Published in final edited form as:
Addict Behav. 2011 ; 36(1-2): 61–67. doi:10.1016/j.addbeh.2010.08.022.

Tobacco Use and Nicotine Dependence among HIV-Infected and Uninfected Injection Drug Users

Mariah M. Marshall[1], **Gregory D. Kirk**[1,2], **Neil E. Caporaso**[3], **Meredith C. McCormack**[1,2], **Christian A. Merlo**[2], **John C. Hague**[1], **Shruti H. Mehta**[1], and **Eric A. Engels**[2,3]

[1]Department of Epidemiology, School of Public Health, Johns Hopkins University, Baltimore, MD
[2]Department of Medicine, School of Medicine, Johns Hopkins University, Baltimore [3]Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Rockville, Maryland

Abstract

Introduction—Urban U.S. populations are burdened by intersecting epidemics of HIV-infection, injection drug use, and cigarette smoking. Given the substantial morbidity attributable to tobacco in these populations, we characterized smoking behaviors, nicotine addiction, and tobacco exposure among HIV-infected and HIV-uninfected injection drug users (IDUs) in Baltimore, Maryland.

Methods—Smoking behaviors among participants in the ALIVE Study were assessed using interviewer-administered questionnaires. Smoking history and nicotine dependence (Fagerstrom Index scores) were compared by HIV and drug injecting status. Serum cotinine (a nicotine metabolite) was measured for a sample of participants by enzyme immunoassay.

Results—Among 1,052 participants (29.7% HIV-infected, 39.8% active injectors), 85.2% were current smokers and 9.3% former smokers. Smoking prevalence, age at smoking initiation, and cumulative tobacco exposure were similar by HIV status. Median Fagerstrom scores of 4 for HIV-infected and HIV-uninfected smokers indicated moderate nicotine dependence. Daily cigarette consumption was identical by HIV status (median 10 cigarettes), although HIV-infected participants were less likely to smoke 1+ pack daily compared to HIV-uninfected participants (18.0% vs. 26.9%, p=0.001). Compared to former injectors, active injectors had higher smoking prevalence (90.5% vs. 81.7%, p=0.0001), greater daily cigarette consumption (30.7% vs. 19.6% smoked 1+ pack daily, p=0.0001), and slightly higher Fagerstrom scores (median 5 vs. 4). Cotinine levels paralleled self-reported cigarette consumption.

Discussion—Tobacco use is extremely common among inner city IDUs. Smoking behavior and nicotine dependence did not materially differ by HIV status but were associated with active drug injection. Cessation efforts should target the dual dependence of cigarettes and drugs experienced among this population.

INTRODUCTION

Human immunodeficiency virus (HIV) infection and injection drug use have long been recognized to coexist in contemporary urban populations. Tobacco use constitutes a third epidemic that may also impact urban populations with dramatic adverse health consequences. Cigarette smoking is common among HIV-infected individuals (prevalence estimates ranging

Address correspondence to Mariah M. Marshall, MHS, Department of Epidemiology, School of Public Health, Johns Hopkins University, 2213 McElderry St. M-105, Baltimore, MD 21205; mmarshal@jhsph.edu.

from 35-70% compared to approximately 20% in the general U.S. population), (Burkhalter, Springer, Chhabra, Ostroff, & Rapkin, 2005; CDC, 2007; Gritz, Vidrine, Lazev, Amick, & Arduino, 2004; Thompson, Nanni, & Levine, 1996) likely reflecting increased smoking in persons who engage in high risk sexual or drug use behaviors associated with HIV transmission. Given the success of highly active antiretroviral therapy (HAART) in prolonging survival among HIV-infected individuals, chronic smoking-related conditions such as lung cancer, chronic obstructive pulmonary disease (COPD), and cardiovascular disease account for a growing proportion of morbidity and mortality. (Braithwaite et al., 2005; d'Arminio Monforte et al., 2005; Lewden et al., 2005) An elevated risk of lung cancer, (Chaturvedi et al., 2007; Engels et al., 2006; Kirk et al., 2007) COPD, (Diaz, Clanton, & Pacht, 1992; Diaz et al., 2000; Sahebjami, 1992) and cardiovascular disease (Friis-Moller et al., 2003; Grunfeld et al., 2009; Lewden et al., 2005; Mary-Krause, Cotte, Simon, Partisani, & Costagliola, 2003; Saves et al., 2003) has been observed among HIV-infected individuals, and lung cancer is now the third most common malignancy in this population. (Chaturvedi et al., 2007; Kirk et al., 2007)

Injection drug users (IDUs) comprise one of the major HIV transmission groups. Independent of HIV infection, injection drug use is associated with substantial morbidity and mortality, (McGinnis & Foege, 1999) although the burden of tobacco use and of smoking-related disease remains uncertain. Further, IDU's predisposition to addiction may confer an enhanced physiological dependence to nicotine. (Clemmey, Brooner, Chutuape, Kidorf, & Stitzer, 1997; Frosch, Shoptaw, Nahom, & Jarvik, 2000; Stark & Campbell, 1993) Although injection drug use represents a chronic, relapsing, medical condition, many IDUs are able to achieve injection cessation for prolonged periods. (Galai, Safaeian, Vlahov, Bolotin, & Celentano, 2003) The impact of injection cessation on the smoking behavior of former IDUs has not been fully explored.

Although the health consequences of HIV infection among IDUs have been well documented, the contribution of cigarette smoking to the disease process among this population is unclear. It remains unknown to what degree HIV status and injection drug use influence tobacco use. We, therefore, performed a cross-sectional study within a large inner-city cohort of IDUs in Baltimore, Maryland in which we collected detailed smoking histories to examine the prevalence of cigarette smoking. We determined whether smoking behavior and the level of nicotine dependence differed between HIV-infected and HIV-uninfected participants, and between active and former injectors. To further quantify tobacco exposure, we also measured serum levels of cotinine (a metabolite of nicotine) in a sample of participants.

