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Excess mortality among people who report lifetime use of illegal drugs in the United States: A 20-year follow-up of a nationally representative survey

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Abstract

Objective—The purpose of this study was to determine the mortality risks, over 20 years of follow-up in a nationally representative sample, associated with illegal drug use and to describe risk factors for mortality.

Methods—We analyzed data from the 1991 National Health Interview Survey, which is a nationally representative household survey in the United States, linked to the National Death Index through 2011. This study included 20,498 adults, aged 18–44 years in 1991, with 1,047 subsequent deaths. A composite variable of self-reported lifetime illegal drug use was created (hierarchical categories of heroin, cocaine, hallucinogens/inhalants, and marijuana use).

Results—Mortality risk was significantly elevated among individuals who reported lifetime use of heroin (HR=2.40, 95% CI: 1.65–3.48) and cocaine (HR=1.27, 95% CI: 1.04–1.55), but not for those who used hallucinogens/inhalants or marijuana, when adjusting for demographic characteristics. Baseline health risk factors (smoking, alcohol use, physical activity, and BMI) explained the greatest amount of this mortality risk. After adjusting for all baseline covariates, the association between heroin or cocaine use and mortality approached significance. In models

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adjusted for demographics, people who reported lifetime use of heroin or cocaine had an elevated mortality risk due to external causes (poisoning, suicide, homicide, and unintentional injury). People who had used heroin, cocaine, or hallucinogens/inhalants had an elevated mortality risk due to infectious diseases.

Conclusions—Heroin and cocaine are associated with considerable excess mortality, particularly due to external causes and infectious diseases. This association can be explained mainly by health risk behaviors.

Keywords

Drug use; Heroin; Cocaine; Mortality; NHIS

1. INTRODUCTION

Illegal drug use significantly contributes to years lived with disability and to excess mortality (Degenhardt et al., 2013; Whiteford et al., 2013). These studies suggest that heroin and cocaine use, in particular, are associated with premature mortality (Degenhardt et al., 2011a, 2011b; Mathers et al., 2013), while results for cannabis and amphetamines are more equivocal (Calabria et al., 2010; Singleton et al., 2009). However, most of the existing studies have focused on clinical populations or cohorts of people who used illegal drugs.

Only a few studies have examined illegal drug use and mortality in the general United States population. Using data from the Epidemiologic Catchment Area (ECA) study, Eaton and colleagues (2013) found that both drug and alcohol abuse and dependence are associated with elevated mortality risk. Another study that used ECA data demonstrated that heroin use, including infrequent use, was associated with about a 3.5 fold excess risk of mortality, with the cause of death most commonly due to infections or injury (Lopez-Quintero et al., 2015). In two population-based studies, cocaine (Muhuri and Gfroerer, 2011; Qureshi et al., 2014) or heroin use (Muhuri and Gfroerer, 2011) were associated with elevated mortality risk; although, in one study, the association between cocaine use and mortality was no longer significant once the model adjusted for socioeconomic status, cigarette use, and alcohol use (Muhuri and Gfroerer, 2011).

There has been little examination of the factors that may explain the association between illegal drug use and mortality in the general population. Muhuri and Gfroerer (2011) reported that demographic and socioeconomic status factors, as well as current smoking and drinking, partially accounted for elevated mortality among individuals with substance use disorders. Additional factors that may also play a role in explaining the association between substance use and mortality have yet to be examined using population-based data. First, there are high rates of comorbidity of drug use and mental disorders (Compton et al., 2007; Grant et al., 2004; Kessler et al., 2005). Mental disorders are consistently associated with elevated risks of mortality (Walker et al., 2015) and, therefore, may be a risk factor for premature death among people who use drugs. Second, people who use illegal drugs may be less likely to engage in health promoting behaviors (Harrell et al., 2012) or to receive regular and quality healthcare (Benjamin-Johnson et al., 2009).

Given the paucity of population-based research on this topic, we used a nationally representative survey, the National Health Interview Survey (NHIS), to determine the mortality risks associated with illegal drug use over 20 years of follow-up. We examined the potential contributions of demographic, socioeconomic, health status, health risk factors, and health systems factors to the association between illegal drug use and mortality. We also describe mortality due to particular causes of death—external causes (including suicide, homicide, and unintentional injuries), drug poisoning, infectious disease, HIV, heart disease, and cancer.

2. METHODS

2.1 Data source and population

The 1991 NHIS was a nationally representative, cross-sectional, household survey of the civilian, noninstitutionalized population of the United States, with interviews conducted continuously throughout the year by interviewers from the U.S. Census Bureau under contract for the National Center for Health Statistics (NCHS). Basic health and demographic information was collected on all household members in a basic core questionnaire, with additional information collected in special topic supplements. The core and each supplement data file were weighted to account for probability of selection and non-response and post-stratified to Census controls to be representative of the US population. Details of the NHIS methodology for data years 1985–1994 have been published elsewhere (Adams and Benson, 1992; Massey et al., 1989).

