Published in final edited form as:

J Psychoactive Drugs. 2020 ; 52(5): 412–420. doi:10.1080/02791072.2020.1804648.

A review of factors associated with age of first injection

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Abstract

Injection drug use is of increasing public health concern in the United States. Misuse of and addiction to opioids has contributed to declining life expectancies and rebounding risk of HIV and HCV acquisition among people who inject drugs. While some effective treatment strategies for individuals with substance use disorders have been established, effective interventions to prevent injection drug use require greater tailoring to sub-populations and social contexts. To better understand contextual variables associated with initiation of injection drug use, we conducted a narrative review of the existing literature that assessed correlates of age of first injection. We found sixteen studies that met our inclusion criteria. Across studies, later injection drug use initiation was associated with being African American and female, while early initiation was associated with earlier illicit substance use, childhood trauma, and incarceration. We also found that early initiation was associated with riskier substance-using behaviours, though the findings were mixed with respect to differences between early and late initiates in infectious disease prevalence. These correlates of age of first injection can potentially inform tailored injection prevention strategies. By identifying the features and behaviors of relevant sub-populations before they inject, interventions to prevent injection drug use could become more effective.

Keywords

injection drug use; IDU; injection initiation; people who inject drugs; PWID; substance use

INTRODUCTION

The opioid-related overdose crisis in the United States has caused more than 400,000 deaths since 1999 (Scholl et al. 2018). Mortality rates for opioid-related deaths continue to rise substantially, particularly due to increased uptake of potent synthetic opioids such as fentanyl among people who inject drugs (PWID) (Rudd et al. 2016). Moreover, methamphetamine use is experiencing a resurgence predominantly among PWID in the

western United States and has resulted in a more than quadrupling of psychostimulant overdose deaths from 2011 to 2017 (Kariisa et al. 2019). Given the potency and availability of the most commonly injected drugs, especially opioids, injection drug use has been of particularly increasing concern in the past decade.

The current opioid-related overdose and public health crisis began in the late 1990s with increased opioid medication prescriptions, which led to broad misuse of prescription and non-prescription opioids, including injection drug use initiation (Kolodny et al. 2015; Mateu-Gelabert et al. 2015), and consequently increased the risk of infectious disease transmission (Schwetz et al. 2019). The prevalence of Human Immunodeficiency Virus (HIV) and Hepatitis C Virus (HCV) continues to be higher among people who use illicit substances than among individuals who do not use illicit substances (Aceijas and Rhodes 2007; Mathers et al. 2008). In fact, sharing equipment during injection drug use is thought to be one of the most common ways to become infected with HCV (Palmateer et al. 2014). While PWID do not make up the bulk of people living with HIV, recent outbreaks among PWID in Appalachia (Evans et al. 2018), northern Massachusetts (Brown 2019; Cranston et al. 2019), Seattle (Golden et al. 2019), and Indiana (Conrad et al. 2015) have sparked concern about potential increases in rates of HIV transmission in injection drug using communities.

To mitigate these dual public health problems, it is important to understand initiation of risky substance use behaviors, especially among PWID. However, most efforts to address substance use disorders in PWID historically have focused on treatment rather than prevention (Werb et al. 2013). A growing body of work has discovered effective behavioral interventions and structural approaches to prevent injection initiation, but calls have been made to tailor these interventions for specific populations and contexts to increase their efficacy (Werb et al. 2018). One such intervention called “Break the Cycle” was developed to prevent the social spreading of injection drug use by educating PWID how to reject initiation requests from non-PWID (Hunt et al. 1998). In fact, one of the first studies on initiation of injection drug use identified this kind of social initiation as a prevalent concern among young PWID in Australia (Crofts et al. 1996). “Change the Cycle,” a variant of “Break the Cycle” tailored to a Canadian context, was shown to decrease the proportion of PWID offering to initiate non-PWID as well as the prevalence of PWID who spoke positively about injection drug use to non-PWID (Strike et al. 2014). However, a recent study of another adaption employed in Tallinn, Estonia and Staten Island, New York City found that, despite comparable reductions in numbers of individuals assisted with their first injection at both locations, the baseline rate of assisted injection initiation in Tallinn was substantially smaller than in Staten Island (Des Jarlais et al. 2019). This finding highlights that such interventions may be differentially applicable across populations. Considering the heterogeneity of PWID as well as their social environments, there is a clear need to better understand specific sub-populations in the development of preventive interventions.