METHODS

Study Participants and Exposure Assessment

The AIDS Linked to the Intra-Venous Experience (ALIVE) Study is a long-standing cohort study that has recruited and followed IDUs in Baltimore, Maryland since 1988. (Anthony et al., 1991) Eligibility criteria at enrollment include age of at least 18 years, ability to provide informed consent, and history of injection drug use. Cohort participants are seen at biannual visits, when data are obtained on recent drug use including intensity and route of use, medical illnesses, and HIV treatment. Blood samples are routinely collected for repository storage.

Participants in this study were evaluated at routinely scheduled follow-up visits from January 2007 to September 2008. In total, 1,052 ALIVE participants underwent a structured interview regarding smoking history, exposure to second-hand smoke (SHS), symptoms of lung disease, and personal and family history of respiratory conditions. Additional questions on use of smoked illicit drugs were included. All participants provided written informed consent, and the study protocol was approved by institutional review boards of Johns Hopkins School of Public Health and the National Cancer Institute.

We defined active injection drug use as any reported drug injection within the last six months. Never smokers were individuals who had smoked fewer than 100 cigarettes over their lifetime. Former smokers were individuals who had smoked at least 100 lifetime cigarettes but none within the previous 30 days. Current smokers had both smoked 100 or more lifetime cigarettes and smoked at least once in the last 30 days. Individuals who lived with anyone who regularly smoked cigarettes in their home were considered exposed to SHS in the home. Individuals who regularly spent time when not at home where people smoked cigarettes were defined as exposed to SHS outside the home. To measure nicotine dependence, we used the Fagerstrom Index, (Fagerstrom & Schneider, 1989) which includes questions regarding time to first cigarette use after waking, difficulty refraining from smoking in prohibited areas, the cigarette one would most hate to give up, number of cigarettes smoked per day during the last week, smoking frequency during the beginning of the day, and smoking while sick.

Cotinine levels were measured in serum specimens collected on the same day as the interview. Because cotinine levels vary by race (Caraballo et al., 1998) and the majority of ALIVE participants are African American and male, only African American men were included in this sample. From those with available samples, 270 participants were randomly selected for cotinine measurement based on current smoking patterns and HIV status. Current smoking categories included nonsmokers, light/moderate smokers (less than 1 pack [20 cigarettes] per day), and heavy smokers (1 pack [20 cigarettes] per day or greater). Among HIV-infected participants, sampling was further based on degree of immune suppression (stratified as CD4 count 0-299 vs. 300+ cells/mm^3). We randomly selected up to 50 participants in each stratum, if available. Cotinine was measured using an enzyme immunoassay (OraSure Technologies, Bethlehem, PA), which is calibrated across a range from 2 to 50 ng/ml. Because we tested serum samples diluted 1:20, the assay provided results corresponding to serum levels up to 1000 ng/ml. Cotinine levels measured using this assay are highly correlated with levels measured by gas chromatography. (Boffetta et al., 2006)

Statistical Analysis

We compared demographic characteristics, smoking history, and measures of nicotine dependence in HIV-infected and HIV-uninfected participants using the chi-square test for categorical variables and the Wilcoxon rank sum test for continuous variables. A total Fagerstrom score was calculated for each current smoker by assigning points to possible answers of each question of the Fagerstrom Index. (Fagerstrom & Schneider, 1989) Individuals with total scores of 7-10 points were considered to have high nicotine dependence, those with 4-6 points medium nicotine dependence, and those with 0-3 points low nicotine dependence. (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) Similar methods were employed for analyses comparing active to former injection drug users. Cotinine levels in HIV-infected and HIV-uninfected individuals as well as in active and former IDUs were compared within smoking strata (nonsmokers, light/moderate smokers, heavy smokers) using the Wilcoxon rank sum test. We also performed multivariate linear regression to determine whether HIV status or active injection drug use was independently associated with differing cotinine levels.

RESULTS

Demographic Characteristics

Demographic characteristics of the 1,052 participants, stratified by HIV status (29.7% HIV-infected) are described in Table 1. The median age was 49 years among both HIV-infected and HIV-uninfected individuals, although HIV-infected participants were underrepresented at the extremes of the age distribution (less than 30 or greater than 60 years old). Compared with HIV-uninfected participants, HIV-infected individuals were more likely to be female and black, although only race differed significantly. Income levels did not vary by HIV status;

however, there was limited variability in formal income reported, with 94.5% of HIV-infected and 91.5% of HIV-uninfected participants reporting less than $10,000 annually.

As shown in Table 1, 419 participants (39.8%) reported actively injecting drugs in the prior 6 months. Compared to HIV-uninfected participants, HIV-infected individuals were less likely to be currently injecting drugs, and among those currently injecting, HIV-infected individuals were less likely to be injecting daily or more. HIV-infected participants were also less likely to be currently injecting heroin alone compared to HIV-uninfected participants. The age at initiation of injection drug use was significantly younger for HIV-infected individuals compared to HIV-uninfected individuals (median 20 vs. 21 years, p=0.026).

