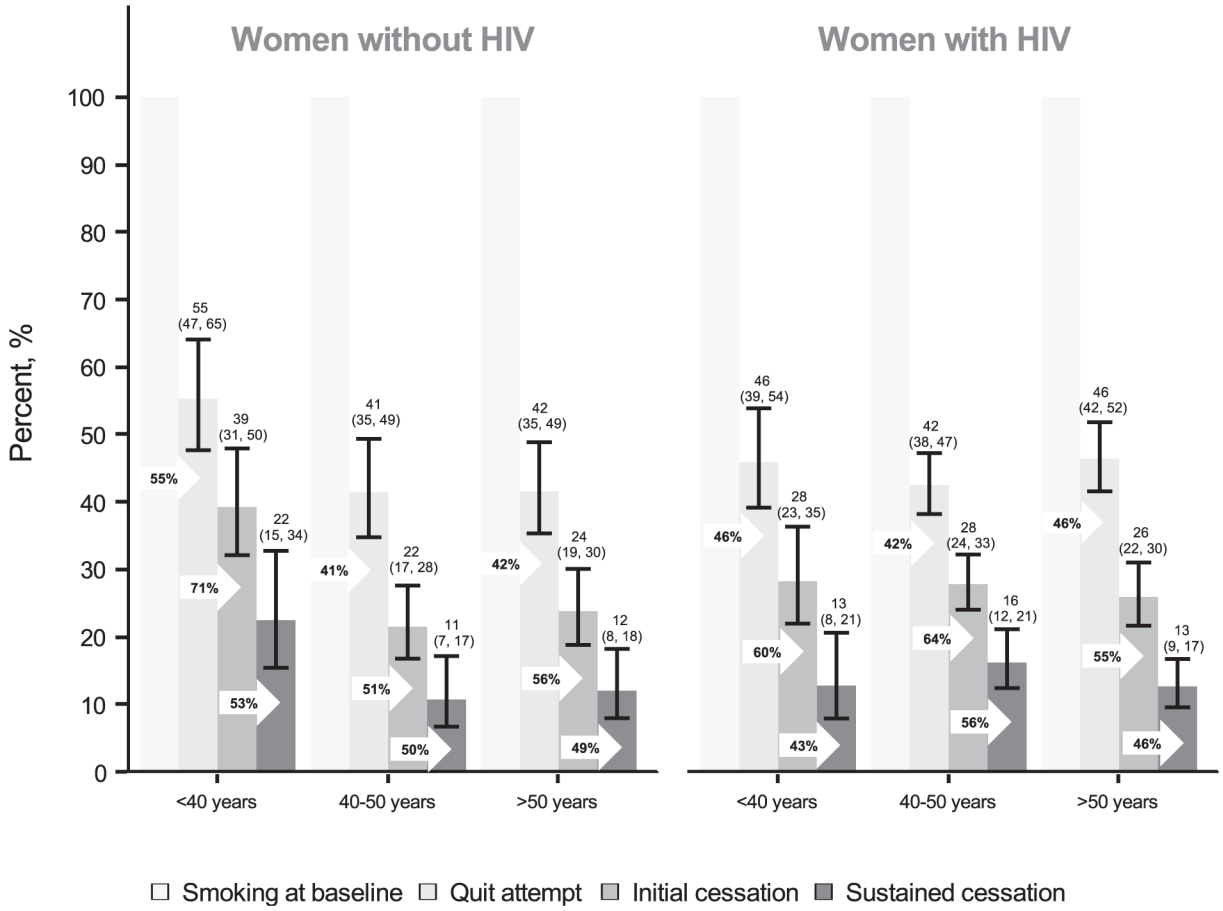

Fig. 2. Smoking cessation cascade by HIV serostatus and age among 1165 smokers participating in the Women's Interagency HIV Study between 2014 and 2019.

Includes 400 smokers without HIV (<40 years: *n* = 90; 40–50 years: n= 152; >50 years: n = 158) and 765 smokers with HIV (<40 years: n= 135; 40–50 years: n= 319; >50 years: n= 311).

