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Drug use generations and patterns of injection drug use: Birth cohort differences among people who inject drugs in Los Angeles and San Francisco, California

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Abstract

Objectives—A robust literature documents generational trends in drug use. We examined the implications of changing national drug use patterns on drug injection histories of diverse people who inject drugs (PWID).

Methods—Drug use histories were collected from 776 active PWID in 2011–13. Using descriptive statistics, we examine drug use initiation by year and birth cohort (BC) differences in drug first injected. A multivariate linear regression model of time to injection initiation ([TTII] (year of first injection minus year of first illicit drug use) was developed to explore BC differences.

Results—The first drug injected by BC changed in tandem with national drug use trends with heroin declining from 77% for the pre-1960's BC to 58% for the 1960's BC before increasing to 71% for the 1990's BC. Multivariate linear regression modeling found that shorter TTII was associated with the 1980's/1990's BC (−3.50 years; 95% Confidence Interval [CI]=−0.79, −6.21) as compared to the 1970's BC. Longer TTII was associated with being female (1.65 years; 95% CI=0.40, 2.90), African American (1.69 years; 95% CI=0.43, 2.95), any substance use treatment

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Author Disclosures

Ricky Bluthenthal designed the study (along with Alex Kral), conducted the statistical analysis, and prepared drafts of the manuscript. Ricky Bluthenthal, Philippe Bourgois, and Lynn Wenger managed the literature searches and summaries of previous related work. Lynn Wenger managed the study protocol. All authors contributed to and have approved the final manuscript.
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prior to injection (4.22 years; 95% CI=2.65, 5.79), and prior non-injection use of drug that was first injected (3.29 years; 95% CI=2.19, 4.40).

Conclusion—National drug trends appear to influence injection drug use patterns. The prescription opiate drug era is associated with shorter TTII. Culturally competent, demographically and generationally-targeted prevention strategies to combat transitions to drug injection are needed to prevent or shorten upstream increases in risky practices on a national level.

Keywords

Illicit prescription opioid use; birth cohorts; time to injection initiation; heroin initiation; life course theory; injection drug use

1. Introduction

1.1. Changing trends in injection drug use

For much of the previous twenty years, people who inject drugs (PWID) were regarded as an aging population (Armstrong, 2007) and rates of drug injection were understood to be declining (Brady et al., 2008). Recent reports indicate that drug injection may be increasing among young persons in the North America. For instance, Klevens and colleagues report that despite stable prevalence of injection drug use among high school seniors from 1995 to 2013, increases in some subgroups (non-Hispanic Blacks) and regions (Arkansas, Hawaii, Maine, Maryland, and New York) have been detected (Klevens et al., 2016). Using a modelling approach that relies on multiple local and national datasets, Tempalski and colleagues estimated that per population portion of PWID increased in the 15 to 29 years of age subgroup in 2006–07 as compared to this subgroup in 1996–97 (Tempalski et al., 2013). The causes of these emerging trends are worthy of study. In the following, we use a drug use generations framework to explore how patterns of injection drug use are changing among birth cohorts of PWID.

1.2. Drug use generations in the United States

North America has experienced national and regional drug epidemics of heroin, powder cocaine, crack cocaine, methamphetamine, and prescription drugs (especially pain relievers) over the last 40 years (Bourgois, 2003a; Bourgois and Schonberg, 2000; Compton et al., 2005; Golub et al., 2005; Gruenewald et al., 2013; Maxwell and Rutkowski, 2008; Roy et al., 2012). One method for understanding the trajectory and implications of these trends is to use the “drug generation framework”(Golub and Johnson, 1994a, b; Golub et al., 2005; Johnson and Golub, 2002). Key to this approach is tracking birth cohort changes in drug use preferences as a way of identifying transitions between drug “generations” or eras. This approach has been successfully used to examine transitions from heroin injection in the 1970’s to crack cocaine smoking in the 1980’s (Golub and Johnson, 1999), from crack cocaine in the 1980’s to marijuana/blunt smoking in the 1990’s (Golub and Brownstein, 2013), and the emergence of nonmedical use of opiate prescription drugs in the 2000’s (Golub et al., 2015; Golub et al., 2013).

The origins of the current nonmedical use of opiate prescription drugs lies in the development of long-acting opioid pain medications and the new focus on pain management, both of which occurred in the early-1990's (Kolodny et al., 2015; Manchikanti et al., 2012; Maxwell, 2011). These long-acting opioid-based pain medications have become widely available and while the vast majority of patients prescribed these medications use them as indicated, documented increases in nonmedical use are indisputable (Cheatle, 2015; Roland et al., 2016).

The current nonmedical use of opiate prescription drugs has been characterized by significant increases in overdose deaths (Unick et al., 2013), increased mortality (Cottler et al., 2016), at least one significant HIV/HCV outbreak (CDC, 2015; Peters et al., 2016), and a substantial rise in the number of heroin users (Jones et al., 2015b; Maxwell, 2015). Another potential consequence of this trend is changes in injection drug use patterns.