We used the public-use 1991 NHIS Drug and Alcohol Use supplement (NHIS-DAU; NCHS, 1992a), which was the only year in which this supplement was administered. The NHIS-DAU was self-administered in the home, using paper and pencil, and no telephone follow-up was permitted. For this analysis, we also used selected variables from another supplement from the same year—the Health Promotion and Disease Prevention supplement—and from the core questionnaire (NCHS, 2016a, 1992b). The 1991 NHIS-DAU was administered only to adults aged 18–44, with a final sample of 21,174 people. The final response rate for the NHIS-DAU was 75.4%, calculated by multiplying the NHIS household response rate (95.7%) by the NHIS-DAU sample person conditional response rate (78.8%) (NCHS, 1992a).

2.2 Outcome

The 1991 NHIS data was linked with the restricted-use mortality files through December 31, 2011. Information about data linkage and access is available on the NCHS website (NCHS, 2016b, 2016c). The NCHS Research Ethics Review Board approved the linkage of NHIS participants to National Death Index data. The mortality files include information on vital status, cause of death, and date of death. Briefly, to determine eligibility for matching, records are screened to determine if they contained particular combinations of identifying information (e.g., last name, first name, and social security number; NCHS Office of Analysis and Epidemiology, 2013). Mortality status is then established through probabilistic record matching with the National Death Index; the matching methodology is described elsewhere (NCHS Office of Analysis and Epidemiology, 2013). Of the 21,174 individuals

who completed the NHIS-DAU, 20,984 people had linked data on mortality status. All analyses were conducted on the 20,498 respondents who had both linked mortality and complete illegal drug use data.

The outcome variable is time to death. Follow-up time is defined as time from interview to death for decedents and interview to December 31, 2011 for survivors. The mean length of follow-up was 12.45 years for decedents and 20.52 years for survivors.

2.3 Illegal drug use variable

Respondents were asked if they had ever used (yes or no) heroin, cocaine, inhalants, hallucinogens, and marijuana. A composite variable of illegal drug use was created based on self-reported lifetime use of these drugs. The variable included a hierarchy of mutually exclusive categories of drug use: 1) heroin use (regardless of use of the other drugs), 2) cocaine use, no heroin (regardless of use of inhalants, hallucinogens, and marijuana), 3) inhalant or hallucinogen use, no heroin or cocaine (regardless of marijuana use), 4) marijuana use, no other drug use, and 5) no drug use.

2.4 Covariates

We examined five sets of factors that may be associated with mortality: demographics, socioeconomic factors, health status, health risk factors, and health systems factors. Demographic information included sex, age (18–24, 25–34, 35–44), and race/ethnicity (Hispanic, non-Hispanic Black, non-Hispanic White, and other). Socioeconomic factors included marital status, family income, and education. Health status included self-rated health (fair/poor, good, and very good/excellent) and negative mood. Negative mood, which was used as a proxy for mental health status, was assessed by 5 questions on how often participants felt bored, restless, depressed or low, upset by something said about them, and lonely in the past 2 weeks. The response options ranged from “never” (0) to “very often” (4), resulting in a summed score of 0–20 (Schoenborn and Horm, 1993). The negative mood variable was then categorized into low (0–2), moderate (3–9), and high (≥10) scores. Health risk factors included cigarette smoking status (never, former, or current smoker); episodic heavy alcohol use (no alcohol use in the past 12 months, alcohol use but no episodic heavy drinking days (days with 5 or more drinks), 5 or more drinks in a single day less than once a month, or 5 or more drinks in a single day once a month or more in the past year); physical activity (categorized by average daily kilocalorie (kcal) expenditure as sedentary (<1.5 kilocalories), moderately active (1.5 to <3kcal), or very active (≥3 kcal)); and body mass index (BMI) calculated from self-reported height and weight. Health systems factors included time since last routine check-up at the doctor (<1 year ago, 1–3 years ago, or 4 or more years ago), health insurance status, and whether or not the participant had a usual place of care.

2.5 Data Analysis

Data analyses were conducted using SUDAAN, which takes into account the complex survey design and the weights. First, we calculated the percentage and standard error for the baseline characteristics of participants by each category of illegal drug use. We then tested the differences between people who reported lifetime use of each category of illegal drug

(using the hierarchical drug use variable) and people who had never used illegal drugs, using the chi-square statistic.

We used Cox proportional hazards modeling to model time to death for all-cause mortality while adjusting for various covariates. We fit a series of models adding covariates in groups to the base model of illegal drug use, age, sex, and race/ethnicity. The blocks of covariates—socioeconomic status, health status, health risk factors, and health systems factors—were added separately. All of the covariates were added in the final model. For variables that had missing data, we included an "unknown" category to retain as much data as possible. Of the 20,498 respondents, 9.21% had one missing response and 1.27% had 2 or more missing responses.