Smoking Behavior and Nicotine Dependence by HIV Status

Overall, 85.2% of participants were current smokers and 9.3% were former smokers (94.5% were ever smokers), and no difference in smoking prevalence was observed by HIV status (Table 1). Few differences were apparent between HIV-infected and HIV-uninfected individuals with regard to smoking history (Table 2). The median age at initiation of smoking was 14 years overall, corresponding to a median duration of 33 years and 19 cumulative pack-years of smoking, and these characteristics did not differ between the two groups. In each group, smokers consumed on average half a pack of cigarettes per day, although the distribution was shifted to heavier consumption for HIV-uninfected individuals (e.g., 18.0% of HIV-infected vs. 26.9% of HIV-uninfected smoked at least 1 pack of cigarettes per day, p=0.001). Most HIV-infected (75.9%) and HIV-uninfected (70.2%) participants smoked 100 mm size cigarettes, which are larger than both regular and king size cigarettes. Participants smoked menthol cigarettes almost exclusively, but use of cigars and pipes was uncommon. Most HIV-infected and HIV-uninfected individuals reported exposure to SHS in the home, both in childhood and subsequently (Table 2). Exposure to SHS outside the home was reported by more than two-thirds of participants, with a slightly higher percentage reported by HIV-infected compared to HIV-uninfected participants (73.2% vs. 67.9%, p=0.087). Lifetime history of smoking illicit drugs, particularly marijuana and crack cocaine, was very common among ALIVE participants. Smoking of illicit drugs within the last 6 months was less common but HIV-uninfected persons reported both more lifetime (90.9% vs. 85.8%, p=0.014) and current (23.5% vs. 15.4%, p=0.003) use of marijuana compared to HIV-infected persons. Lifetime and current smoking of crack cocaine and heroin did not differ by HIV status. Fagerstrom Index scores were similar in HIV-infected and HIV-uninfected current smokers, with both groups having median scores of 4, corresponding to medium nicotine dependence.

Smoking Behavior and Nicotine Dependence by IDU Status

Although the prevalence of ever smoking was similar among active (95.2%) and former IDUs (94.0%), current smoking was significantly more common among active IDUs (90.5% vs. 81.7%, respectively, p=0.007, Table 3). Age of cigarette smoking initiation, duration of smoking, and cumulative pack-years did not differ between active and former IDUs. While the median number of cigarettes smoked per day did not differ between these groups, active IDUs were more likely to report more intense cigarette consumption compared to former IDUs (30.7% vs. 19.6% smoked a pack or more daily respectively, p<0.001). Active IDUs were also more likely to smoke 100 mm cigarettes compared to former IDUs (75.9% vs. 69.1%, p=0.010). Use of menthol cigarettes, cigars, and pipes did not differ by IDU status. Exposure to SHS was commonly reported and prevalence was similar among active and former IDUs. Active IDUs were more likely to have ever smoked marijuana (92.8% vs. 87.2%, p=0.004) and to have smoked marijuana (30.8% vs. 14.7%, p<0.001), crack cocaine (46.8% vs. 20.9%, p<0.001), and heroin (3.6% vs. 1.1%, p=0.006) within the last 6 months. Active IDUs had slightly higher Fagerstrom index scores compared to former IDUs (median 5 vs. 4) and a greater percentage

of active IDUs was defined as having a high level of nicotine dependence, although these differences were not significant (p=0.144).

Serum Cotinine Levels by HIV and IDU Status

Cotinine measurements for 270 African American male participants are presented in Table 4 by HIV status and in Table 5 by IDU status. Cotinine levels paralleled self-reported cigarette use, although for current light/moderate smokers (N=150) and heavy smokers (N=70), there were a wide range of serum cotinine levels. Within both these smoking strata, HIV-uninfected participants had slightly higher cotinine levels than HIV-infected participants, although the differences were of borderline significance. More refined stratification of smokers by cigarette consumption revealed a similar pattern (Table 4). Although we sampled HIV-infected participants by CD4 count, no differences in cotinine levels were found between participants with CD4 counts less than 300 cells/mm^3 and those with CD4 counts of 300 or greater cells/mm^3 (data not shown). Within strata of reported cigarette use, cotinine levels appeared higher in active IDUs than former IDUs, but none of these differences were significant (Table 5). Overall, in a multivariate model accounting for reported cigarette smoking, cotinine levels were lower in HIV-infected than HIV-uninfected subjects (p=0.007) but were unrelated to active injection drug use (p=0.452).

Among current nonsmokers (N=50), serum cotinine levels did not differ significantly between HIV-infected and HIV-uninfected individuals (median 25.0 vs. 19.7 ng/ml, respectively, p=0.505) or between active and former IDUs (median 10.3 vs. 21.4 ng/ml, respectively, p=0.272). Of interest, cotinine levels above 10.0 ng/ml have been suggested to indicate recent use of tobacco. (Pirkle et al., 1996) Among these 50 participants who reported that they had not smoked in the past week, 68% had cotinine levels above 10.0 ng/ml, but neither HIV infection nor active injection drug use was associated with cotinine levels above this value (Tables 4 and 5).

DISCUSSION

The present study of more than 1,000 IDUs in Baltimore, Maryland, is unique in providing detailed smoking data collected explicitly to address the prevalence of cigarette smoking and the issue of differential smoking behavior and nicotine dependence in HIV-infected and HIV-uninfected populations and among both active and former IDUs. Overall, cigarette smoking was nearly ubiquitous in this urban IDU population, as 94.5% of participants reported ever smoking. Although the prevalence of current smoking did not differ by HIV infection status, current smoking was more common among active compared to former IDUs (90.5% vs. 81.7%).

With current smokers comprising over 85% of ALIVE participants, this population of largely African American, inner city IDUs of low socioeconomic status has a much higher prevalence of current cigarette smoking than the general U.S. population (approximately 20%). (CDC, 2007; U.S. Department of Health and Human Services, 2009) Even in comparison to populations more similar demographically to ALIVE, smoking prevalence is still markedly high. Nationally, 22% of African Americans were current smokers in 2006. (U.S. Department of Health and Human Services, 2009) Of those Americans living below the poverty threshold, 30% smoked cigarettes. (U.S. Department of Health and Human Services, 2009) Smoking prevalence in ALIVE is also higher than the 35-70% previously estimated for HIV-infected persons in the U.S. (Burkhalter et al., 2005; Gritz et al., 2004; Thompson et al., 1996) This high prevalence of cigarette smoking reflects the combined effects of multiple biological, psychological, and socioeconomic factors that underlie both injection drug use and tobacco use.

