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HEALTH AND SOCIAL HARMS ASSOCIATED WITH CRYSTAL METHAMPHETAMINE USE AMONG STREET-INVOLVED YOUTH IN A CANADIAN SETTING

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Abstract

Background and objectives—Despite recent increases in crystal methamphetamine use among high-risk populations such as street-involved youth, few prospective studies have examined the health and social outcomes associated with active crystal methamphetamine use.

Methods—We enrolled 1,019 street-involved youth in Vancouver, Canada, in a prospective cohort known as the At-Risk Youth Study (ARYS). Participants were assessed semi-annually and a generalized estimating equation (GEE) logistic regression was used to identify factors independently associated with active crystal methamphetamine use.

Results—Among 1,019 participants recruited into ARYS between 2005 and 2012 the median follow up duration was 17 months, 320 (31.4%) participants were female and 454 (44.6%) had previously used crystal methamphetamine at baseline. In adjusted GEE analyses, active crystal methamphetamine use was independently associated with **Caucasian ethnicity (Adjusted Odds Ratio [AOR] = 1.37; 95% Confidence Interval [CI]: 1.04 – 1.81)**, homelessness (AOR = 1.34; 95% CI: 1.15 – 1.56), injection drug use (AOR = 3.40; 95% CI: 2.76 – 4.19), non-fatal overdose (AOR = 1.46; 95% CI: 1.07 – 2.00), being a victim of violence (AOR = 1.19; 95% CI: 1.02 – 1.38), involvement in sex work (AOR = 1.39; 95% CI: 1.03 – 1.86) and drug dealing (AOR = 1.60; 95% CI: 1.35 – 1.90).

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Discussion and conclusions—Prevalence of crystal methamphetamine use was high in this setting and active use was independently associated with a range of serious health and social harms.

Scientific Significance—Evidence-based strategies to prevent and treat crystal methamphetamine use are urgently needed.

Keywords

crystal methamphetamine; youth; injection drug use; social harm; homelessness

INTRODUCTION

Past studies have shown that illicit drug use is common among street-involved youth^{1–3} and has been associated with a range of health and social harms including spread of infectious diseases, drug overdose, risky sexual practices and confrontations with police.^{4–8} Street-involved youth may be particularly susceptible to the health and social harms of illicit drug use given their marginalized position, low socioeconomic status and poor access to health care services.⁹ In recent years, reports have revealed a high prevalence of crystal methamphetamine use among street-involved youth,¹⁰ mirroring a global trend that puts amphetamine-type stimulants as the second most widely used illicit drug in the world, following cannabis.¹¹ Methamphetamine is manufactured from common, easily obtainable precursor chemicals¹² and is synthesized in small-scale, local “meth labs”. As such, it is widely available and easy to obtain on the street level.¹³

Crystal methamphetamine is a highly potent form of methamphetamine and is more commonly injected than other forms of methamphetamine, resulting in higher addiction potential and blood borne disease transmission.¹⁴ Existing evidence indicates that crystal methamphetamine use may be associated with high-risk sexual and drug use activities, although the majority of this data is from studies of gay men and adult drug users.^{15–23} For example, crystal methamphetamine use has been associated with unprotected anal intercourse in HIV positive men,²⁰ unprotected anal intercourse with casual partners²³ and having multiple sexual partners.^{21, 22} In terms of high-risk drug activities, crystal methamphetamine use has been associated with injection drug use,¹⁰ and syringe borrowing and lending.¹⁵ Other health and social harms associated with crystal methamphetamine use include incarceration, trading sex for money and alcohol and cigarette consumption.^{8, 24}

Despite the recognition of increasing crystal methamphetamine use among young people, few prospective studies have examined health and social outcomes associated with active crystal methamphetamine use in longitudinal analyses. Therefore, we took advantage of a large, longitudinal prospective cohort of street-involved youth to examine the distinct health and social harms associated with active crystal methamphetamine use in this population.