1.3. Injection drug use trends and prescription opiate drugs

A key question is whether the most recent drug epidemic of nonmedical use of prescription opiate drugs is associated with changes in drug use administration routes (Firestone and Fischer, 2008; Fischer et al., 2006; Maxwell, 2011, 2015; Roy et al., 2011; Roy et al., 2012). Based on published studies, it appears that nonmedical use of prescription opiates can lead to injection drug use through a 2-step process.

First, nonmedical use of prescription opiate drugs can lead to heroin use. Using national surveys, Jones found that past year use of heroin increased significantly among nonmedical users of prescription opioid drugs as compared to people who did not use prescription opioid drugs during the decade of the 2000's (Jones, 2013). In a more recent national study, Cerda and colleagues found that nonmedical prescription opioid drug use among youth was a significant predictor of subsequent heroin use (Cerda et al., 2015). An analysis of data from the Veterans Aging Cohort Study, found that nonmedical use of prescription opioid drugs resulted in a 5-fold higher hazard ratio of initiating heroin as compared to participants who without nonmedical prescription opioid drug use (Banerjee et al., 2016). Other studies have documented the connection between nonmedical prescription opiate drug use at the local and regional level (Cicero and Kuehn, 2014), including an observational cohort of young adult nonmedical prescription opioid drug users in Ohio that reported an 2.8% annual rate of heroin uptake (Carlson et al., 2016). Several studies among PWID have now documented that nonmedical use of prescription opioid drugs preceded heroin use and injection for most (Novak et al., 2016; Peavy et al., 2012; Pollini et al., 2011). Qualitative accounts in diverse North American regions have described patterns of injection drug use among younger birth cohorts that differ under the influence of nonmedical prescription opioid drug use and heroin injection as compared to those patterns observed in earlier birth cohorts (Firestone and Fischer, 2008; Mars et al., 2014; Siegal et al., 2003).

Second, heroin use is strongly associated with injection modes of use. For instance, Novak and Kral found that 50% of people who use heroin reported injection as compared to users of methamphetamines and cocaine where injections rates of 13% and 3%, respectively, were reported (Novak and Kral, 2011). It is possible therefore for the non-medical use of prescription opiates to influence patterns of injection drug use.

1.4. Examining trends in injection drug use through drug use histories

One way to explore drug use epidemics and their impact on injection drug use is to compare drug use histories among birth cohorts of PWID through retrospective accounts. Key questions include whether patterns of drug use among PWID conform to changing national trends and whether these national trends are associated with changes in drug injection initiation patterns (i.e., first drug injected) by birth cohort and time to injection initiation (TTII).

TTII is measured here as the number of years between first illicit drug use (including nonmedical use of prescription drugs) and first injection drug use. TTII has been studied in a variety of locales (Clatts et al., 2011; DeBeck et al., 2016b; Malekinejad and Vazirian, 2012; Mehta et al., 2012; Ross et al., 2008; Vorobjov et al., 2013; Young and Havens, 2011) but to date, no reports are available on US samples that include a wide range of substance use patterns. TTII is one way to examine how injection initiation patterns change in relationship to different "drug generations."(Golub and Johnson, 1994b; Golub et al., 2005; Johnson and Golub, 2002)

In the following, we examine whether national drug use patterns are associated with drug use patterns and injection patterns among birth cohorts of PWID. We also examine whether drug use trends are associated differences in birth cohort TTII among a large, diverse sample of PWID in California.

2. Methods

2.1. Sampling, recruitment and sample size

Data for this study come from a mixed-methods life course study of injection initiation among PWID in Los Angeles and San Francisco, California. Using targeted sampling and community outreach techniques (Bluthenthal and Watters, 1995; Kral et al., 2010; Lopez et al., 2013; Watters and Biernacki, 1989), we recruited respondents who had injected in the last 30 days (as verified by visible signs of venipuncture) (Cagle et al., 2002), were 18 years of age or older, and were willing and able to provide informed consent. Eligible respondents completed a 30-minute, quantitative survey using computer assisted personal interviewing software (Questionnaire Development System, Nova Research, Bethesda, MD) with a trained research interviewer in a private setting. Participants received $15USD for completing the survey. Study methods have been described in greater detail elsewhere (Arreola et al., 2014; Wenger et al., 2016). Our analytic sample consisted of 776 participants for whom we had complete data on age at first drug use and first injection. Study procedures were approved by the institutional review boards at RTI International and the University of Southern California.