Despite the markedly elevated prevalence of smoking in the ALIVE cohort, the reported intensity of smoking (on average 10 cigarettes per day) was not especially high. Nationally, 47% of current smokers smoke more than 15 cigarettes per day, compared with 20.3% of HIV-infected and 30.7% of HIV-uninfected ALIVE participants. (U.S. Department of Health and Human Services, 2009) Of those living below the poverty level in the U.S., 10% smoke more than 25 cigarettes per day, still noticeably higher than seen in the ALIVE cohort (5.8% in HIV-infected and 4.3% in HIV-uninfected participants). (U.S. Department of Health and Human Services, 2009) The low intensity of smoking observed in ALIVE might arise because IDUs may limit their cigarette consumption due to financial constraints, or they may choose to preferentially buy drugs rather than cigarettes.

The low intensity of cigarette use among current smokers could also be explained by other factors. Of note, only 5% of U.S. African American smokers consume more than 25 cigarettes per day, similar to what we observed among ALIVE participants. (U.S. Department of Health and Human Services, 2009) Like many urban, African American populations in the U.S., ALIVE participants smoked mentholated cigarettes almost exclusively, which may allow greater depth of inhalation. (Sellers, 1998) Thus, these participants may be similarly exposed to tobacco compared to the general U.S. population even though they consume fewer cigarettes per day. Furthermore, the large 100 mm size cigarettes preferentially smoked by our participants may result in higher nicotine levels despite relatively fewer cigarettes smoked.

Upon stratifying on reported cigarette consumption and through linear regression modeling, we found that levels of cotinine (a metabolite of nicotine) appeared slightly lower among HIV-infected participants. This difference could reflect that poorer health in HIV-infected individuals may impair their ability to smoke as much as HIV-uninfected individuals. However, there were no differences in smoking intensity or cotinine levels by CD4 count. We did not find significant differences in cotinine levels by injection status after accounting for cigarette consumption.

Cotinine levels among nonsmokers indicated that around 68% had been exposed to tobacco smoke levels consistent with active smoking. (Pirkle et al., 1996) These results suggest that some individuals who reported no use of cigarettes could actually have been smoking. An alternative explanation is that elevated cotinine levels could reflect exposure to SHS, particularly since African Americans metabolize cotinine more slowly than do whites. (Perez-Stable, Herrera, III, & Benowitz, 1998) Even nonsmoking IDUs may be highly exposed to SHS, as most study participants live in a population-dense, urban environment in row houses or apartments with shared walls that may allow smoke to penetrate. (Ellis et al., 2009) SHS, and perhaps smoking of illicit drugs, increase the risk of lung cancer and pulmonary disease, (Berthiller et al., 2008; Environmental Protection Agency, 1992; Fontham et al., 1994; Tashkin, 2001) and therefore, represent important sources of morbidity among IDUs. Unfortunately, we did not collect information restricted to recent SHS exposure, so we could not evaluate whether it accounted for the elevated cotinine levels among non-smoker participants. Further studies should evaluate the epidemiology and health effects of SHS and smoked drugs in similar high-risk urban populations.

Based on the Fagerstrom Index, the majority of urban IDUs in this study were classified as having low or medium nicotine dependence. Typically, studies in U.S. and European populations have reported mean Fagerstrom scores ranging from 2.5 to 4.3, (John et al., 2003; Luo et al., 2008; Stavem, Rogeberg, Olsen, & Boe, 2008) only slightly lower than observed in our study. Some investigators have proposed using a Fagerstrom score of 4 or 6 as a cut-point to define nicotine dependence. (Frikart, Etienne, Cornuz, & Zellweger, 2003) By that standard, as many as half of the ALIVE cohort would be nicotine-dependent, a far

greater prevalence than documented in the U.S. population (12-15%) using other metrics. (Grant, Hasin, Chou, Stinson, & Dawson, 2004; Hughes, Helzer, & Lindberg, 2006)

One of the most notable findings of our study is that injection cessation was associated with a number of positive aspects of smoking behavior. Specifically, our data indicated that former injectors were less likely to be current smokers, and among these smokers, reported lower cigarette consumption and Fagerstrom scores compared to active IDUs. Interestingly, the proportion of former IDUs who were classified as highly nicotine dependent appeared lower than observed among active IDUs. Similar results were observed in another study in which both cigarette smoking prevalence and Fagerstrom scores were lower among former injectors than active injectors in drug treatment programs. (Clarke, Stein, McGarry, & Gogineni, 2001) Furthermore, we found that former IDUs were also less likely to currently smoke marijuana, crack cocaine, and heroin compared to active IDUs. In total, the data suggest a behavioral pattern of cigarette consumption and smoked-drug use that parallels that of injection drug use. While many substance abuse professionals suggest that smoking cessation efforts should be deferred until drug dependence issues have been addressed, an alternative approach reinforcing smoking cessation concurrent with drug treatment may be optimal for some individuals. Clinical trials evaluating these different approaches would be appropriate. Further research should also evaluate the daily usage patterns of cigarette smoking and injection drug use to more fully determine the role of shared triggers and cues, so that targeted cessation methods can be developed to focus on individuals who are dually dependent.

Strengths of this study include our systematic evaluation of a wide range of smoking characteristics and nicotine addiction in a large, well-characterized sample of IDUs. The high prevalence of tobacco use provided a sufficient sample size to compare smoking behaviors by HIV and IDU status. Furthermore, our use of cotinine as a biomarker for tobacco exposure allowed validation of self-reported behaviors in a subset of participants.