There is some indication that the age of initiation of drug use differs by demographic and contextual factors. A limited number of cross-sectional studies have identified a range of correlates of age of first injection. Understanding how age of first injection is related to these demographic and contextual factors may be important in developing effective intervention

strategies to prevent injection drug use initiation. The purpose of this review was to examine the existing literature regarding correlates of age of first injection and to synthesize the descriptive data in service of identifying specific populations for whom targeted prevention efforts may be most helpful and appropriate.

METHODS

We conducted a narrative literature review of the available research that reported correlates of age of injection drug use initiation by searching PubMed (www.ncbi.nlm.nih.gov) for articles published through July, 2019. Our original PubMed search included the following combination of terms: (“injection drug use initiation” OR “injection drug use onset”) AND “age.” Among the articles returned, we searched titles and abstracts for studies that assessed associations between age at the time of injection initiation, or the age range classification (i.e. early versus late), and specific characteristics, factors, or behaviors. This initially resulted in eight articles included in the review. We additionally looked at articles that cited our included publications and cross-referenced included articles, which resulted in the inclusion of two additional abstracts. Upon review of related articles that did not meet our inclusion criteria, we identified and included six more relevant articles. To confirm our findings, we used similar search strategies in Google Scholar (www.scholar.google.com).

Studies were included in this review if they assessed one or more correlations with age of first injection. Most of the studies included disaggregated age range by “early” and “late” initiation to identify correlates of age of first injection. However, we also included studies that treated age of first injection as a continuous variable, so long as they assessed an association between a measurable variable and age of initiation. We excluded articles that simply identified age of first injection as a demographic variable or discussed correlates of injection initiation in general without specifying age of first injection. Accordingly, articles that described risk factors for injection drug use or pathways to injection initiation, but did not report relationships with age of first injection, were excluded due to the lack of detail regarding factors associated with the age at which individuals first inject. At least one study was excluded because it used current age as a proxy for early versus late initiation of injection drug use. Sixteen studies were ultimately included based on these criteria.

RESULTS

We identified fourteen papers and two abstracts that assessed correlates of age of first injection (see Table 1). In our review of these sixteen studies, we synthesized the results in relation to differences in demographics, previous drug use, historical, social, behavioral, and biological factors. The populations across studies were demographically heterogeneous: one was conducted in San Francisco, California (Kral et al. 2009), one in both San Francisco and Los Angeles, California (Arreola et al. 2014), one in multiple major US cities (Ompad et al. 2005), and one included multiple Californian regions (Bluthenthal et al. 2009). In addition, three studies were conducted in Baltimore, Maryland, three in Canada, and one study each were conducted in Iran, Afghanistan, Pakistan, Malaysia, Estonia, and Australia (Table 1). Additionally, two studies’ participant pools were exclusively male (Parviz et al. 2006; Bautista et al. 2010).

Several studies determined characteristics and behaviors of individuals who inject drugs to be associated with belonging to a specific age group at the time of their first injection, though age groups were categorized differently across studies. “Early” initiates were defined as individuals initiating injection drug use at 16 (Abelson et al. 2006; Miller et al. 2006), 17 (Barker et al. 2017), 18 (Uusküla et al. 2010), 21 (Fuller et al. 2001, 2005), 22 (Bautista et al. 2010; Shushtari et al. 2017), 23 (Vicknasingam, Narayanan, and Navaratnam 2009), or 29 (Kral et al. 2009; Arreola et al. 2014; Bluthenthal et al. 2009). “Late” initiates were defined as individuals initiating injection drug use at ages older than these cutoffs, except in the study conducted by Bautista and colleagues, where a “middle group” of injection drug users who initiated between the ages of 23 and 28 was additionally studied.