METHODS

The At-Risk Youth Study (ARYS) is a prospective cohort study of Vancouver street-involved youth that has been described in detail previously.²⁵ In brief, snowball sampling

and extensive street-based outreach methods were utilized. Eligibility for the study included age 14 to 26 years at baseline, use of illicit drugs other than marijuana in the past 30 days, and street-involved, defined as being absolutely or temporarily without stable housing, or having accessed street-based youth services in past six months. Similar conditions have previously been used to define street-involvement among youth^{26, 27}. At baseline and every six months thereafter, participants completed an interviewer-administered questionnaire pertaining to socio-demographic information, sex- and drug-related risk behaviors including specific drugs used and modes of use. At every visit, participants also provided blood samples in order to ascertain HIV and hepatitis C (HCV) infection status and received \$20 CAD as remuneration. ARYS was ethically approved by the Research Ethics Board of the University of British Columbia. For the present analyses, all individuals who were recruited between September 2005 and May 2012 were included.

In order to address the present study's aims, we compared those youth who reported using crystal methamphetamine in the past six months to those who did not (ie. past users or never users). Covariates were selected *a priori* based on their known or hypothesized relationship with the primary outcome. Demographic variables considered as potentially associated with active crystal methamphetamine use included gender (female vs. male) and ethnicity (Caucasian vs. other). Social and behavior variables included homelessness (yes vs. no); injection drug use (yes vs. no); daily marijuana use (yes vs. no); cocaine use (yes vs. no); crack cocaine smoking (yes vs. no); heroin use (yes vs. no); requiring help injecting (yes vs. no); borrowing or sharing syringes (yes vs. no); any injection of drugs in public (yes vs. no); unsafe sex (defined as vaginal or anal penetration without a condom (yes vs. no)); being a victim of violence (yes vs. no); having a police encounter (defined as having been stopped, searched or detained by police (yes vs. no)); incarceration (defined as being in detention, prison, or jail overnight or longer (yes vs. no)); involvement in sex work (defined as exchanging sex for money, gifts, food, shelter, clothes, drugs or other (yes vs. no)); and drug dealing (yes vs. no). All social and behavioural variables refer to the six-month period prior to the interview. Health-related variables included non-fatal overdose in the past six months (yes vs. no), hepatitis C positivity (yes vs. no) and HIV positivity (yes vs. no). All variable definitions have been used extensively and were identical to earlier publications.^{28,29}

Although no explicit inclusion criterion required that youth spend a minimum amount of time on the street or actually live on the street to qualify for the study, in practice, the street-based recruitment produced a sample of youth who spent extensive time on the street, a large proportion of whom were homeless (defined as having no secure place to sleep). Still, because our study lacked an explicit requirement that youth live on the street, we use throughout the present manuscript the term "street-involved youth" rather than "street youth", since the latter of these terms is generally applied to youth known to live full-time or part-time on the street.

Initially, we compared covariates of interest at baseline stratified by baseline crystal methamphetamine use in the past six months using Pearson's Chi-square test (dichotomous variables) and the Wilcoxon rank test (continuous variables). Then, since serial measures for cohort participants were available, variables potentially associated with active crystal methamphetamine use during each follow-up were evaluated using generalized estimating

equations (GEE) with logit link for binary outcomes. This enabled us to examine variables associated with reporting crystal methamphetamine use during the entire study period.

As a first step, bivariate GEE analyses were used to determine potential factors associated with active crystal methamphetamine use. We then fit a multivariate model where all variables that had a p value ≤ 0.10 in GEE bivariate analyses were considered in a full model. Variable selection for the final model was done using the Quasilikelihood under the Independence model Criterion (QIC) statistic with a backward model selection procedure.³⁰ All possible combinations of candidate variables were screened to identify the model with the best overall fit as indicated by the lowest QIC value. These methods provide standard errors adjusted by multiple observations per person using an exchangeable correlation structure. Therefore, data from every participant follow-up visit was considered in this analysis. This approach serves to examine behaviors and characteristics that correlated with times when a participant used crystal methamphetamine within individuals and between individuals. All statistical analyses were performed using SAS software version 9.3 (SAS, Cary, NC, USA). All p -values are two sided.