Several limitations should also be mentioned. While the community-based ALIVE cohort is representative of IDUs in inner city Baltimore, Maryland, our results may not be generalizable to other IDU populations, such as populations with a greater proportion of women or racial/ethnic groups other than African Americans. Also, although intensity of cigarette smoking could be verified by cotinine measurement, other information self-reported by participants (e.g., age at smoking initiation, use of illicit drugs) may have been inaccurate. However, given the consistent similarities in behaviors reported by HIV-infected and HIV-uninfected IDUs, we believe that the accuracy of participants' reporting did not differ by HIV status.

In conclusion, tobacco use was nearly universal among the urban, predominantly African American IDUs in our study. Our findings provide an important context for understanding the development of tobacco-related disease among HIV-infected IDU populations, which may increase substantially in future years as survival lengthens with availability of HAART. (Lewden et al., 2005; Marshall, McCormack, & Kirk, 2009) Patterns of smoking behavior strongly parallel those of active drug injection, emphasizing the need for cessation efforts to target the dual dependence of cigarettes and drugs experienced in the IDU population. Tobacco cessation interventions specifically intended for inner-city IDUs and HIV-infected persons should be a public health priority.

Acknowledgments

FUNDING

Support: This work was supported by NIH grants R01HL090483, R01DA04334 and R01DA12568, and by the Intramural Research Program of the National Cancer Institute.

Abbreviations

HIV	Human Immunodeficiency Virus
AIDS	Acquired Immune Deficiency Syndrome
SHS	second hand smoke

REFERENCES

Anthony JC, Vlahov D, Nelson KE, Cohn S, Astemborski J, Solomon L. New evidence on intravenous cocaine use and the risk of infection with human immunodeficiency virus type 1. American Journal of Epidemiology 1991;134(10):1175–1189. [PubMed: 1746528]

Berthiller J, Straif K, Boniol M, Voirin N, Benhaim-Luzon V, Ayoub WB, et al. Cannabis smoking and risk of lung cancer in men: a pooled analysis of three studies in Maghreb. Journal of Thoracic Oncology 2008;3(12):1398–1403. [PubMed: 19057263]

Boffetta P, Clark S, Shen M, Gislefoss R, Peto R, Andersen A. Serum cotinine level as predictor of lung cancer risk. Cancer Epidemiology, Biomarkers & Prevention 2006;15(6):1184–1188.

Braithwaite RS, Justice AC, Chang CC, Fusco JS, Raffanti SR, Wong JB, et al. Estimating the proportion of patients infected with HIV who will die of comorbid diseases. The American Journal of Medicine 2005;118:890–898. [PubMed: 16084183]

Burkhalter JE, Springer CM, Chhabra R, Ostroff JS, Rapkin BD. Tobacco use and readiness to quit smoking in low-income HIV-infected persons. Nicotine and Tobacco Research 2005;7:511–522. [PubMed: 16085522]

Caraballo RS, Glovino GA, Pechacek TF, Mowery PD, Richter PA, Strauss WJ, et al. Racial and ethnic differences in serum cotinine levels of cigarette smokers. The Journal of the American Medical Association 1998;280(2):135–139.

CDC. Cigarette smoking among adults--United States, 2006. Morbidity and Mortality Weekly Report 2007;56(44):1157–1161. [PubMed: 17989644]

Chaturvedi AK, Pfeiffer RM, Chang L, Goedert JJ, Biggar RJ, Engels EA. Elevated risk of lung cancer among people with AIDS. AIDS 2007;21:207–213. [PubMed: 17197812]

Clarke JG, Stein MD, McGarry KA, Gogineni A. Interest in smoking cessation among injection drug users. American Journal on Addictions 2001;10(2):159–166. [PubMed: 11444157]

Clemmey P, Brooner R, Chutuape MA, Kidorf M, Stitzer M. Smoking habits and attitudes in a methadone maintenance treatment population. Drug and Alcohol Dependence 1997;44(2-3):123–132. [PubMed: 9088784]

d'Arminio Monforte A, Sabin CA, Phillips A, Sterne J, May M, Justice A, et al. The changing incidence of AIDS events in patients receiving highly active antiretroviral therapy. Archives of Internal Medicine 2005;165(4):416–423. [PubMed: 15738371]

Diaz PT, Clanton TL, Pacht ER. Emphysema-like pulmonary disease associated with human immunodeficiency virus infection. Annals of Internal Medicine 1992;116(2):124–128. [PubMed: 1727615]

Diaz PT, King MA, Pacht ER, Wewers MD, Gadek JE, Nagaraja HN, et al. Increased susceptibility to pulmonary emphysema among HIV-seropositive smokers. Annals of Internal Medicine 2000;132(5): 369–372. [PubMed: 10691587]

Ellis J, Gwynn C, Garg RK, Philburn R, Aldous KM, Perl SB, et al. Secondhand smoke exposure among nonsmokers nationally and in New York CIty. Nicotine & Tobacco Research 2009;11(4):362–370. [PubMed: 19351780]

Engels EA, Brock MV, Chen J, Hooker CM, Gillison M, Moore RD. Elevated incidence of lung cancer among HIV-infected individuals. Journal of Clinical Oncology 2006;24:1383–1388. [PubMed: 16549832]

Environmental Protection Agency. Respiratory health effects of passive smoking: lung cancer and other disorders. Environmental Protection Agency, Office of Air and Radiation; Washington, DC: 1992.

Fagerstrom KO, Schneider NG. Measuring nicotine dependence: a review of the Fagerstrom Tolerance Questionnaire. Journal of Behavioral Medicine 1989;12(2):159–182. [PubMed: 2668531]

Fontham ET, Correa P, Reynolds P, Wu-Williams A, Buffler PA, Greenberg RS, et al. Environmental tobacco smoke and lung cancer in nonsmoking women. A multicenter study. The Journal of the American Medical Association 1994;271(22):1752–1759.