To examine mortality due to specific causes of death, we fit Cox proportional hazards models that adjusted for age, sex, and race/ethnicity. The specific causes of death we examined were external causes (including suicide, homicide, and unintentional injuries), HIV, cancer, and heart disease. We also examined drug poisoning (including accidental, suicidal, and undetermined intent) and infectious diseases overall as we hypothesized that these causes would be particularly relevant to drug users. We were unable to examine suicide separately due to low numbers. The cause of death models were only adjusted for demographics; they could not be fully adjusted because of the small numbers of events.

3. RESULTS

3.1 Sample Characteristics

In 1991, the prevalence of any lifetime drug use among adults aged 18–44 was 46.8%. The prevalence of ever using a particular illegal drug was 1.3% for heroin, 14.7% for cocaine, 12.2% for inhalants or hallucinogens, and 45.6% for marijuana use (see Table 1). The percentages of drug use for the composite hierarchical variable were 1.3% for heroin, 13.4% for cocaine (no heroin), 4.5% for inhalants/hallucinogens (no heroin or cocaine), and 27.6% for marijuana (no other drugs). 73% of heroin users reported taking every category of drug in our study. Almost all of the remaining heroin users were also poly-drug users, reporting using drugs from 2 additional categories. Cocaine users also reported using drugs from other categories (data not shown). Over the 20-year follow-up, 518 people who used drugs died, while 529 people who had never used drugs died (Table 1). Compared to individuals who were alive at the end of the 20-year follow-up period, decedents were more likely to have reported lifetime use of illegal drugs at baseline.

Compared to people who did not use drugs, individuals with a lifetime use of any drug category at baseline were significantly more likely to be male, white, and separated, divorced or widowed (see Table 2). People who used any type of drug were also more likely to smoke cigarettes and report any episodic heavy drinking days. People who used heroin were over three times as likely (65.2%) and people who used cocaine (46.0%) or inhalants or hallucinogens (40.6%) were about twice as likely to be current smokers compared to non-drug users (20.8%). People who used any drug also reported more symptoms of negative moods than people who never used drugs.

3.2 Factors contributing to all-cause mortality

Mortality was significantly elevated among individuals who used heroin (HR=2.40, 95% CI: 1.65–3.48) and cocaine (HR=1.27, 95% CI: 1.04–1.55) in Model 1, which included age, sex, and race/ethnicity (see Table 3). Use of either hallucinogens/inhalants or marijuana was not significantly associated with mortality for any of the models. Individuals who were older at baseline, male, and non-Hispanic Black also had elevated mortality. These factors continued to be significantly associated with mortality in all of the subsequent models.

In Model 2, which added socioeconomic factors, the HR for mortality associated with heroin use was reduced to 2.09 (95% CI: 1.43–3.05), while the HR for cocaine remained about the same (HR=1.25, 95% CI: 1.02–1.53). Married individuals had a lower risk of mortality, while individuals with a low household income or low educational attainment had a greater risk of mortality.

In Model 3, the addition of health factors to the base model of drug use and demographics reduced the HR for mortality associated with heroin use to 2.01 (95% CI: 1.39–2.91), while the HR for cocaine again remained about the same (HR=1.24, 95% CI: 1.01–1.51). This model shows a dose-response relationship between self-rated health and mortality. The HRs associated with mortality were 1.83 (95% CI: 1.59–2.10) for people who reported good health and 3.50 (95% CI: 2.86–4.29) for people reporting fair/poor health. Additionally, high levels of negative mood (HR=1.55, 95% CI: 1.25–1.91), but not moderate levels, were significantly associated with mortality.

In Model 4, the addition of health risk factors to the base model reduced the association between mortality and heroin use to an HR of 1.6 (95% CI: 1.13–2.50); the association with cocaine use was no longer significant. Individuals who reported currently smoking, no drinks in the past 12 months, episodes of heavy drinking at least monthly, low physical activity, and being obese had a significantly elevated risk of mortality. Of these health risk factors, cigarette smoking had the highest association with mortality; people who reported current smoking had 2.31 times the risk of mortality (95% CI: 1.96–2.72) compared to people had who never smoked.

The addition of health systems factors in Model 5 to the base model reduced the HR for mortality associated with heroin use (HR=2.24, 95% CI: 1.52–3.30) but did not have much effect on the HR for cocaine (HR=1.25, 95% CI: 1.02–1.52). Compared to individuals who reported a routine check-up with a doctor in the past year, individuals who received a check-up in the past one to three years had a 22% lower risk of mortality (HR=0.78, 95% CI: 0.67–0.92). Individuals without health insurance had a greater risk of mortality than those who were insured (HR=1.60, 95% CI: 1.35–1.89).

In the full model with all covariates, neither heroin use nor cocaine use were significantly associated with elevated mortality, although the association between heroin and mortality approached significance (HR=1.47, CI: 0.98–2.22). Most of the covariates remained significantly associated with mortality; however, negative moods and health insurance status were no longer significant.