RESULTS

Between September 2005 and May 2012, 1,019 street youth were recruited into the ARYS cohort. Among these individuals, the median age was 22 (inter-quartile range [IQR]: 20 – 24), 320 (31.4%) were female, and 686 (67.3%) were Caucasian. This sample contributed a total of 3347 observations. The median follow up duration was 17 months.

Among the 1,019 participants recruited into ARYS, 704 (69.0%) reported a history of crystal methamphetamine use at baseline and 454 (44.5%) reported using crystal methamphetamine in the 6 months prior to baseline interview. As shown in Table 1, socio-demographic and behavioural characteristics associated with prior use of crystal methamphetamine at baseline included: Caucasian ethnicity, homelessness, drug injecting, crack cocaine smoking, heroin use, non-fatal overdose, requiring help injecting, syringe sharing, public injection, hepatitis C positivity, police encounters, involvement in sex work, and drug dealing (all $p < 0.05$). Gender, daily marijuana use, cocaine use, HIV positivity, unsafe sex, being a victim of violence and incarceration were not associated with prior crystal methamphetamine use.

Over the study period, 38.6% ($n=1292$) of observations included a report of active crystal methamphetamine use. Among 205 individuals who had not reported crystal methamphetamine use at baseline and had at least one follow up visit, 46 (22.4%) reported crystal methamphetamine use at some point during follow-up for an incidence density of 12.2 per 100 person-years. As there was heterogeneity in the number and times of follow-up visits, it was not possible to categorize participants as steady or short-term users of crystal methamphetamine.

The results of the bivariate and multivariate GEE analyses are presented in Table 2. In the multivariate GEE model, factors that were independently associated with active crystal methamphetamine use included: Caucasian ethnicity (Adjusted Odds Ratio [AOR] = 1.37

[95% Confidence Interval [CI]: 1.04 – 1.81]); homelessness (AOR = 1.34 [95% CI: 1.15 – 1.56]); injection drug use (AOR = 3.40 [95% CI: 2.76 – 4.19]); non-fatal overdose (AOR = 1.46 [95% CI: 1.07 – 2.00]); being a victim of violence (AOR = 1.19 [95% CI: 1.02 – 1.38]); involvement in sex work (AOR = 1.39 [95% CI: 1.03 – 1.86]); and drug dealing (AOR = 1.60 [95% CI: 1.35 – 1.90]).

DISCUSSION

In the present study, we found a high prevalence of crystal methamphetamine use among street-involved youth upon recruitment into the study and found that Caucasian ethnicity, homelessness, injection drug use, non-fatal overdoses, being a victim of violence, involvement in sex work and drug dealing were independently associated with active crystal methamphetamine use over study follow-up. In our study, 69% of participants reported a prior history of crystal methamphetamine use. This is much higher than the 6.6% reported in non-injection drug using Canadian street youth,³¹ or the 2.8% reported in a large, cross-sectional analysis of American youth.³²

To our knowledge, this is the first study to show prospectively that active crystal methamphetamine use is associated with injection drug use in street-involved youth. Given the known harms of injection drug use, this finding has important public health implications. As the popularity of crystal methamphetamine use has increased worldwide,^{11,33} the association with injection drug use has important implications for infectious disease transmission and efforts to prevent initiation in to injecting.³⁴ As people who inject methamphetamine are more likely to engage in risky injection practices than users of other injection drugs,³⁵ the risk of disease transmission is even more concerning. Although several safer injecting programs exist in the study locale (Vancouver, Canada) resulting in decreasing rates of HCV and HIV in injection drug users,³⁶ global coverage of recommended HIV prevention interventions for drug users remains low.¹⁴ In a previous analysis, our study population was found to have high rates of injection drug use with 41.1% of participants reporting previous use.²⁹ This is similar to a study of street youth in Montreal in which 44% of participants had a history of injection drug use,³⁷ but slightly more than the 28% prevalence of injection drug users in a cohort of Los Angeles based street-involved youth.⁸ It is likely that these populations represent groups of youth who participate in high-risk activities including illicit drug use.