2.2. Key study domains and variables

Informed by Life Course Theory (Elder, 1994; Godette et al., 2006), we were interested in the time and timing of critical events and in particular, the first use of common illicit drugs and the first drug injected by birth cohort. To identify the year of first use of common illicit drugs we used the following variables and calculations. Each participant was asked if they

had ever used each of the following drugs: crack cocaine, powder cocaine, amphetamine/methamphetamine/speed, heroin, speedball (cocaine and heroin admixture), goofball (speed and heroin admixture), and nonmedical use of prescription drugs composed of opioids, tranquilizers, sedatives, stimulants, methadone, and buprenorphine, we asked the following questions. Those responding affirmatively were asked “How old were you when you first used [drug type]?” To calculate year of first use, we added age at first use to birth year.

Data on first drug injected was collected using the following item: “What drug did you inject the first time?” with the following response options: crack, powder cocaine, methamphetamine, heroin, speedball, goofball, dilaudid, morphine, codeine, other opiates, talwin/ritalin, other stimulants, anti-depressants, and steroids. Based on the distribution of responses, we recoded this item to “heroin/opiate pills” (including heroin, speedball, goofballs and opiate based prescription drugs), “stimulants” (including crystal methamphetamine, speed, cocaine, crack-cocaine, and stimulant producing prescription medications). A small number of participants (N=4) initiated injection drug use with depressants or disassociative prescription medications. Because of the small number, we dropped these participants from the analysis of this issue. To determine TTII, we subtracted age of first illicit drug use from the item used to determine age of first injection (“The first time you injected, how old were you?”). Age at first illicit use was determined by computing the minimum response to age at first use for the following drugs: crack cocaine, powder cocaine, amphetamine/methamphetamine/speed, heroin, speedball (cocaine and heroin admixture), goofball (speed and heroin admixture), marijuana and misuse of prescription medications composed of opiates, tranquilizers, sedatives, and stimulants. TTII ranged from 0 (for those reporting first illicit drug use and first injection at the same age) to 40 years.

We were particularly interested in patterns of drug use by birth cohort (defined as born pre-1960’s, the 1960’s, 1970’s and 1980’s or later). We also considered age, gender, race/ethnicity (White, African American, Hispanic, and all others), attainment of high school graduation or equivalent (yes or no), sexual minority status (gay, lesbian, bisexual vs. heterosexual), military service (yes or no), and parental alcohol or drug use problems (yes or no) as confounding variables in the analysis of TTII.

2.3. Statistical Analyses

We used descriptive statistics to characterize patterns of drug use over time. Specifically, to examine change in uptake of drugs by year, we calculated the proportion of participants who reported first use for each year and then grouped these by half-decade categories to facilitate interpretation. A similar approach has been used by other scholars to examine changes in prevalent cocaine, crack cocaine, and heroin use (Agar and Reisinger, 2002; Golub and Johnson, 1994a, b; Johnson and Golub, 2002). We also categorized TTII by ten-year birth cohort and report mean and median TTII.

For multivariate analysis, TTII (in years) was treated as the dependent variable. We conducted bivariate analysis using ANOVA to compare means with statistical significance at $p<0.05$ level. Variables found to be significant in bivariate analysis were examined for co-linearity. Variables found to be collinear at the 0.300 level were excluded from the multivariate model based on the strength of their association with the dependent variable.

For multivariate linear regression analysis, variables were considered to be independently associated with TTII at the $p<0.05$ level.

3. Results

3.1. Sample characteristics

Respondents were racially and ethnically diverse with 33% of subjects being white, 30% being African American, and 25% being Hispanic (Table 1). The sample was 26% female, 74% male, and 15% gay, lesbian, or bisexual. Respondents were very low-income with 62% reporting being homeless and 81% reporting a monthly income below $1,351 (<150% of the federal poverty level in 2012). Mean age was 48.1 (Standard deviation [SD]=11.44; Median=50; Interquartile range [IQR]=42, 57) and mean years of drug injection were 27.9 (SD=13.63; Median=28; IQR 16, 37).

Drug use prevalence was as follows: heroin (94%), marijuana (93%), crack cocaine (87%), powder cocaine (86%), methamphetamine (73%), prescription opiates (63%), and prescription tranquilizers (58%). The most common drug ever injected was heroin (80%) followed by powder cocaine (69%), methamphetamine (62%), crack cocaine (33%), and prescription opiate drugs (32%). The most reported first drug injected was heroin and/or prescription opiate pills (66%; of whom 97% started with heroin) followed by stimulants, including methamphetamine, cocaine, and prescription medications (33%; of whom 67% started with methamphetamines), and anti-depressant and disassociate prescription medications (<1%).

Mean age of first illicit drug use was 13.5 (Standard Deviation [SD]=4.5; Median=13; Interquartile Range [IQR] 12, 15) and mean age of injection initiation was 21.7 (SD=8.6; Median=19; IQR 16, 25). Overall, mean TTII for the sample was 8.2 years (SD=8.0; Median=6; IQR 2, 12).