3.3 Specific causes of death

People who reported lifetime use of heroin or cocaine (no heroin) had elevated risk of mortality due to external causes (suicide, homicide, and unintentional injury; see Table 4). The risk of death due to drug poisoning was only significant among people who used heroin (HR=7.79, 95% CI: 2.45–24.71). People who used heroin, cocaine, and hallucinogens or inhalants had an elevated risk of mortality due to infectious diseases (HRs ranged from 2.8–3.8), and HIV in particular (HRs ranged from 3.7–5.5). Only individuals who reported heroin use had an elevated mortality risk due to cancer (HR=2.96, 95% CI: 1.43–6.14). There was no significant association between illegal drug use and heart disease-related death.

4. DISCUSSION

Our results show that people who report lifetime heroin or cocaine use have elevated mortality compared to non-users, when adjusted for age, sex, and race/ethnicity. Preventable mortality among people who use illegal drugs, as in the general population, is likely determined by multiple factors. We examined several factors that may contribute to mortality among people who report lifetime illegal drug use in a nationally-representative survey with a 20-year follow-up. Our findings indicate health risk factors explain most of the elevated risk of mortality among individuals with a lifetime use of either heroin or cocaine. Lifetime use of hallucinogens and inhalants or marijuana alone were not significantly associated with mortality.

Health risk factors explained much of the association between illegal drug use and mortality. These factors, which include current cigarette smoking, heavy alcohol use, physical inactivity, and obesity, are among the leading preventable causes of death in the United States (Mokdad et al., 2004) and contribute to the development of chronic medical conditions. Engaging individuals who use illegal drugs in health promotion activities has been found to result in positive health outcomes (Okoli and Khara, 2014), including decreased illegal drug use (Weinstock et al., 2008; Winhusen et al., 2014).

Two health status factors, poorer self-rated health and negative mood, also explained a small amount of the association between illegal drug use, particularly heroin use, and mortality. Given that the 1991 NHIS did not include assessments of mental disorders, negative mood served as a proxy for mental health status. Among treated cohorts of people who use drugs, there is evidence that comorbid mental disorders are associated with premature mortality (Bogdanowicz et al., 2015; Nyhlén et al., 2011). Given the high prevalence of comorbidity for illegal drug use and mental disorders (Compton et al., 2007; Grant et al., 2004; Kessler et al., 2005), as well as the association of mental disorders with elevated mortality risk (Walker et al., 2015), mental disorders are a concern in this population. Coordination of substance use services with primary care and mental health services is challenging and it has been suggested that the absence of coordinated care can result in fragmented care for patients (Croft and Parish, 2013; Pincus et al., 2007). Strategies to address these challenges have included use of case managers and enhancing communication between primary care and substance use treatment providers (Gurewich et al., 2014).

People who report using illegal drugs have elevated mortality risks due to external causes and infections. We found that people who had ever used heroin have an elevated risk of drug poisoning deaths. The death rates from heroin overdose have substantially increased in recent years (Rudd et al., 2014); thus, comprehensive approaches to prevent overdose have been suggested (Hawk et al., 2015). Not surprisingly, individuals who reported using heroin, cocaine, or hallucinogens/inhalants had elevated mortality risks due to infections, particularly HIV. Evidence-based strategies to reduce HIV transmission among people who use illegal drugs include opioid substitution therapy, antiretroviral therapy, and needle and syringe exchange programs (Degenhardt et al., 2010).

4.1 Limitations and strengths

These findings should be considered in light of several limitations. Respondents were not asked about frequency, amount, and timing of drug use or treatment received for drug use. Individuals' risk of mortality may differ, in ways we could not estimate in this study, depending on their patterns and duration of drug use. Drug use treatment, particularly opiod maintenance treatment (Clausen et al., 2008), may reduce the risk of mortality. Thus, if respondents received opiod maintenance therapy at some time during the 20-year follow-up, this would lead to the underestimation of the effect of illegal drugs on mortality.

All of the NHIS drug use data and other baseline characteristics were collected at the same time and drug use patterns may have changed over the course of the 20-year follow-up. Specifically, individuals who were classified as non-users in 1991 may have subsequently used drugs during the follow-up period, which may lead to underestimation of the association between illegal drug use and mortality. Illegal drug use was self-reported and may have been underreported if individuals were unwilling to disclose lifetime use of drugs, which could also lead to underestimation of the mortality associated with drug use; however, this effect may be small given the large size of the non-use group. Additionally, many of the people who reported lifetime drug use used more than one type of drug, particularly those who used heroin or cocaine. Polysubstance use is associated with poor health outcomes and risky behaviors (Morley et al., 2015; Smith et al., 2011). Sample size constraints limited our ability to directly examine the specific associations between polysubstance use or particular combinations of substances and mortality.