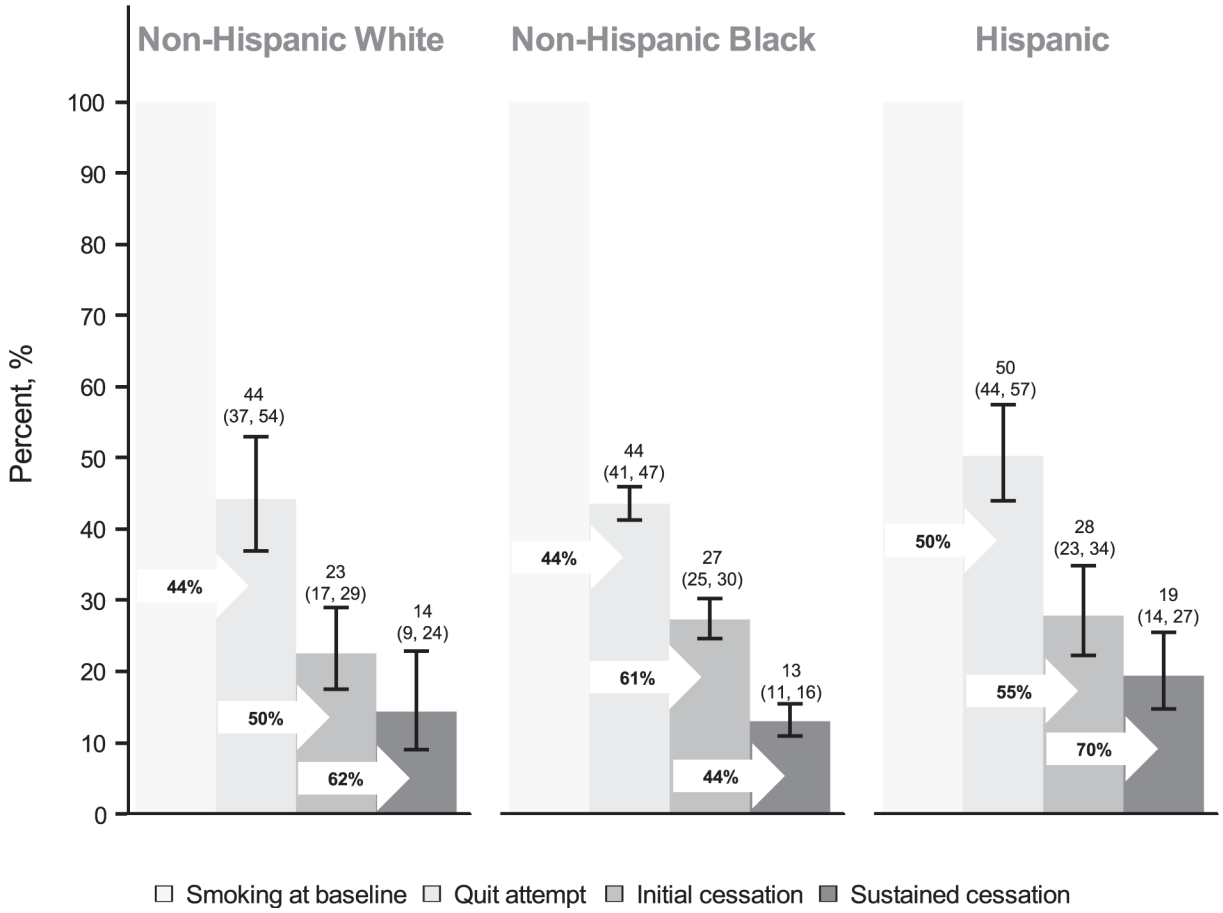

Fig. 3. Smoking cessation cascade by race/ethnicity among 1165 smokers participating in the Women's Interagency HIV Study between 2014 and 2019.