3.2. Drug use trends

In prior studies, national peaks or highest prevalence ratios of drug used have been identified as the early 1970's for heroin, mid-1970's for powder cocaine, 1980's for crack cocaine, and 2000's for methamphetamine and prescription opiate drugs (Golub and Johnson, 1994a, b; Johnson and Golub, 2002; Maxwell, 2005, 2011). In Figure 1, we present data on the proportion of first use of a drug by half-decades to examine if national patterns of use were comparable to drug use histories in our PWID sample. Drug use uptake patterns in our sample mirrored national trends with heroin use uptake peaking in the early 1970's. Heroin was surpassed by cocaine use in the late 1970's and early 1980's, which in turn was surpassed by crack cocaine use in the late 1980's. As crack cocaine declined, methamphetamine uptake increased in the late 1990's and early 2000's, then to be surpassed by the growth in prescription opiate drug use in the late 2000's.

3.3. Trends in first drug injected

We next examined changes in first drug injected by birth cohort (Figure 2). Heroin (including speedballs and goofballs) and prescription opiate pills were the most common

first drug injected for all of the birth cohorts. However, the proportion that first injected heroin declined with the 1960's and 1970's birth cohort and then rose again for the 1980's and 1990's birth cohorts.

3.4. Birth cohort differences and TTII

TTII fluctuated by birth cohort with increases observed for the 1960's and 1970's birth cohorts as compared to the pre-1960's birth cohort. This trend was reversed for the 1980's and 1990's birth cohorts, where shortening of TTII was observed (Figure 3).

To examine factors associated with these changing trends, we conducted linear regression statistical analyses to predict TTII while controlling for age (Table 3). We found that shorter TTII was associated with being born in the 1980's or later as compared to those born in the 1970's (we used the seventies as the referent as this was the cohort with the longest TTII). Longer TTII was associated with any drug treatment prior to first injection, being African American, being female, and using first injected drug by other means prior to injection. In the multivariate analysis any drug treatment prior to first injection was the variable with the strongest absolute beta effect.

4. Discussion

In our view, the emergence of prescription opiate drugs in the 1990's and 2000's appears to be changing the patterns of injection drug use. The shorter TTII in the newer birth cohorts can be viewed as a marker of this change and might be considered a leading indicator of the changing prevalence in injection drug use overall. Published qualitative studies have found that prior prescription opiate misuse can lead to injection drug use (Lankenau et al., 2012a; Lankenau et al., 2012b; Mars et al., 2014; Roy et al., 2011). This can occur with injection of opiate prescription medications (an increasingly difficult task with the advent of abuse deterrent formulations of these drugs) or through switching to heroin, which is cheaper and has increasingly become available throughout the US (Carlson et al., 2016; Cicero and Ellis, 2015; Jones, 2013). National and local studies have now confirmed that the vast majority of young heroin users began opioid use with prescription drugs (Cicero and Kuehn, 2014; DeBeck et al., 2016b; Novak et al., 2016; Peavy et al., 2012; Pollini et al., 2011) and that heroin use is strongly associated with injection routes of administration (Novak and Kral, 2011; Pirozzi et al., 2014). As a consequence, we would expect the current trend of increased drug injection among younger cohorts in the US to continue (Chatterjee et al., 2011; Klevens et al., 2015).

Nonetheless, more research exploring pathways to injection drug use are needed with a focus on the prescription opiate-heroin connection. These new studies should also explore cultural and generational pathways to injection drug use such as changing "drug fashions." (Bourgois, 2003b) For instance, cultural norms such as 'heroin chic' in the 1990's may have reduced heroin stigma among whites and suburban populations (Denham, 2008; McCoy et al., 2005) even as the "blunts and 40's" hip-hop generation's long term shift to marijuana was occurring among inner city youth who had witnessed the devastation of the HIV epidemic among an older generation (Bourgois, 2003b; Golub and Johnson, 1999). Changing drug availability and cultural shifts among various subpopulations may be

operating in tandem to create the current trends; more research is needed to understand these potentially reinforcing developments.

We also found that substance abuse treatment prior to injection increased TTII. Studies have found that substance use treatment inhibited injection uptake among heroin sniffers (Kelley and Chitwood, 2004) and that trying but being unable to obtain substance use treatment lead to more rapid uptake of injection (DeBeck et al., 2016a). These results, along with our own, suggest that one promising response to the increased risk of injection drug use would be to increase substance use treatment for prescription opioid and heroin users.

In our study, women had statistically significant longer TTII as compared to men. While there are no comparable studies that have found gender differences in TTII, research on early onset of injection have found that women are at elevated risk for injection initiation in Canada (Miller et al., 2011; Miller et al., 2006) and Estonia (Vorobjov et al., 2013). National differences in drug availability, gender roles and vulnerabilities, and a host of other known (e.g., sex work and differential law enforcement interfaces)(Bourgois et al., 2004; Fuller et al., 2001; Miller et al., 2006) and unknown factors may explain this difference between our findings and those of other studies. In general, the TTII we found in Los Angeles and San Francisco was within the range reported in other studies where TTII as short as 1.3 years have been reported in Tallinn, Estonia (Vorobjov et al., 2013) and up to 10 years were reported in Appalachia, US (Young and Havens, 2011). More research is needed on TTII and factors associated with it, including consideration of drug supply patterns, exposure to drug epidemics and gender and ethnic differences in progress to injection initiation.