To our knowledge, this is also the first study to show longitudinally that homelessness is associated with active crystal methamphetamine use in street-involved youth after adjustment for a range of confounders, including other drug use patterns. One possible link between homelessness and active crystal methamphetamine use is that street-involved youth use the drug in part to stay alert while sleeping on the street.³⁸ Our findings are similar to a longitudinal analysis of adult injection drug users, which found that homelessness was associated with initiating methamphetamine injection.³⁹ As well, Coady et al. found in cross sectional analysis that at least daily methamphetamine use was associated with homelessness.⁴⁰ Future research should seek to unpack the relationship between active crystal methamphetamine use and homelessness to determine the whether active crystal

methamphetamine use results in instability that leads to homelessness or whether crystal methamphetamine is simply a drug of choice among homeless individuals.

In addition, the present study found that active use of crystal methamphetamine was associated with a range of other health and social harms including non-fatal overdose, being a victim of violence, involvement in sex work and drug dealing. Together these findings are consistent with studies of methamphetamine use in other populations,⁴¹ and point to a very broad set of risks associated with active crystal methamphetamine use. These findings highlight the urgent need to identify prevention and treatment strategies that seek to reduce crystal methamphetamine use, as well as participation in high-risk activities among crystal methamphetamine users.⁴² Importantly, studies have shown that criminal justice measures aimed at reducing methamphetamine use have been largely ineffective and financially costly.^{13,42} These findings suggest that public health and addiction treatment measures to compliment law enforcement efforts are required.

This study has several limitations. As there are no voters' lists or other registries from which to draw a random sample, caution is required when interpreting our results to other populations of street youth. However, it is noteworthy that the cohort demographics are similar to other local and international studies of street-involved youth.^{6,43} Second, there is a concern of socially desirable responding in studies of marginalized populations.⁴⁴ With respect to this concern, we know of no reason why risk behaviors would be differentially reported between crystal methamphetamine users and non-users. Nevertheless, although confidentiality is assured as part of the interview and interviewers are trained to build trust and rapport with the participants it is possible we underestimated some behaviors in the present study.

Since this is an observational study, there is always the potential for residual confounding. For instance, youth using crystal methamphetamine may carry other personal characteristics (e.g. mental health concerns) or genetic predisposition to high intensity drug use, neither of which were measured in the present study. Nevertheless, our study clearly demonstrates health and social harms associated with crystal methamphetamine use.

While our analyses explored correlates of crystal methamphetamine use and many participants transitioned in and out of using crystal methamphetamine during the study period, our analyses did not specifically explore potential health benefits of reducing or eliminating crystal methamphetamine use or specific health concerns experienced when crystal methamphetamine use is first initiated. Future studies should explore these issues and, in particular, the role of crystal methamphetamine treatment in reducing the harms of crystal methamphetamine use.

In summary, the present study found a high prevalence of active crystal methamphetamine use among street-involved youth and that this behavior measured longitudinally was associated with Caucasian ethnicity, homelessness, injection drug use, non-fatal overdoses, being a victim of violence, involvement in sex work and drug dealing. These findings highlight the urgent need for novel evidence-based prevention and treatment initiatives for crystal methamphetamine use.

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TABLE 1

Characteristics of street-involved youth at baseline stratified by crystal methamphetamine use in the six months prior to baseline