Demographic factors

Across studies, the most prevalent demographic correlate of age of first injection associated with “late” initiation was identified as being African American (Fuller et al. 2001, 2005; Ompad et al. 2005; Bluthenthal et al. 2009; Kral et al. 2009; Arreola et al. 2014). Two of these studies identified African Americans as being more likely than White individuals to initiate late (Fuller et al. 2005; Arreola et al. 2014), one study found that African Americans were more likely to initiate late compared to participants who identified as White, Hispanic, Native American, and other race/ethnicity collectively (Fuller et al. 2001), and one study found that African Americans were more likely to initiate late compared independently to Hispanics, Native Americans, and other race/ethnicity (Bluthenthal et al. 2009). Additionally, Ompad et al. (2005) found that African Americans were more likely to be older when initiating injection drug use than White or Hispanic individuals. However, three of these studies defined late initiation as the first injection occurring at age 30 or older (Bluthenthal et al. 2009; Kral et al. 2009; Arreola et al. 2014) while two utilized 21 years of age as the cutoff for early versus late initiation (Fuller et al. 2001, 2005). In contrast, Fuller et al. (2005) found that, when neighborhood-level variables, such as employment rate and poverty level, are considered, African Americans with lower neighborhood socioeconomic statuses in Baltimore were four times more likely to begin injecting drugs in adolescence than Whites living in more affluent neighborhoods. An international study also identified race as a significant factor: in an Australian sample, “early” injection drug use initiation was associated with being Indigenous Australian compared to other non-Aboriginal races (Abelson et al. 2006).

Another demographic correlate identified in the literature as being associated with age of injection initiation was gender, but findings were mixed. Three published reports, all of which defined late initiation as 30 years or older, found that late-onset initiates were more likely to identify as female than male (Bluthenthal et al. 2009; Kral et al. 2009; Arreola et al. 2014). Moreover, identifying as female was associated with a later age of initiation (18.8 years old versus 18.3 years old) (Ompad et al. 2005). However, one study found that females were more likely to initiate injection drug use earlier (i.e. 16 years old) rather than later (Miller et al. 2006). Because this study did not include any participants above the age of 30, it is unclear whether these results are inconsistent with findings indicating females were

more likely to be late-onset initiates. The limited age ranges preclude direct comparison of these results.

Other demographic factors associated with early-onset injection included homelessness and unreliable sources of income. Two studies found that homelessness was associated with injection drug use initiation before the ages of 16 (Abelson et al. 2006) and 22 (Shushtari et al. 2017). Studies also found that early initiates were more likely to have unstable income sources, such as sex work and drug dealing (Abelson et al. 2006; Miller et al. 2006), as well as lower socioeconomic statuses (Shushtari et al. 2017).

Prior drug use

Prior drug use, including age of first illicit drug use, patterns of drug use, and type of drug consumed, were associated with the age at which an individual begins to inject drugs. Two studies found that early injection drug initiates were younger at the time of their first use of an illicit substance (Arreola et al. 2014; Shushtari et al. 2017). Specifically, Shushtari et al. (2017) found that individuals who initiated injection drug use before 22 years old were more likely to have started non-injection illicit drug use before the age of 20. In addition, they transitioned from non-injection drug use to injection drug use more quickly (Abelson et al. 2006; Arreola et al. 2014). Despite this quicker transition for early initiates, individuals who initiated injection drug use late (i.e. >29 years old) were more likely to have used the drug they were currently injecting prior to injection initiation (Arreola et al. 2014). In agreement with this finding, two studies found an association between later age of initiation and use of non-injection drugs, such as LSD, benzodiazepines, and ecstasy (Abelson et al. 2006) prior to injection drug use initiation (Ompad et al. 2005).

Prior use of specific substances was differentially associated with age of injection initiation. People who initiated injection drug use early were more likely to have used heroin and speedballs (Bluthenthal et al. 2009), exclusively smoked crack, and smoked marijuana prior to injection initiation (Fuller et al. 2001). Early-onset injectors were also more likely to have ever used methamphetamine (Shushtari et al. 2017). However, individuals who initiated injection at or before 21 years old were less likely to have used cocaine prior to injection when compared to individuals who initiated injection after turning 22 years old (Fuller et al. 2001). Despite these relationships between specific prior substances used and age of initiation, no significant differences have been found in the preferences of drugs used between individuals who initiated injection drug use before versus after 30 years old (Arreola et al. 2014).