Lastly, we found that African Americans had a longer TTII than other race/ethnicities. No comparable data exist in published studies, although research over the last two decades has indicated that heroin use among African Americans appears to be declining (Golub and Johnson, 2005). One national study reported that even among people who use heroin, African Americans had lower odds of transiting into injection drug use (Broz and Ouellet, 2008). While another national study indicates that 90% of new initiates to heroin use since 1990 are white; representing a significant change in demographics from prior eras (Cicero et al., 2014). Related to this, Carlson also found that transitions from opiate medication to heroin injection were significantly more likely to occur among white people in Ohio as compared to African Americans (Carlson et al., 2016). Similarly a qualitative study in inner city Philadelphia documented a strong stigma among young African American and Puerto Rican opioid users against transitioning to injection in contrast to white users. (Mars et al., 2014) With these trends in mind, the longer TTII among African Americans in our sample may be another indicator of the declining popularity of heroin among this population of drug users. Additional research exploring the forces propelling these drug administration preference trends across ethnicity and gender are needed.

Our study results should be considered within the context of several potential study design limitations. All data in this study are based on self-reports and are subject to recall bias and social desirable responding. We have examined the reliability of self-reported age of first use and first injection by comparing reports in the quantitative and qualitative interviews for this study (Dyal et al., 2015). Results indicate adequate agreement in reported age and in

sequencing of drugs used. In general, multiple studies have found that PWID have adequate recall of drug use patterns (Dowling-Guyer et al., 1994; Napper et al., 2010; Weatherby et al., 1994). PWID are a hidden and stigmatized population and so representative sampling of this population is not possible. However, the targeted sampling approach we have taken to recruit PWID has been found to yield similar samples to respondent driven sampling approaches that are used widely in this population for national surveillance (Kral et al., 2010; Robinson et al., 2006). Nonetheless, study results are not representative of PWID in Los Angeles, San Francisco, or elsewhere. In addition, our retrospective, cross-sectional approach could be improved on by starting new prospective cohorts of people who use drugs but have yet to inject for purposes of examining changes in drug use preferences and routes of administration.

We also have three limitations related to the older age of our sample participants (79% are 40 or older). First, we are missing data on PWID from older cohorts who have died due to mortality related HIV/AIDS, overdose, and other ailments common to PWID or who have ceased drug injection. It is worth noting that California PWID were less effected by HIV/AIDS mortality due to lower HIV prevalence rates in the late 1980's as compared to PWID in the Northeast, Mid-Atlantic, and some Midwestern cities (Kral et al., 1998). Nonetheless, how premature mortality or cessation of drug injection might impact estimates from our retrospective consideration of TTII is hard to know and should be regarded as a limitation. Second, our sample includes relatively few participants born since 1990 (n=14). So have less precise information on this cohort in general and specifically with regards to TTII. To account for this, we re-ran the regression analysis without these respondents and all associations remained including that those born in the eighties had significantly shorter TTII as compared to those born in the seventies (p=0.017). Third, younger PWID in our sample started injection earlier than older cohorts (p=0.019). To account for this, we reran the regression model controlling for age at first injection and found that the birth cohort differences between those in the seventies as compared to those in the eighties remained statistically significant (p=0.031). Given the limitations, we believe more studies on younger birth cohorts of PWID and non-injection drug users are needed to substantiate this finding.

5. Conclusion

The shorter TTII observed in more recent birth cohorts suggest that opportunities to combat uptake in drug injection are urgently needed to prevent long-term population-level increases in risky practices. The exceptionally strong absolute beta effect on TTII of "any drug treatment prior to first injection" in our multivariate analysis, suggests that increasing access to substance abuse treatment--especially for opiate prescription and heroin users (Jones et al., 2015a)--might be a cost-effective public health priority (see also (Cicero et al., 2012; Dart et al., 2015b). Other potential upstream public health approaches to preventing transitions to injection that might have longer-term population cohort level effects might include 1) interventions to prevent nonmedical use of prescription opioids, (Cicero et al., 2012; Dart et al., 2015b)--including controls on pharmaceutical advertising to physicians; (Netherland and Hansen, 2016) 2) culturally competent and generationally targeted interventions to prevent injection initiation among youth who use drugs through non-injection routes of administration, (Des Jarlais et al., 1992; Werb et al., 2013) with a focus

on other drugs like methamphetamine and vulnerable populations as well, and 3) working with established PWID to reduce behaviors that facilitate injection initiation among people who are naïve to injection (Arreola et al., 2014; Bluthenthal and Kral, 2015; Bluthenthal et al., 2015; Stillwell et al., 1999; Strike et al., 2014).