Socioeconomic status, health status, and health risk factors may also have changed between the NHIS interview in 1991 and the time of death or end of follow-up. Using smoking as an example, a small number of never smokers may have started smoking, though the incidence of smoking initiation declines after late adolescence (O'Loughlin et al., 2014), and some current smokers would have quit. Smoking cessation improves life expectancy by up to 10 years (Jha et al., 2013). Due to these changes, the estimates of the association between smoking and mortality may be conservative. However, changes in socioeconomic status and health likely occurred randomly and would not have systematic effects on the estimates. Additionally, when measuring educational status, it is important to note that younger adults (ages 18–24 years) would be less likely to have completed more than a high school education compared to older individuals. Data on the health factors were collected at one point in time, thus we cannot fully disentangle the causal relationships between the

variables. For example, we cannot determine if poor self-rated health results from, leads to, or is just associated with drug use.

There are additional factors, such as diagnosis of a chronic medical condition and quality of health care, that we were unable to measure that may help to explain the association between illegal drug use and mortality. Finally, when examining specific causes of death, we could not run fully adjusted models due to the small number of events. The associations between drug use and mortality for specific causes may have been further attenuated if we had been able to adjust for all covariates, particularly health risk factors, which explained much of the effect in the all-cause analyses. Additionally, we were unable to account for competing risks.

The strengths of this study include the large sample size from a nationally-representative survey and the extended follow-up time. The wide range of topics included in the NHIS allowed us to examine the contributions of a number of factors to the association between illegal drug use and mortality.

4.2 Conclusion

The mortality burden of lifetime heroin and cocaine use can be mainly explained by health risk factors. Addressing these factors may be important strategies in reducing excess mortality in people who use heroin and cocaine.

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Highlights

- Heroin users had a 2.4 times higher risk of mortality, adjusting for demographics.
- Cocaine users had a 1.3 times higher risk of mortality, adjusting for demographics.
- Adjusted for all covariates, heroin and cocaine use were not linked with mortality.
- Health risk factors explained most of the mortality risk for drug users.
- Main causes of death for drug users were external causes, poisoning, and infections.

Table 1

Prevalence of lifetime drug use and mortality: 1991 National Health Interview Survey

	Percentage of lifetime drug use	Decedents	Alive in 2011
	n=21174 %[a] (SE)	n=1047 % (SE)	n=19451 % (SE)
Lifetime drug use			
Heroin	1.3 (0.1)	3.6 (0.6)	1.2 (0.1)
Cocaine, no heroin	13.4 (0.4)	15.7 (1.3)	13.3 (0.4)
Inhalants/Hallucinogens, no cocaine/heroin	4.5 (0.2)	4.9 (0.7)	4.5 (0.2)
	27.6 (0.4)	25.2 (1.3)	27.7 (0.4)
Marijuana use, none of above	53.2 (0.6)	50.5 (1.6)	53.4 (0.6)
No substance use			
Heroin ever use			
Yes	1.3 (0.1)	3.6 (0.6)	1.1 (0.1)
No		96.4 (0.6)	98.9 (0.1)
Cocaine ever use			
Yes	14.7 (0.4)	19.3 (1.3)	14.5 (0.4)
No		80.7 (1.3)	85.5 (0.4)
Inhalants/hallucinogens ever use			
Yes	12.2 (0.3)	13.5 (1.2)	9.4 (0.3)
No		86.5 (1.2)	90.6 (0.3)
Marijuana ever use			
Yes	45.6 (0.6)	48.5 (1.7)	45.5 (0.6)
No		51.5 (1.7)	54.5 (0.6)

Abbreviations: SE=standard error

[a]All percentages were weighted

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Table 2

Baseline characteristics of persons who reported lifetime use of heroin, cocaine, inhalants/hallucinogens, marijuana, and no lifetime use of substances: 1991 National Health Interview Survey[a]