Friis-Moller N, Weber R, Reiss P, Thiebaut R, Kirk O, d'Arminio Monforte A, et al. Cardiovascular disease risk factors in HIV patients--association with antiretroviral therapy. Results from the DAD study. AIDS 2003;17(8):1179–1193. [PubMed: 12819520]

Frikart M, Etienne S, Cornuz J, Zellweger JP. Five-day plan for smoking cessation using group behaviour therapy. Swiss Medical Weekly 2003;133:39–43. [PubMed: 12596085]

Frosch DL, Shoptaw S, Nahom D, Jarvik ME. Associations between tobacco smoking and illicit drug use among methadone-maintained opiate-dependent individuals. Experimental and Clinical Psychopharmacology 2000;8:97–103. [PubMed: 10743909]

Galai N, Safaeian M, Vlahov D, Bolotin A, Celentano DD. Longitudinal patterns of drug injection behavior in the ALIVE Study cohort,1988-2000: description and determinants. American Journal of Epidemiology 2003;158(7):695–704. [PubMed: 14507606]

Grant BF, Hasin DS, Chou SP, Stinson FS, Dawson DA. Nicotine dependence and psychiatric disorders in the United States: results from the national epidemiologic survey on alcohol and related conditions. Archives of General Psychiatry 2004;61(11):1107–1115. [PubMed: 15520358]

Gritz ER, Vidrine DJ, Lazev AB, Amick BC 3rd, Arduino RC. Smoking behavior in a low-income multiethnic HIV/AIDS population. Nicotine and Tobacco Research 2004;6(1):71–77. [PubMed: 14982690]

Grunfeld C, Delaney JA, Wanke C, Currier JS, Scherzer R, Biggs ML, et al. Preclinical atherosclerosis due to HIV infection: carotid intima-medial thickness measurements from the FRAM study. AIDS 2009;23(14):1841–1849. [PubMed: 19455012]

Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerstrom Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. British Journal of Addiction 1991;86(9):1119–1127. [PubMed: 1932883]

Hughes JR, Helzer JE, Lindberg SA. Prevalence of DSM/ICD-defined nicotine dependence. Drug and Alcohol Dependence 2006;85(2):91–102. [PubMed: 16704909]

John U, Meyer C, Hapke U, Rumpf HJ, Schumann A, Adam C, et al. The Fagerstrom test for nicotine dependence in two adult population samples-potential influence of lifetime amount of tobacco smoked on the degree of dependence. Drug and Alcohol Dependence 2003;71(1):1–6. [PubMed: 12821200]

Kirk GD, Merlo C, Driscoll P, Mehta S, Galai N, Vlahov D, et al. HIV infection is associated with an increased risk for lung cancer independent of smoking. Clinical Infectious Diseases 2007;45:103–110. [PubMed: 17554710]

Lewden C, Salmon D, Morlat P, Bevilacqua S, Jougla E, Bonnet F, et al. Causes of death among human immunodeficiency virus (HIV)-infected adults in the era of potent antiretroviral therapy: emerging role of hepatitis and cancers, persistent role of AIDS. International Journal of Epidemiology 2005;34 (1):121–130. [PubMed: 15561752]

Luo Z, Alvarado GF, Hatsukami DK, Johnson EO, Bierut LJ, Breslau N. Race differences in nicotine dependence in the Collaborative Genetic study of Nicotine Dependence (COGEND). Nicotine and Tobacco Research 2008;10:1223–1230. [PubMed: 18629733]

Marshall MM, McCormack MC, Kirk GD. Effect of cigarette smoking on HIV acquisition, progression, and mortality. AIDS Education and Prevention 2009;21:28–39. [PubMed: 19537952]

Mary-Krause M, Cotte L, Simon A, Partisani M, Costagliola D. Increased risk of myocardial infarction with duration of protease inhibitor therapy in HIV-infected men. AIDS 2003;17(17):2479–2486. [PubMed: 14600519]

McGinnis JM, Foege WH. Mortality and morbidity attributable to use of addictive substances in the United States. Proceedings of the Association of American Physicians 1999;111(2):109–118. [PubMed: 10220805]

Perez-Stable EJ, Herrera B, P. J III, Benowitz NL. Nicotine metabolism and intake in black and white smokers. The Journal of the American Medical Association 1998;280(2):152–156.

Pirkle JL, Fiegai KM, Bernert JT, Brody DJ, Etzel RA, Maurer KR. Exposure of the US population to environmental tobacco smoke: the third national health and nutrition examination survey, 1988-1991. The Journal of the American Medical Association 1996;275(16):1233–1240.

Sahebjami H. Emphysema-like changes in HIV. Annals of Internal Medicine. Annals of Internal Medicine 1992;116:876. [PubMed: 1567106]

Saves M, Chene G, Ducimetiere P, Leport C, Le Moal G, Amouyel P, et al. Risk factors for coronary heart disease in patients treated for human immunodeficiency virus infection compared with the general population. Clinical Infectious Diseases 2003;37(2):292–298. [PubMed: 12856222]

Sellers EM. Pharmacogenetics and ethnoracial differences in smoking. The Journal of the American Medical Association 1998;280(2):179–180.