These data suggest that during periods of crack cocaine and methamphetamine ascendance, TTII appeared to be longer. While drug preference alone cannot explain variations in uptake of injection drug use or TTII, it appears that these prevalent non-injection drug use patterns can influence some aspects of injection drug use. Our data indicate that we may be in a period where the most common drugs of misuse – prescription opiate drugs - are leading to more rapid uptake of injection drug use among susceptible populations. While the negative health consequences of nonmedical use of prescription opioids have been widely reported and include large increases in drug overdose (Dart et al., 2015a), at least one local HIV and HCV outbreak (CDC, 2015; Strathdee and Beyrer, 2015), and growing numbers of people using heroin (Jones et al., 2015b), its potential contribution to increases in the prevalence of people who inject drugs has not been well documented (Jordan et al., 2014).

Any escalation in the number of people who inject drugs holds substantial risk for individuals and population health. PWID are at elevated risk for HCV, HIV, and sexually transmitted infections, abscesses and soft tissue infections, mental health disorders, drug overdose, and premature mortality (Aceijas and Rhodes, 2007; Aceijas et al., 2004; Boivin et al., 2005; Ebright and Pieper, 2002; Khan et al., 2013; Mackesy-Amiti et al., 2013; Mackesy-Amiti et al., 2012; Nelson et al., 2011; Onyeka et al., 2016; Roy et al., 2008; Schrager et al., 2015). In the United States, mortality rates for young PWID have been reported to be 10 times higher than the general public in one study (Evans et al., 2012) and over 7 times higher in one multisite study (Vlahov et al., 2008). Local studies in India (Solomon et al., 2009), Scotland (Nambiar et al., 2015), the Czech Republic (Zabransky et al., 2011), as well as a wide variety of country types (i.e., low and high income) have reported elevated mortality among PWID (Mathers et al., 2013; Onyeka et al., 2016). The re-emergence of injection routes of drug administration should be considered a significant public health problem requiring immediate action.

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Highlights

- National drug trends are associated with injection drug use patterns
- Recent birth cohorts of people who inject drugs (PWID) are initiating injection more rapidly than older birth cohorts.
- Efforts to prevent injection initiation among susceptible drug users are urgently needed

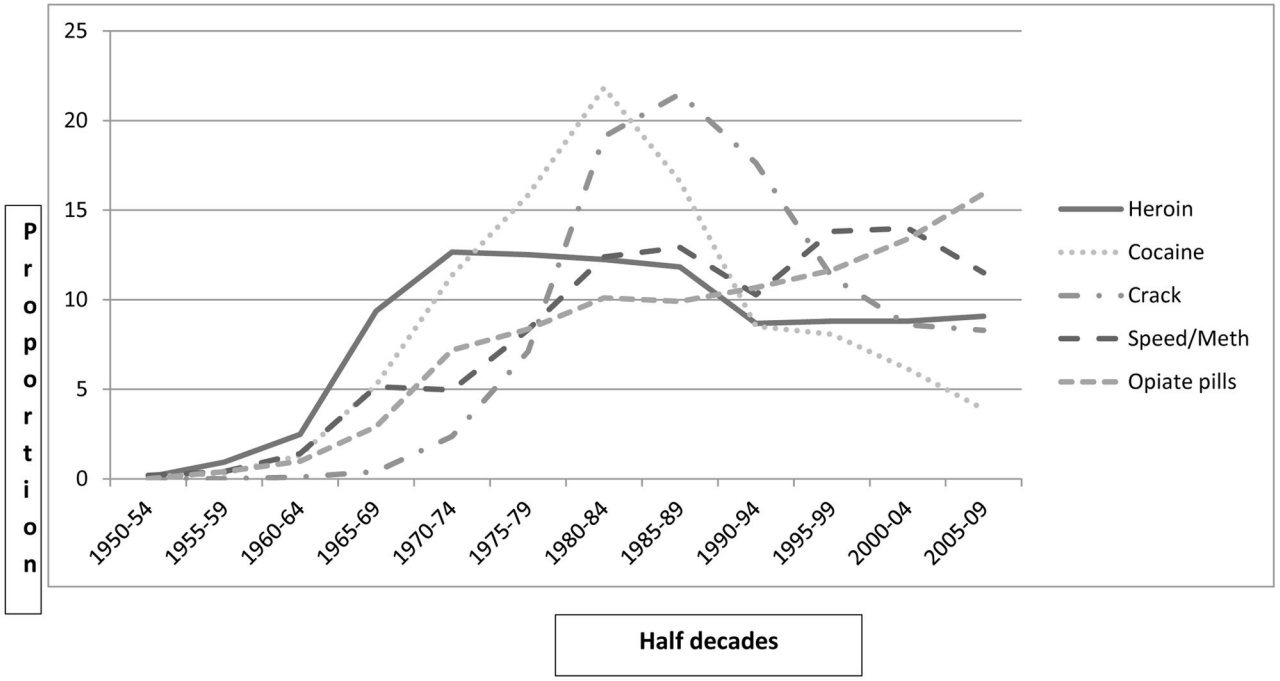

Figure 1.
First year drug used by proportion among PWID, 2011–2013 (N=776).