	Heroin	Cocaine, no heroin	Inhalants or hallucinogens, no cocaine or heroin	Marijuana use, no other drugs	No substance use
	n=271 %[b] (SE)	n=2659 % (SE)	n=890 % (SE)	n=5679 % (SE)	n=10999 % (SE)
Age at interview					
18–24	10.3 (1.8)	16.0 (0.9)	29.1 (1.9)	20.2 (0.7)	23.5 (0.8)
25–34	41.9 (3.4)	56.5 (1.1)	34.1 (1.8)	45.5 (0.7)	37.9 (0.6)
35–44	47.8 (3.3)	27.5 (1.1)	36.8 (1.7)	34.2 (0.7)	38.6 (0.6)
Sex					
Male	68.6 (2.8)	56.2 (1.0)	54.2 (1.6)	45.3 (0.7)	38.9 (0.6)
Female	31.4 (2.8)	43.8 (1.0)	45.8 (1.6)	54.7 (0.7)	61.1 (0.6)
Race/ethnicity[c]					
Hispanic	8.9 (2.2)	7.0 (0.6)	8.1 (1.0)	6.4 (0.4)	12.4 (0.6)
Non-Hispanic Black	14.4 (2.8)	6.8 (0.6)	8.4 (1.2)	11.7 (0.3)	15.0 (0.7)
Non-Hispanic white	76.7 (2.8)	86.2 (0.8)	83.6 (1.3)	81.9 (0.7)	72.5 (0.8)
Marital status					
Married	46.3 (3.3)	49.4 (1.0)	48.3 (1.9)	56.2 (0.8)	56.4 (0.8)
Never married	32.0 (3.6)	35.2 (1.1)	40.0 (2.0)	28.5 (0.8)	31.4 (0.8)
Divorced/separated/widowed	21.7 (2.7)	15.5 (0.7)	11.7 (1.1)	15.3 (0.5)	12.1 (0.4)
Household income					
Less than $20,000/year	39.5 (2.9)	32.9 (1.1)	37.7 (2.0)	31.7 (0.8)	35.9 (0.8)
≥ $20,000/year	60.5 (2.9)	67.1 (1.1)	62.3 (2.0)	68.3 (0.8)	64.1 (0.8)
Education					
Less than high school diploma	22.5 (2.9)	10.2 (0.6)	10.4 (1.0)	11.1 (0.4)	14.2 (0.5)
High school diploma	33.6 (2.9)	34.9 (0.9)	36.0 (1.8)	37.4 (0.8)	38.0 (0.6)
More than high school	43.9 (3.2)	54.9 (1.0)	53.6 (1.9)	51.6 (0.8)	47.7 (0.7)
Negative mood					

	Heroin	Cocaine, no heroin	Inhalants or hallucinogens, no cocaine or heroin	Marijuana use, no other drugs	No substance use
	n=271 %[b] (SE)	n=2659 % (SE)	n=890 % (SE)	n=5679 % (SE)	n=10999 % (SE)
Low negative mood	24.7 (2.6)	27.5 (1.7)	27.5 (1.7)	33.7 (0.8)	41.7 (0.9)
Moderate negative mood	46.4 (3.1)	58.4 (3.1)	58.2 (1.9)	54.9 (0.8)	49.4 (0.8)
High negative mood	19.0 (2.6)	13.6 (0.7)	14.3 (1.3)	11.5 (0.5)	8.9 (0.4)
Self-rated health					
Very good/excellent	61.9 (3.2)	75.6 (0.9)	72.1 (1.5)	74.6 (0.6)	72.3 (0.5)
Good	27.9 (2.9)	18.7 (0.7)	22.8 (1.4)	19.9 (0.6)	21.5 (0.5)
Fair/poor	10.2 (1.8)	5.7 (0.5)	5.1 (0.9)	5.5 (0.3)	6.2 (0.3)
Cigarette smoking status					
Current	65.2 (2.8)	46.0 (1.0)	40.6 (1.8)	36.2 (0.7)	20.8 (0.5)
Former	22.5 (2.5)	24.9 (0.8)	18.9 (1.3)	19.7 (0.6)	11.2 (0.4)
Never	12.2 (2.0)	29.1 (1.0)	40.5 (1.8)	44.2 (0.8)	68.0 (0.6)
Episodic heavy alcohol use status					
No drinks in past 12 months	24.5 (3.3)	10.2 (0.6)	15.1 (1.3)	12.5 (0.5)	33.4 (0.7)
Had a drink in past 12 months, but never ≥5 drinks/day	24.7 (2.9)	29.8 (1.0)	36.6 (1.7)	46.3 (0.8)	46.9 (0.6)
≥5 drinks/day < once a month	32.4 (3.5)	45.9 (1.0)	36.4 (1.7)	31.3 (0.7)	14.5 (0.4)
≥5 drinks/day once a month or more	18.4 (2.6)	14.1 (0.6)	11.9 (1.2)	9.9 (0.5)	5.1 (0.2)
Physical activity (daily kcal expenditure)	52.0 (3.6)	46.9 (1.0)	49.1 (2.0)	50.7 (0.8)	57.2 (0.7)
Sedentary (<1.5 kcal)	14.7 (2.2)	18.4 (0.8)	15.7 (1.4)	18.6 (0.5)	16.2 (0.4)
Moderately active (1.5 to <3 kcal)	33.3 (3.8)	34.7 (0.9)	35.2 (1.9)	30.6 (0.7)	26.6 (0.6)
Very active (≥3 kcal)					
BMI					
Underweight (<18.5)	2.2 (0.8)	4.0 (0.4)	3.8 (0.7)	3.9 (0.3)	4.0 (0.2)
Normal weight (18.5 to <25)	48.3 (3.1)	58.6 (1.0)	54.4 (1.8)	53.9 (0.7)	52.1 (0.6)
Overweight (25 to <30)	34.4 (2.9)	27.0 (0.9)	29.1 (1.7)	29.1 (0.6)	28.9 (0.8)
Obese (≥30)	15.1 (2.6)	10.4 (0.6)	12.7 (1.2)	13.1 (0.4)	15.1 (0.4)
Time since last routine check-up					