Stark MJ, Campbell BK. Cigarette smoking and methadone dose levels. The American Journal of Drug and Alcohol Abuse 1993;19(2):209–217. [PubMed: 8484357]

Stavem K, Rogeberg OJ, Olsen JA, Boe J. Properties of the Cigarette Dependence Scale and the Fagerstrom Test of Nicotine Dependence in a representative sample of smokers in Norway. Addiction 2008;103(9):1441–1449. [PubMed: 18783499]

Tashkin DP. Airway effects of marijuana, cocaine, and other inhaled illicit agents. Current Opinion in Pulmonary Medicine 2001;7(2):43–61. [PubMed: 11224724]

Thompson SC, Nanni C, Levine A. The stressors and stress of being HIV-positive. AIDS Care 1996;8:5–14. [PubMed: 8664369]

U.S. Department of Health and Human Services. National Health Interview Survey. Centers for Disease Control and Prevention, National Center for Health Statistics; Hyattsville, MD: 2009.

Table 1

Demographic and Injection Drug Use Characteristics of HIV-infected and HIV-uninfected Study Participants (*N* = 1,052)

Characteristic	HIV-Infected *N* = 312	HIV-Uninfected *N* = 740	*P*
Age, years			0.191
20-29	1 (0.3)	20 (2.7)	
30-39	43 (13.8)	82 (11.1)	
40-49	137 (43.9)	304 (41.1)	
50-59	125 (40.1)	280 (37.8)	
≥ 60	6 (1.9)	54 (7.3)	
Median age	49	49	
Sex			0.078
Male	191 (61.2)	495 (66.9)	
Female	121 (38.8)	245 (33.1)	
Race			0.013
Black	291 (94.2)	644 (88.5)	
White	13 (4.2)	69 (9.5)	
Other	5 (1.6)	15 (2.1)	
Annual income			0.318
Less than $5,000	233 (74.7)	539 (72.8)	
$5,000 – $9,999	52 (16.7)	119 (16.1)	
$10,000 or more	17 (5.5)	63 (8.5)	
Active injection drug use			
By frequency			0.003
None	201 (64.4)	432 (58.4)	
Less than daily	76 (24.4)	160 (21.6)	
Daily or greater	35 (11.2)	148 (20.0)	
By type			0.004
Heroin alone	14 (4.5)	84 (11.4)	
Cocaine alone	10 (3.2)	17 (2.3)	
Heroin and cocaine	63 (20.2)	155 (20.9)	
Other	24 (7.7)	52 (7.0)	
Age first injected drugs, years			
Median (IQR)	20 (17-24)	21(17-26)	0.026

Abbreviations: HIV human immunodeficiency virus, IQR interquartile range

Entries in table are number of participants (%), unless otherwise indicated.

Table 2

Smoking History, Drug Use, and Nicotine Dependence by HIV Status

Characteristic	HIV-Infected *N* = 312	HIV-Uninfected *N* = 740	*P*
Smoking status			0.682
Never	20 (6.4)	38 (5.1)	
Former	30 (9.6)	68 (9.2)	
Current	262 (84.0)	634 (85.7)	
Age in years first smoked cigarettes			
Median (IQR)	14 (12 – 16)	14 (12 – 16)	0.889
Duration of smoking (years)			
Median (IQR)	33 (26 – 38)	33 (25 – 39)	0.500
Cumulative pack-years			
Median (IQR)	19 (11 – 34)	20 (12 – 33)	0.494
Cigarettes smoked per day during last week			
1-9	121 (46.4)	230 (36.4)	0.001
10-19	93 (35.6)	232 (36.7)	
20-39	40 (15.3)	157 (24.8)	
40 or more	7 (2.7)	13 (2.1)	
Median (IQR)	10 (5 – 15)	10 (6 – 20)	
Cigarette size			0.298
Regular	43 (14.8)	123 (17.6)	
King	27 (9.3)	85 (12.1)	
100 mm	220 (75.9)	492 (70.2)	
Smoke menthol cigarettes	284 (97.6)	666 (95.0)	0.065
Ever smoked cigars	16 (5.1)	43 (5.8)	0.662
Ever smoked pipes	6 (1.9)	22 (3.0)	0.336
Exposed to SHS in home			
Before age 13	252 (81.0)	592 (80.1)	0.732
Since age 13	249 (80.1)	591 (80.1)	0.995
Exposed to SHS outside home	227 (73.2)	499 (67.9)	0.087
Ever smoked illicit drugs			
Marijuana	267 (85.8)	672 (90.9)	0.014
Crack cocaine	223 (71.7)	512 (69.3)	0.434
Heroin	28 (9.0)	63 (8.5)	0.801
Other*	21 (6.8)	79 (10.7)	0.047
Current smoked illicit drugs			
Marijuana	48 (15.4)	174 (23.5)	0.003
Crack cocaine	93 (29.8)	235 (31.8)	0.533
Heroin	8 (2.6)	14 (1.9)	0.486
Fagerstrom index score of nicotine dependence			0.348
High dependence (7-10)	46 (17.6)	124 (19.9)	
Medium dependence (4-6)	118 (45.2)	268 (43.0)	

Characteristic	HIV-Infected *N* = 312	HIV-Uninfected *N* = 740	*P*
Low dependence (0-3)	97 (37.2)	231 (37.1)	
Median score (IQR)	4 (2 – 6)	4 (3 – 6)	

Abbreviations: HIV human immunodeficiency virus, IQR interquartile range, SHS second hand smoke

Analyses of cigarette smoking traits are limited to ever smokers. Other comparisons include all participants.

Entries in the table correspond to number of participants (%), unless otherwise indicated.

* Other smoked illicit drugs include phenylcyclohexylpiperidine (PCP), opium, peyote, methaqualone, and methamphetamine.