Familial and socio-structural historical factors

The literature is somewhat divided on the effects of family on age of injection initiation. Two studies found that family effects, particularly childhood trauma due to maternal or paternal substance abuse (Taplin et al. 2014) and familial injection drug use (Abelson et al. 2006), were associated with early-onset injection drug use. Taplin et al. (2014) found that among individuals undergoing opioid dependence therapy, physical neglect was more strongly associated with earlier age of injection compared to other forms of childhood trauma. Despite this evidence indicating that a family history of alcohol and drug use was

associated with childhood trauma (Taplin et al. 2014), Arreola et al. (2014) found no difference in family alcohol and drug use between early and late initiates when age of first injection was dichotomized at 30 years old. However, they did find that early initiates were more likely to have experienced childhood sexual abuse (Arreola et al. 2014). Ompad et al. (2005) additionally found an association between earlier injection drug use initiation and earlier experience of abuse among individuals who have experienced childhood sexual abuse.

In contrast to inconsistent findings related to familial factors, results have consistently indicated an association between prior incarceration (i.e. jail or juvenile detention) and early injection drug use initiation. For example, two studies found that individuals who initiated injection drug use before the ages of 21 (Fuller et al. 2005) and 16 years old (Miller et al. 2006) were more likely to have ever been imprisoned than late initiates. One study also found in a sample of street-involved youth that early initiates (i.e. 17 years old) were more likely to have had a history of being in government care than late initiates (Barker et al. 2017).

Social context

A few studies identified correlates specific to the social context of injection. These studies, despite differences in the age cutoff used to distinguish between “early” and “late” initiation (i.e. 16 versus 29 years old) consistently found that early-onset initiates were more likely to rely on others for assistance with the first injection while late-onset initiates were more likely to self-inject (Abelson et al. 2006; Arreola et al. 2014). While younger individuals were most often assisted by older PWID when initiating injection, older initiates were more likely to be initiated into injection drug use by someone of the same age or younger (Arreola et al. 2014). Overall in terms of social initiation, a study found no difference between early and late initiates in the prevalence of having introduced someone else into injection drug use (Fuller et al. 2005). Additionally, Abelson et al. (2006) found in an Australian sample that several other contextual circumstances were associated with injection at or before the age of 16 years old. Specifically, early initiates were more likely to have first injected with a group of 2 or more individuals (Abelson et al. 2006). They were also less likely to endorse experimentation as a motivation for their first injection and instead were more likely to claim that they injected because it was offered to them (Abelson et al. 2006).

Risk behaviors

Of the studies that looked at risky drug-taking and sexual behaviors, three concluded that individuals who began injection drug use earlier rather than later were more likely to exhibit riskier substance-use behaviors, including recent polydrug use (Arreola et al. 2014; Shushtari et al. 2017), binge drug use (Miller et al. 2006), and high frequency drug use (Arreola et al. 2014). While “early” initiates were riskier in the domain of substance use, they were more likely to take protective measures, albeit measured differently, against the risk of disease transmission early in or prior to their injection trajectories (Fuller et al. 2001, 2005). For instance, Fuller et al. (2005) found that adolescents who initiated injection drug use at age 21 or earlier were less likely to have shared their injection paraphernalia with others during their first year of injection compared to late initiates. Moreover, adolescent

initiates were more likely to report condom usage prior to injection drug use onset (Fuller et al. 2001). However, despite these early protective measures, two studies found that a younger age of injection drug use initiation was associated with receptive needle sharing (Novelli et al 2005; Parviz et al. 2006). Moreover, early initiates were more likely than late initiates to have experienced their sexual debut before the age of 14 (Fuller et al. 2005).