	Heroin	Cocaine, no heroin	Inhalants or hallucinogens, no cocaine or heroin	Marijuana use, no other drugs	No substance use
	n=271 %[b] (SE)	n=2659 % (SE)	n=890 % (SE)	n=5679 % (SE)	n=10999 % (SE)
<1 year ago	43.0 (3.2)	40.8 (1.2)	43.2 (1.9)	45.6 (0.8)	47.9 (0.7)
1–3 years ago	33.3 (2.5)	35.6 (1.0)	36. 7 (1.8)	36.2 (0.7)	35.0 (0.6)
≥4 years ago or never	23.7 (3.1)	23.6 (0.9)	20.1 (1.5)	18.2 (0.6)	17.1 (0.5)
Has health insurance					
No	29.5 (3.1)	19.2 (0.9)	18.7 (1.5)	14.5 (0.5)	17.0 (0.4)
Yes	70.5 (3.1)	80.8 (0.9)	81.3 (1.5)	85.5 (0.5)	83.0 (0.4)
Usual place of care					
No	32.1 (3.0)	30.2 (1.1)	24.3 (1.6)	23.6 (0.7)	23.0 (0.5)
Yes	67.9 (3.0)	69.8 (1.1)	75.7 (1.6)	76.4 (0.7)	77.0 (0.5)

Abbreviations: BMI=body mass index; kcal=kilocalories; SE=standard error

[a] All cross-tabulations, using the chi-square statistic, comparing each category of drug use to non-use were significant at p<0.01.

[b] All percentages were weighted.

[c] The “other” category for race/ethnicity could not be displayed in this table due to small numbers in some of the drug use categories.

Table 3

Hazard ratios for all-cause mortality by substance use adjusted for baseline demographic characteristics and a series of baseline health factors, 1991–2011

	Model 1: Demographics		Model 2: Demographics and Socioeconomic Status		Model 3: Demographics and Health Status		Model 4: Demographics and Health Risk Factors		Model 5: Demographics and Health Systems Factors		Model 6: All variables	
	HR	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**
Substance use category (ref: no drug use)												
Heroin	**2.40**	**1.65–3.48**	**2.09**	**1.43–3.05**	**2.01**	**1.39–2.91**	**1.69**	**1.13–2.50**	**2.24**	**1.52–3.30**	1.47	0.98–2.22
Cocaine, no heroin	**1.27**	**1.04–1.55**	**1.25**	**1.02–1.53**	**1.24**	**1.01–1.51**	1.12	0.90–1.39	1.25	1.02–1.52	1.08	0.87–1.35
Hallucinogens/inhalants, no heroin or cocaine	1.16	0.86–1.56	1.18	0.88–1.58	1.11	0.83–1.49	1.04	0.77–1.41	1.16	0.86–1.56	1.02	0.75–1.38
Marijuana, no heroin, cocaine, or hallucinogens/inhalants	0.95	0.82–1.11	0.97	0.83–1.13	0.94	0.81–1.10	0.89	0.76–1.05	0.96	0.83–1.12	0.89	0.76–1.04
Age (ref: 18–24)												
25–34	**1.95**	**1.48–2.56**	**2.45**	**1.85–3.25**	**1.96**	**1.49–2.57**	**1.78**	**1.36–2.32**	**2.05**	**1.56–2.69**	**2.15**	**1.63–2.84**
35–44	**4.32**	**3.35–5.56**	**5.87**	**4.47–7.72**	**4.15**	**3.23–5.33**	**3.88**	**3.01–4.99**	**4.64**	**3.61–5.96**	**4.84**	**3.67–6.38**
Sex (ref: female)												
Male	**1.61**	**1.39–1.85**	**1.71**	**1.48–1.97**	**1.77**	**1.54–2.05**	**1.60**	**1.38–1.86**	**1.63**	**1.41–1.89**	**1.79**	**1.53–2.09**
Race/ethnicity (ref: non-Hispanic White)												
Hispanic	1.02	0.82–1.27	0.75	0.59–0.94	0.88	0.70–1.10	0.97	0.78–1.21	0.92	0.74–1.16	0.79	0.62–0.99
Non-Hispanic Black	**1.81**	**1.54–2.13**	**1.32**	**1.11–1.57**	**1.49**	**1.26–1.76**	**1.59**	**1.34–1.87**	**1.72**	**1.46–2.03**	**1.23**	**1.03–1.46**
Other	0.74	0.43–1.28	0.73	0.43–1.25	0.71	0.41–1.21	0.79	0.47–1.32	0.73	0.43–1.25	0.74	0.44–1.27
Marital status (ref: married)[a]												
Never married			**1.37**	**1.13–1.65**							**1.37**	**1.14–1.66**
Divorced/separated/widowed			**1.40**	**1.17–1.69**							**1.32**	**1.09–1.59**