Table 3

Smoking History, Drug Use, and Nicotine Dependence by IDU Status

Characteristic	Active IDU *N* = 419	Former IDU *N* = 633	*P*
Smoking status			0.007
Never	20 (4.8)	38 (6.0)	
Former	20 (4.8)	78 (12.3)	
Current	379 (90.4)	517 (81.7)	
Age in years first smoked cigarettes			
Median (IQR)	14 (12 – 16)	14 (12 – 16)	0.137
Duration of smoking (years)			
Median (IQR)	33 (25 – 38)	33 (26 – 39)	0.265
Cumulative pack-years			
Median (IQR)	20 (11 – 33)	19 (12 – 33)	0.512
Cigarettes smoked per day during last week			
1-9	127 (33.6)	224 (43.5)	<0.001
10-19	135 (34.7)	190 (36.9)	
20-39	106 (28.0)	91 (17.7)	
40 or more	10 (2.7)	10 (1.9)	
Median (IQR)	10 (7 – 20)	10 (5 – 15)	
Cigarette size			0.010
Regular	65 (16.3)	101 (17.0)	
King	30 (7.5)	82 (13.8)	
100 mm	302 (75.9)	410 (69.1)	
Smoke menthol cigarettes	383 (96.2)	567 (95.5)	0.552
Ever smoked cigars	27 (6.5)	32 (5.1)	0.455
Ever smoked pipes	15 (3.6)	13 (2.1)	0.132
Exposed to SHS in home			
Before age 13	337 (80.6)	507 (80.2)	0.873
Since age 13	335 (80.1)	505 (79.9)	0.717
Exposed to SHS outside home	287 (68.7)	439 (69.5)	0.619
Ever smoked illicit drugs			
Marijuana	388 (92.8)	551 (87.2)	0.004
Crack cocaine	304 (72.7)	431 (68.2)	0.117
Heroin	38 (9.1)	53 (8.4)	0.691
Other*	38 (9.1)	62 (9.8)	0.698
Current smoked illicit drugs			
Marijuana	129 (30.8)	93 (14.7)	<0.001
Crack cocaine	196 (46.8)	132 (20.9)	<0.001
Heroin	15 (3.6)	7 (1.1)	0.006
Fagerstrom index score of nicotine dependence			0.144
High dependence (7-10)	85 (22.5)	85 (16.5)	
Medium dependence (4-6)	157 (41.5)	234 (45.4)	

Characteristic	Active IDU *N* = 419	Former IDU *N* = 633	*P*
Low dependence (0-3)	136 (36.0)	196 (38.1)	
Median score (IQR)	5 (3 – 6)	4 (2 – 6)	

Abbreviations: IDU injection drug user, IQR interquartile range, SHS second hand smoke

Analyses of cigarette smoking traits are limited to ever smokers. Other comparisons include all participants.

Entries in the table correspond to number of participants (%), unless otherwise indicated.

* Other smoked illicit drugs include phenylcyclohexylpiperidine (PCP), opium, peyote, methaqualone, and methamphetamine.

Table 4

Serum Cotinine Levels by Smoking and HIV Status

Current Smoking Category	HIV-Infected Participants		HIV-Uninfected Participants		*P*
	N	Cotinine, median (IQR)	N	Cotinine, median (IQR)	
Light/moderate smokers	100	372.4 (214.1 – 582.8)	50	487.9 (292.7 – 704.8)	0.104
Heavy smokers	21	494.0 (369.6 – 619.9)	49	741.4 (379.4 – 1000)	0.050
Current smokers, by more detailed categories of cigarette consumption					
1-9 cigarettes per day	55	368.6 (193.0 – 599.5)	24	412.9 (267.8 – 561.5)	0.639
10-19 cigarettes per day	45	394.1 (280.3 – 567.1)	26	581.8 (390.9 – 797.0)	0.072
20-29 cigarettes per day	14	441.4 (332.6 – 570.9)	40	771.6 (361.4 – 1000)	0.057
30+ cigarettes per day	7	586.4 (464.7 – 634.4)	9	564.7 (396.3 – 1000)	0.791
Nonsmokers	11	25.0 (9.9 – 38.1)	39	19.7 (7.4 – 42.2)	0.505
With cotinine > 10 ng/ml	8	29.4 (20.5 – 434.25)	26	30.1 (19.7- 289.6)	0.655

Abbreviations: HIV human immunodeficiency virus, IQR interquartile range

Light/moderate smokers: less than 20 cigarettes per day; heavy smokers: 20 or more cigarettes per day; nonsmokers: no cigarettes within

Entries in table correspond to median cotinine (IQR), unless otherwise indicated.

Table 5

Serum Cotinine Levels by Smoking and IDU Status

Current Smoking Category	Active IDUs		Former IDUs		*P*
	N	Cotinine, median (IQR)	N	Cotinine, median (IQR)	
Light/moderate smokers	61	441.0 (251.6 – 658.7)	87	413.2 (216.9 – 593.4)	0.552
Heavy smokers	28	627.2 (303.8 – 1000)	44	550.9 (356.5 – 1000)	0.398
Current smokers, by more detailed categories of cigarette consumption					
1-9 cigarettes per day	30	462.3 (193.0 – 669.4)	47	368.6 (211.3 – 511.7)	0.478
10-19 cigarettes per day	31	441.0 (312.5 – 595.6)	40	434.9 (221.8 – 728.1)	1.000
20-29 cigarettes per day	23	744.4 (342.6 – 1000)	31	554.4 (343.4 – 885.5)	0.389
30+ cigarettes per day	5	619.9 (214.7 – 634.4)	13	547.3 (396.3 – 1000)	0.805
Nonsmokers	9	10.3 (3.0 – 23.1)	41	21.4 (9.2 – 38.1)	0.272
With cotinine > 10 ng/ml	5	23.1 (20.2 – 617.2)	29	29.9 (19.7 – 186.7)	0.865

Abbreviations: HIV human immunodeficiency virus, IQR interquartile range

Light/moderate smokers: less than 20 cigarettes per day; heavy smokers: 20 or more cigarettes per day; nonsmokers: no cigarettes within

Entries in table correspond to median cotinine (IQR), unless otherwise indicated.