Health outcomes

Eight studies assessed differences in health outcomes between early and late injection initiates, primarily focusing on injection-associated infectious diseases, such as HIV and HCV. An Iranian study found that early-onset initiates were more likely to self-report having HIV (Shushtari et al. 2017). Being 17 years old or younger (Uusküla et al. 2010) or 23 years old or younger (Vicknasingam, Narayanan, and Navaratnam 2009) at the time of first injection was also shown to be associated with a greater likelihood of testing positive for HIV. In addition, a study conducted in Canada found that early initiates were more likely to be infected with both HIV and HCV (Miller et al. 2006). On the other hand, several published reports did not find differences in these health outcomes among individuals who initiated injection drug use early versus late. Specifically, a study conducted in Afghanistan did not find differences in HCV risk among three age cohorts (Bautista et al. 2010), two Californian studies did not find differences in HIV risk (Arreola et al. 2014; Bluthenthal et al. 2015), and studies conducted in urban California and Baltimore did not find differences in HIV prevalence (Fuller et al. 2005; Arreola et al. 2014) between early and late initiates.

The studies that dichotomized age of first injection at 22 were inconsistent with respect to discrepancies in prevalence of infectious disease between early and late initiates. One of these studies found a higher likelihood of disease among early initiates (Shushtari et al. 2017) while the other found no difference in prevalence between early and late initiates (Bautista et al. 2010), though they respectively assessed HIV and HCV. Nevertheless, the two studies that dichotomized age of first injection at 29 were consistent regarding the finding that no differences in HIV risk existed between early and late injection initiates (Bluthenthal et al. 2009; Arreola et al. 2014).

DISCUSSION

Though most of the studies included in this review defined the age ranges for “early” and “late” injection drug initiation differently, some consistent correlates of age of first injection were identified. Early initiators were more likely to have experienced childhood trauma (Abelson et al. 2006; Taplin et al. 2014; Ompad et al. 2005), to have relied on others for assistance during their first injection (Abelson et al. 2006; Arreola et al. 2014), and were younger at the time of their first use of an illicit substance (Arreola et al. 2014; Shushtari et al. 2017). There was also evidence that late initiates were more likely to be African American (Fuller et al. 2001, 2005; Bluthenthal et al. 2009; Kral et al. 2009; Arreola et al. 2014; Ompad et al. 2005) and to identify as female (Bluthenthal et al. 2009; Kral et al. 2009; Arreola et al. 2014; Ompad et al. 2005). Post-injection correlates, such as risk behaviors and health outcomes, were also identified. Our synthesis indicates that earlier injection initiation was associated with riskier drug-taking behaviors (Miller et al. 2006; Arreola et al. 2014;

Shushtari et al. 2017) but that there were discrepancies in findings pertaining to differences in prevalence of infectious diseases, such as HIV and HCV, between early- and late-onset injection initiates. These dissimilarities might have arisen due to differential definition of age of first injection, ranging from 16 years old (Abelson et al. 2006) to 29 years old (Miller et al. 2006; Bluthenthal et al. 2009; Arreola et al. 2014)), sample heterogeneity, or other factors.

This review provides insight into the characteristics and behaviors of populations who began injecting drugs at different times in their lives. Given the need for effective strategies to prevent injection initiation (Werb et al. 2013) in light of the evolving opioid-related overdose crisis (Scholl et al. 2018), these data, particularly the demographic and pre-injection historical information, might be useful for the targeted identification of populations at risk of injecting. For example, based on the existing data, efforts to prevent early injection tailored to younger males and White substance users who are surrounded by friends or family who inject drugs may be particularly effective in reducing initiation of injection drug use. Relatedly, efforts to prevent later initiation of drug use may benefit from being tailored toward women and African Americans who are actively using other substances, but not injecting. Additionally, already established prevention interventions, such as “Break the Cycle” (Hunt et al. 1998; Des Jarlais et al. 2019), may become more effective by being informed of the differing ways in which early and late initiates are introduced to injection drug use by PWID.

The literature’s lack of consensus on prevalence and risk of infectious disease among individuals who initiate injection at different ages reveals a need for additional analyses of age of first injection as a continuous variable, a consistent cut-off for dichotomizing age of first injection, or for the consideration of more than two age ranges. For example, expanding upon the analysis conducted by Bautista et al. (2010) to include an additional “middle-aged” group of individuals who initiated injection drug use in their early-to-mid 20s when studying this phenomenon might be necessary to capture a fuller picture. This group might look quite different than both adolescent initiates and individuals who initiated past the age of 29 years old, especially with respect to the factors that influenced them to inject. Thus, the methods of dichotomizing age of first injection found in these studies might obscure critical information pertaining to differences in individuals who initiate injection at different times in their lives.