(Non-Hispanic White: $n = 115$; non-Hispanic Black: $n = 869$; Hispanic: $n = 144$).

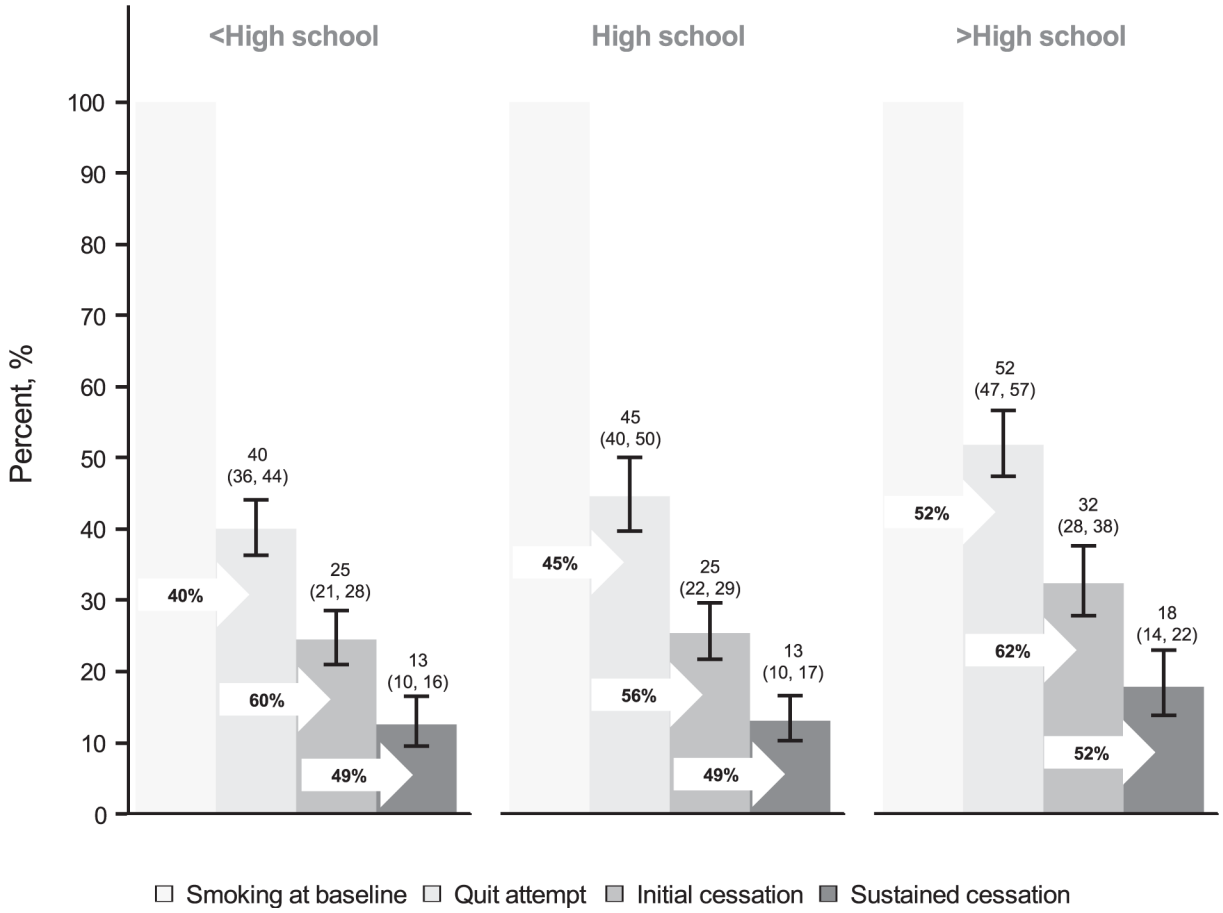

Fig. 4. Smoking cessation cascade by educational attainment among 1165 smokers participating in the Women's Interagency HIV Study between 2014 and 2019.

(<High school: $n = 472$; High school: $n = 372$; >High school: $n = 320$).