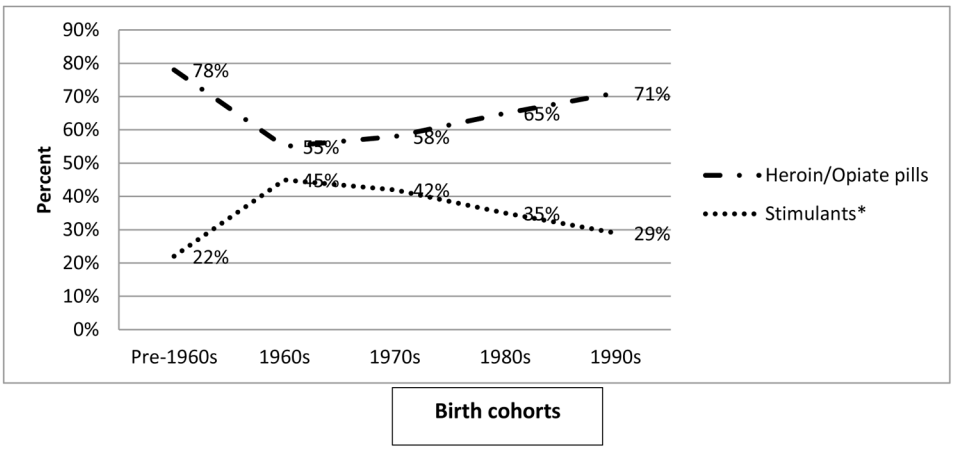

Figure 2.
First drug injected by birth cohort among PWID 2011–13 (N=776).

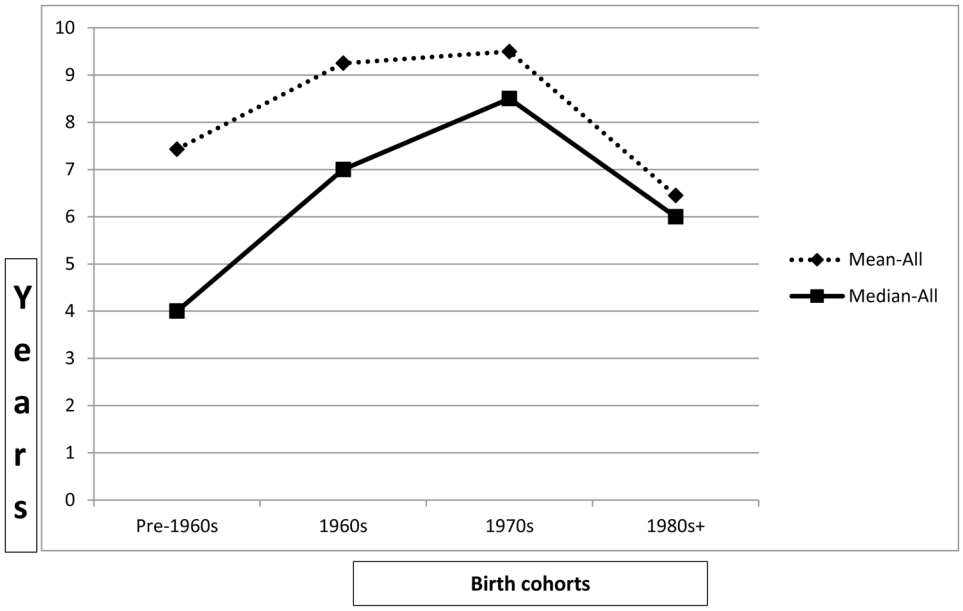

Figure 3.

Time to injection initiation by birth cohort by mean and median years, 2011–13 (N=776).

*Stimulants includes methamphetamines, cocaine, and stimulant prescription medications

Table 1

Selected demographic, socioeconomic, and drug use characteristics of sample (N=776).