Several recent studies, not included in this review, have revealed other important determinants of injection drug use initiation. Specifically, due to fluctuations in national drug trends, such as the rise in prescription opiate consumption in the late 2000s, belonging to a particular birth cohort has been shown to be associated with differential rates and pathways of transition from non-injection illicit substance use to injection (Novak et al. 2016; Bluthenthal et al. 2017). For instance, Bluthenthal et al. (2017) found that individuals born in the 1980s or 1990s who came of age during the opiate era experienced a significantly shorter transition to injection drug use than did individuals born in the 1970s. Moreover, in a Californian study, the length of transition time has been shown to vary by drug consumed and, depending on the drug, by the demographic group to which an individual belongs (Bluthenthal et al. 2018). In that study, the time to transition to injection

of methamphetamine was significantly shorter for gay men. Considering the multitude of pathways and dynamic influences that can lead to injection drug use, these generational and drug effects can provide more insight into the context of injection initiation. Frequent appraisal of these findings in conjunction with those specific to age of initiation may be instrumental for successful prevention of injection drug use.

While this review is the first we are aware of to synthesize the literature examining correlates of age of first injection, there are several limitations. In addition to the differing methods of disaggregating age of first injection that compromise the comparability of these studies, the sample populations examined were heterogeneous with respect to location, culture, and community (i.e. urban versus rural) and were selected from convenience samples. Moreover, there was limited investigation of age of first injection in relation to demographic and contextual factors. Several studies either assessed disparate variables entirely or found significant differences between early- versus late-onset of injection drug use with respect to variables that other studies did not report. More work is needed to identify sub-populations who may benefit from targeted prevention and intervention strategies that address injection drug use.

This review identified correlates of age of injection drug use initiation in the literature, which may inform increasingly effective prevention and treatment interventions. Despite the limited research on this topic, these findings are especially important as the opioid-related overdose crisis continues to place mounting pressure on public health in the United States. While treatment programs have been established to help those already impacted by this epidemic, there are growing numbers of individuals initiating injection drug use. Programs that focus on prevention of injection drug use may benefit by considering age of first injection. Prevention programs, so informed, may be well placed to improve public health by preventing a new cohort of individuals from initiating injection drug use and offsetting the related morbidity and mortality of those most at risk.

Acknowledgements:

Matthew McLaughlin's time on this project was supported by the National Institute on Drug Abuse Summer Research Internship Program. Dr. Abigail Batchelder's time on this project was supported by the National Institute on Drug Abuse under Grant K23DA043418.

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Table 1.