	Model 1: Demographics		Model 2: Demographics and Socioeconomic Status		Model 3: Demographics and Health Status		Model 4: Demographics and Health Risk Factors		Model 5: Demographics and Health Systems Factors		Model 6: All variables	
	HR	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**
Household Income (ref: ≥$20,000 per year)[a]												
<$20,000 per year			**1.60**	**1.41–1.83**							**1.24**	**1.08–1.41**
Education (ref: more than high school)[a]												
Less than high school			**2.19**	**1.85–2.60**							**1.36**	**1.12–1.64**
High school diploma or GED			**1.50**	**1.32–1.71**							**1.19**	**1.04–1.36**
Self-rated health (ref: very good/excellent)[a]												
Good					**1.83**	**1.59–2.10**					**1.46**	**1.26–1.68**
Fair/poor					**3.50**	**2.86–4.29**					**2.34**	**1.90–2.88**
Negative mood (ref: low negative mood)[a]												
Moderate negative mood					1.12	0.96–1.30					1.07	0.91–1.24
High negative mood					**1.55**	**1.25–1.91**					1.23	1.00–1.51
Cigarette smoking status (ref: never smoker)[a]												
Current smoker							**2.31**	**1.96–2.72**			**1.89**	**1.59–2.24**
Former smoker							0.85	0.69–1.06			0.84	0.67–1.04
Episodic heavy alcohol use status (ref: current drinkers, but no heavy alcohol use episodes)[a]												
≥5 drinks/day once a month or more							**1.75**	**1.42–2.15**			**1.60**	**1.29–1.99**
≥5 drinks/day less than once a month							1.10	0.92–1.32			1.11	0.93–1.33
No drinks in past 12 months							**1.46**	**1.24–1.73**			**1.33**	**1.13–1.58**

	Model 1: Demographics		Model 2: Demographics and Socioeconomic Status		Model 3: Demographics and Health Status		Model 4: Demographics and Health Risk Factors		Model 5: Demographics and Health Systems Factors		Model 6: All variables	
	HR	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**
Physical activity (ref: very active)[a]												
Sedentary							**1.38**	**1.16–1.64**			**1.26**	**1.06–1.50**
Moderately active							**1.30**	**1.04–1.62**			**1.28**	**1.03–1.60**
BMI (ref: normal weight (18.5 to <25))[a]												
Underweight (<18.5)							1.14	0.76–1.72			1.08	0.72–1.64
Overweight (25 to <30)							1.08	0.94–1.25			1.03	0.90–1.20
Obese (≥30)							**1.59**	**1.35–1.87**			**1.33**	**1.12–1.57**
Time since last routine check-up (ref: <1 year ago)[a]												
1–3 years ago									**0.78**	**0.67–0.92**	**0.83**	**0.71–0.97**
4+ years ago									0.85	0.71–1.01	0.83	0.70–0.99
Insurance coverage (ref: has health insurance)[a]												
No health insurance									**1.60**	**1.35–1.89**	1.10	0.92–1.31
Usual place of care (ref: has a usual place of care)[a]												
No usual place of care									1.01	0.86–1.19	0.97	0.83–1.15

Abbreviations: CI=confidence interval; BMI=body mass index; HR=hazard ratio

[a]Category included for missing responses (HR estimates for missing category not included in the table)

Table 4

Hazard ratios for specific causes of death by substance use, 1991–2011

	External causes[b]		Drug Poisoning[c]		Infectious disease[d]		HIV		Cancer		Heart Disease	
	HR	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**	**HR**	**(95% CI)**
Substance use category[a]												
Heroin	**3.54**	**1.77–7.07**	**7.79**	**2.45–24.71**	**3.83**	**1.53–9.57**	**5.50**	**1.89–16.04**	**2.96**	**1.43–6.14**	1.33	0.62–2.86
Cocaine, no heroin	**1.89**	**1.28–2.80**	1.59	0.59–4.32	**2.81**	**1.39–5.70**	**3.68**	**1.53–8.82**	0.86	0.55–1.35	0.75	0.48–1.17
Hallucinogens/inhalants, no heroin or cocaine	1.43	0.73–2.81	2.43	0.64–9.24	**2.84**	**1.12–7.24**	**4.54**	**1.62–12.73**	0.78	0.37–1.63	0.58	0.25–1.31
Marijuana, no heroin, cocaine, or hallucinogens/inhalants	1.44	0.99–2.08	0.80	0.30–2.15	0.57	0.27–1.20	0.66	0.25–1.70	0.86	0.66–1.13	0.95	0.67–1.33

Abbreviations: CI=confidence interval, HIV=Human Immunodeficiency Virus

[a]Reference group is no drug use; adjusted for age, sex, and race/ethnicity.

[b]Includes suicide, homicide and unintentional injury (including poisoning)

[c]Includes accidental, suicidal and undetermined intent combined

[d]Includes HIV