Characteristic	N (%)
Study Site	
Los Angeles	397 (51%)
San Francisco	379 (49%)
Biological sex	
Male	571 (74%)
Female	203 (26%)
Intersex	2 (<1%)
Age	
<29	80 (10%)
30 to 39	86 (11%)
40–49	223 (29%)
50 or more	388 (50%)
Birth Cohort	
Pre-Sixties	339 (44%)
Sixties	242 (31%)
Seventies	104 (13%)
Eighties or later	91 (12%)
Race	
White	264 (34%)
African American	233 (30%)
Hispanic	192 (25%)
All others	82 (11%)
High school or equivalent education or more – Yes	498 (64%)
Born in the US – Yes	734 (95%)
Gay, lesbian, or bisexual – Yes	118 (15%)
Any US military service – Yes	84 (11%)
Currently homeless – Yes	483 (62%)
Self-reported HIV positive – Yes	53 (7%)
Parental drug use	
Parent with an alcohol use problem – Yes	441 (57%)
Parent with an drug use problem – Yes	205 (26%)
Monthly income	
<$1,351	626 (81%)

Characteristic	N (%)
$1,351 plus	147 (19%)
Years of drug injection	
<10 years	126 (16%)
10 to 19 years	128 (17%)
20 or more years	522 (67%)
Ever used	
Heroin	727 (94%)
Marijuana	723 (93%)
Crack cocaine	676 (87%)
Powder cocaine	668 (86%)
Methamphetamine	565 (73%)
Speedball	522 (67%)
Opiate prescription medication	491 (63%)
Tranquilizers prescription medication	450 (58%)
Methadone	336 (43%)
Goofball	262 (34%)
Stimulant prescription medication	168 (22%)
Sedative prescription medication	158 (20%)
Buprenorphine	118 (15%)
Used first drug injected by other means before first injection	
Yes	384 (49%)
Ever injected	
Heroin	722 (93%)
Powder cocaine	536 (69%)
Speedball	515 (66%)
Methamphetamine	479 (62%)
Goofball	258 (33%)
Crack cocaine	253 (33%)
Opiate prescription medication	249 (32%)
Stimulant prescription medication	76 (10%)
Tranquilizers prescription medication	59 (8%)
Methadone	40 (5%)
Sedative prescription medication	30 (4%)
Buprenorphine	13 (2%)
First drug injected	
Stimulants including methamphetamine, cocaine, & prescription drugs	258 (33%)
Heroin & opiate prescription drugs	514 (66%)
Other	4 (1%)
Drug treatment experiences, ever	

Characteristic	N (%)
Methadone detoxification	350 (45%)
Methadone maintenance	330 (43%)
Outpatient	246 (32%)
Residential	317 (41%)
Self-help	402 (52%)
Buprenorphine	68 (9%)
Drug treatment experiences, last 30 days	
Methadone detoxification	71 (9%)
Methadone maintenance	189 (24%)
Outpatient	67 (9%)
Residential	16 (2%)
Self-help	76 (10%)
Buprenorphine	11 (1%)
Any drug treatment experience prior to injection drug use – Yes	109 (14%)
Injection frequency, last 30 days	
Less than once a day	361 (47%)
Once or twice a day	214 (27%)
Three times or more a day	201 (26%)

Table 2

Selected bivariate factors associated with time to injection initiation (N=776).

Variables	N	Mean in Years	Standard Deviation	Median	P=
Biological sex					
Male	571	7.69	7.49	6.0	0.006
Female	203	9.48	9.12	7.0	
Age cohort					0.002
Born prior to the 1960's	340	7.45	8.52	4.0	
Born during the 1960's	242	9.27	8.56	7.0	
Born during 1970's	104	9.49	6.68	8.5	
Born in or after 1980	91	6.45	4.15	6.0	
African American/Black					0.02
No	544	7.74	7.41	5	
Yes	233	9.16	9.06	7	
High school education or equivalent					0.03
No	278	7.31	7.56	5	
Yes	498	8.65	8.17	6	
Parent with an alcohol use problem					0.01
No	335	7.33	7.18	5	
Yes	441	8.80	8.49	6	
Parent with a drug use problem					ns
No	571	8.04	8.14	6	
Yes	205	8.53	7.51	6	
Relationship to injection initiator – Family member					0.002
No	706	8.42	8.00	6	
Yes	69	5.35	7.13	3	
Any treatment prior to first injection					0.0001
No	667	7.50	7.49	5	

Variables	N	Mean in Years	Standard Deviation	Median	P=
Yes	109	12.27	9.53	10	
Ever used first drug injected prior to injection					0.0001
No	392	6.41	7.37	4	
Yes	384	9.96	8.18	8	

ns=Not significant.

Table 3

Multivariate Linear Regression Model of Factors Associated with Time to Injection Initiation (N=776)

Variables	Beta In years	Standard Error	95% Confidence Interval	P=
Any drug treatment prior to first injection	4.22	0.80	2.65, 5.79	<0.001
Ever used drug prior to first injection	3.29	0.56	2.19, 4.14	<0.001
African American	1.66	0.64	0.43, 2.95	0.009
Female	1.65	0.64	0.40, 2.89	0.01
Born pre-sixties	−1.27	1.68	−4.52, 2.02	ns
Born in the sixties	0.12	1.12	−2.07, 2.31	ns
Born in the seventies	Referent	--	--	--
Born in the eighties or later	−3.50	1.38	−6.21, −0.79	0.01

Controlling for age

ns=Not significant.