Summary Table

Study (Year(s) of Data Collection) Location	Injection Initiation Age Range Disaggregation	Participant Characteristics	Relevant Findings
Abelson et al. (2000–2002) Sydney, Brisbane, and rural new South Wales, Australia	Early: 16 Late: >16	336 participants, 59% male, 100% 16–25 years, Mean age of first injection: 18.5 years, 23% initiated injection drug use at 12–16 years	Early initiation was associated with having family who injected drugs, having left school early, an unreliable source of income, a short pre-injection career, and homelessness.
Arreola et al. (2011–2013) San Francisco and Los Angeles, CA	Early: 29 Late: >29	696 participants, Over 25% female, Mean age at first drug use: 13.7 years (SD: 4.6 years), Mean age of first injection: 22 years (SD: 8.9 years)	Late initiation was associated with being female, African American, having been in treatment prior to injection initiation, initiating illicit drug use at an older age, and being assisted into injection by someone of the same age or younger.
Barker et al. (2005–2014) Vancouver, Canada	Early: 17 Late: >17	581 participants, Median age: 22 years (IQR: 21–24 years), 31% female, 39% initiated injection drug use before the age of 18	Early initiation was associated with a history of government care.
Bautista et al. (2005–2006) Kabul, Afghanistan	Early: 0–22 Middle: 23–28 Late: >28	459 participants, 100% male	Early, middle, and late initiates had the same initial HCV risk.
Bluthenthal et al. (2001–2003)* California, USA	Early: 29 Late: >29	Not provided.	Early initiation was associated with prior heroin or speedball use, being male, and race/ethnicity other than African American.
Fuller et al. (1997–1999) Baltimore, MD	Early: 21 Late: >21	144 participants, Median age: 25 years (15–30 years), 60% female, Median age at first injection: 21 years (10–28 years)	Late initiation was associated with being African American and a lower likelihood of having been arrested as a juvenile; however, African Americans in minority neighborhoods were four times more likely to initiate early than their white counterparts.
Fuller et al. (1997–1999) Baltimore, MD	Early: 21 Late: >21	226 participants, Median age: 25 years (15–30 years), 61% female, Median age at first injection: 23 years (10–30 years)	Early initiation was associated with races other than African American, as well as condom use, lack of cocaine use, and exclusive crack smoking prior to injection initiation.
Kral et al. (1986–2005)* San Francisco, CA	Early: 29 Late: >29	Not provided.	Late initiation was associated with being female, African American, and lesbian/gay.
Miller et al. (1996–2003) Vancouver, Canada	Early: 16 Late: >16	542 participants, 47% female, 100% 29 years, 38% initiated injection drug use at 16 years	Early initiation was associated with being female, a sex worker, binge drug use, having been in juvenile detention or jail, and being infected with HIV and HCV.
Novelli et al. (2000–2002) Baltimore, MD	Age treated as continuous variable.	420 participants, 58.8% male, Median length of time injecting: 2 years	Younger age at first injection was associated with receptive needle sharing.
Ompad et al. (1997–1999) Multiple US cities	Age treated as continuous variable.	2198 participants, 63.3% male, Mean age: 23.7 years (SD: 3.8 years), Mean age at initiation of injection drug use: 19.6 years (SD: 4.2 years)	Earlier age of experience of sexual abuse was associated with an earlier age of injection initiation. Being White was associated with an earlier age of injection initiation than being Hispanic or African American. Identifying as female was associated with a later age of injection initiation. A later age of injection initiation was associated with use of non-injection drugs prior to injection.
Parviz et al. (1996) Karachi, Pakistan	Age treated as continuous variable.	242 participants, 100% male, Median age of first injection: 25 years	Younger age at first injection was associated with receptive needle sharing.

Study (Year(s) of Data Collection) Location	Injection Initiation Age Range Disaggregation	Participant Characteristics	Relevant Findings
Shushdari et al. (2014) <i>Kermanshah, Iran</i>	Early: 22 Late: >22	450 participants, Median age: 28 years (18–68 years), Mean age at first drug use: 21.4 years (SD: 5.6 years), Mean age at first injection: 22.8 years (SD: 8.9 years), Mean duration of injection: 6.0 years (SD: 4.6 years)	Early initiation was associated with drug use at a younger age, polydrug use, methamphetamine use, recent syringe borrowing, recent syringe lending, recent cooker sharing, and injecting two or more times a day.
Taplin et al. (2005–2007) <i>Vancouver and Montreal, Canada</i>	Age treated as continuous variable.	87 participants, Mean age: 38 years, 41% female, 72.9% reported at least one type of moderate to extreme childhood abuse or neglect	Earlier age of first injection was associated with emotional, physical, and sexual abuse, as well as emotional and physical neglect.
Uuskula et al. (2007) <i>Tallinn, Estonia</i>	Early: 17 Late: >17	350 participants, 84% male, Mean age at first injection: 18.7 years (SD: 5.6 years), Mean number of years injecting: 7.9 years (SD: 4.4 years)	Early initiation was associated with being HIV-positive.
Vicknasingam, Narayanan, and Navaratnam (2006–2007) <i>Multiple Malaysian cities</i>	Early: 23 Late: >23	526 participants, 95.2% male, Mean age: 37 years (SD: 8.1 years)	Early initiation was associated with being HIV-positive.

* Published abstract