Characteristic	Total (%) (n = 1019)	Crystal methamphetamine use		p-value
		No (%) (n = 565)	Yes (%) (n = 454)	
Female	320 (31.4)	173 (30.6)	147 (32.4)	0.528
Caucasian	686 (67.3)	350 (62.0)	336 (74.0)	<0.001
Homelessness [†]	743 (72.9)	391 (69.2)	352 (77.5)	0.002
Injection drug use	299 (29.3)	101 (17.9)	198 (43.6)	<0.001
Daily marijuana use	496 (48.7)	275 (48.7)	221 (48.7)	0.848
Cocaine use	502 (49.3)	283 (50.1)	219 (48.2)	0.484
Crack cocaine smoking	603 (59.2)	303 (53.6)	300 (66.1)	<0.001
Heroin use	345 (33.9)	142 (25.1)	203 (44.7)	<0.001
Non-fatal overdose	112 (11.0)	45 (8.0)	67 (14.8)	<0.001
Requiring help injecting	94 (9.2)	32 (5.7)	62 (13.7)	<0.001
Syringe sharing	83 (8.2)	28 (5.0)	55 (12.1)	<0.001
Public injection	223 (21.9)	73 (12.9)	150 (33.0)	<0.001
Hepatitis C positive	104 (10.2)	46 (8.1)	58 (12.8)	0.017
HIV positive	10 (0.98)	6 (1.1)	4 (0.88)	1.000
Unsafe sex	567 (55.6)	304 (53.8)	263 (57.9)	0.292
Victim of violence	454 (44.6)	243 (43.0)	211 (46.5)	0.344
Police encounter	346 (34.0)	173 (30.6)	173 (38.1)	0.013
Incarceration	189 (18.6)	106 (18.8)	83 (18.3)	0.776
Sex work	101 (9.91)	43 (7.6)	58 (12.8)	0.006
Drug dealing	538 (52.8)	275 (48.7)	263 (57.9)	0.003

[†] All behavioral variables refer to activities during the past six months.

There are no missing data points.

Table 2

Bivariate and multivariate GEE analysis of factors associated with crystal methamphetamine use in a cohort of street-involved youth (n=1091)

Characteristic	Unadjusted		Adjusted	
	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
Female				
(yes vs. no)	0.90 (0.71 – 1.13)	0.367		
Caucasian				
(yes vs. no)	1.54 (1.20 – 1.96)	0.001	1.37 (1.04 – 1.81)	0.026
Homelessness[†]				
(yes vs. no)	1.47 (1.29 – 1.68)	<0.001	1.34 (1.15 – 1.56)	<0.001
Injection drug use				
(yes vs. no)	3.60 (2.99 – 4.33)	<0.001	3.40 (2.76 – 4.19)	<0.001
Daily marijuana use				
(yes vs. no)	1.08 (0.93 – 1.26)	0.289		
Cocaine use				
(yes vs. no)	1.31 (1.14 – 1.50)	0.001		
Crack cocaine smoking				
(yes vs. no)	1.51 (1.29 – 1.76)	<0.001		
Heroin use				
(yes vs. no)	2.10 (1.76 – 2.50)	<0.001		
Non-fatal overdose				
(yes vs. no)	1.94 (1.53 – 2.45)	<0.001	1.46 (1.07 – 2.00)	0.017
Requiring help injecting				
(yes vs. no)	2.38 (1.89 – 3.00)	<0.001		
Syringe sharing				
(yes vs. no)	2.25 (1.69 – 3.00)	<0.001		
Public injection				
(yes vs. no)	2.30 (1.89 – 2.80)	<0.001		
Hepatitis C positive				
(yes vs. no)	1.17 (0.91 – 1.50)	0.219		
HIV positive				
(yes vs. no)	0.99 (0.35 – 2.78)	0.981		
Unsafe sex				
(yes vs. no)	1.20 (1.06 – 1.37)	0.006	1.13 (0.96 – 1.33)	0.140
Victim of violence				
(yes vs. no)	1.31 (1.15 – 1.48)	<0.001	1.19 (1.02 – 1.38)	0.022
Police encounter				
(yes vs. no)	1.41 (1.24 – 1.62)	<0.001		
Incarceration				
(yes vs. no)	1.17 (1.00 – 1.37)	0.048		

Characteristic	Unadjusted		Adjusted	
	Odds Ratio (95% CI)	<i>p</i> -value	Odds Ratio (95% CI)	<i>p</i> -value
Sex work				
(yes vs. no)	1.87 (1.45 – 2.41)	<0.001	1.39 (1.03 – 1.86)	0.030
Drug dealing				
(yes vs. no)	1.89 (1.65 – 1.17)	<0.001	1.60 (1.35 – 1.90)	<0.001

[†]All behavioral variables refer to activities during the past six months.