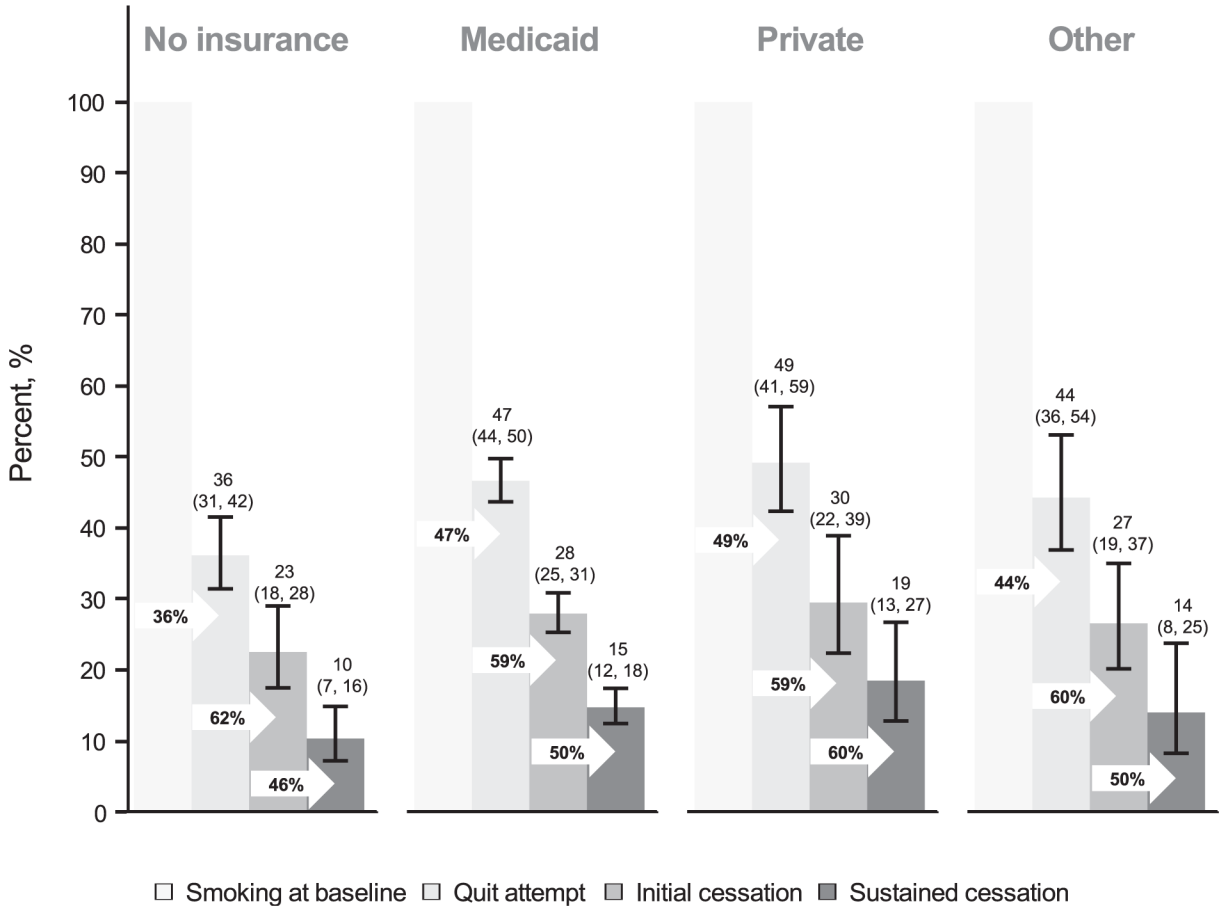

Fig. 5. Smoking cessation cascade by type of health insurance among 1165 smokers participating in the Women's Interagency HIV Study between 2014 and 2019.

(No insurance: $n = 219$; Medicaid: $n = 752$; Private: $n = 100$; Other: $n = 92$).