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Crack across Canada: comparing crack users and crack non-users in a Canadian multi-city cohort of illicit opioid users

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ABSTRACT

Aims To examine possible differences between crack users and crack non-users across Canada. **Design** Cohort study of illicit opioid and other drug users in five cities across Canada. **Setting** Vancouver, Edmonton, Toronto, Montreal and Quebec City, Canada. **Participants** Regular illicit opioid and other street drug users not in treatment at time of assessment. **Measurements** Participants ($n = 677$) were assessed at baseline (2002) by way of an interviewer-administered questionnaire, a psychiatric diagnostic instrument (Composite International Diagnostic Interview), and salivary antibody tests for infectious disease. **Findings** Approximately half the sample had used crack in the past 30 days, although prevalence rates differed strongly between study sites. When examined by discriminant analysis, crack users in the study population were more likely to have: no permanent housing, have illegal and sex work income, indicate physical health problems and hepatitis C virus (HCV) antibodies, use walk-in clinics, use heroin and to have been arrested and in detention (in past year). They were less likely to report depressive symptoms, and use Dilaudid (hydromorphone) and alcohol. **Conclusion** These results illustrate crack users' pronounced social marginalization (as expressed by homelessness and high involvement in illegal activities) as well as extensive health problems compared to non-crack users in the Canadian context. The development of targeted interventions—addressing the dynamics of social marginalization—of this population is urgently needed.

Keywords Canada, crack use, marginalized populations, prevention, public health, social determinants.

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INTRODUCTION

In Canada, illicit street drug use is associated with extensive harms and costs, including elevated levels of mortality (overdose), morbidity [infectious diseases including human immunodeficiency virus (HIV) and hepatitis C virus (HCV)], crime and social costs [1–3]. While predominant research attention has been given to Canada's estimated 125 000 injection drug user (IDU) population over the past decades, evidence suggests that (oral) crack use has become increasingly prevalent among street drug users. Research evidence suggests that crack users are characterized by distinct risks, problems and harms [4,5]. About half the sample of a Canadian multi-site cohort of illicit opioid and other drug users (OPICAN study) reported crack use at baseline, providing a unique opportunity to compare these to crack non-users in the sample. Hence, the aim of this paper is to examine potential differences between crack users and non-users in the OPICAN sample, and thus add a uniquely Canadian perspective on the existing international literature suggesting that crack users in many jurisdictions are characterized by increased social, health and drug use-related risks.

BACKGROUND

Crack use in Canada

Crack use appears to have become increasingly prevalent among street drug users in Canada. A recent survey of

IDUs in Toronto, Regina, Sudbury and Victoria indicated that 52.2% of the total sample had used crack (non-injection, i.e. smoking) in the last 6 months; in Toronto specifically ($n = 221$), more than three-quarters (78.7%) of those surveyed had smoked crack [6]. A study among needle exchange programme (NEP) attendees in Toronto [7] revealed that about four in five (83%) had used crack in the 6 months prior to the study, documenting a substantive increase from the early 1990s [8]. In the Vancouver VIDUS (Vancouver Injection Drug User Study) cohort, crack use had risen from 35% to 55% between 1998 and 2000 alone [9]. Additionally, anecdotal accounts from front-line service providers suggest that crack has become a highly prevalent drug among street drug users in several Canadian cities, causing challenges for interventions [10].

Crack use: distinct risks and harms

Numerous studies have found associations between crack use and various risk or harm characteristics, either in comparison to the general population or to other (non-crack) drug user populations. These characteristics relate predominantly to infectious diseases, sex and health risks, criminal activity, social determinants and marginalization (e.g. social and health service access), and are reviewed briefly below.

Crack smoking has been associated as a risk factor with infectious disease status, including HIV [11–13], but also HCV infection [14,15], among street drug user populations. HIV positivity status was associated with the use of crack, along with other factors, in a sample of 551 IDUs recruited from NEPs in Ontario [16]. Crack cocaine use in a Montreal sample of 437 street youths (controlling for IDU) was shown to be associated with HCV infection [17]. Involvement in crack use (even in the context of polydrug use) has also been found to be associated with increased levels of sexually transmitted infections (STIs) [18,19], as well as elevated levels of pulmonary infections [20], including tuberculosis [21].

Crack users have been shown to display particularly important health risk behaviours. For example, crack/cocaine use has been linked to having multiple sex partners, high-risk sexual behaviours [22,23] and exchanging sex for money or drugs [18,24,25]; these sexual risk behaviours in crack smokers in turn have been shown to be associated with HIV infection, including sexual transmission [19,26,27], and may be particularly critical for women crack users [28]. In a large study of illicit drug users in 22 US cities (28% IDUs only, 42% crack smoking only, 30% both) both groups including crack smokers, were more likely than only IDUs to report multiple sex partners and the exchanging of sex for money or other benefits [29]. Seaman *et al*. found similar results in a sample of out-of-treatment IDUs including crack and non-crack users, where the former had higher levels of sexual risk behaviours [30].

Other health risks among crack smokers are related directly to drug use practices. For example, many crack smokers continue to use glass pipes after they are cracked or broken, and/or use metal implements leading to cuts or burns in the oral cavity [31]. These mouth injuries may be pathways for infectious disease transmission—especially HCV—in crack smokers [13]. Another US study found that crack co-using individuals (compared to crack non-users) in a network sample of IDUs were more likely to engage in HIV risk behaviours (including needle sharing) [32]. Crack use has also been suggested to be a predictor of IDU initiation in a sample of street youth [33].

In addition to distinct risk behaviour characteristics, crack users have been subjected to conditions of pronounced social marginalization and disadvantage, even more so than other illicit drug users. Many crack users live in situations of extreme poverty, deprivation and housing instability [34,35]. The majority of a small sample of female crack users in Toronto were found to be living in unstable housing conditions [36]. Among 602 African American street drug users or sellers in Harlem, frequent crack users were less likely to hold any employment and to receive any social support income [37].

While many street drug users are involved in crime for income generation [23,38], the level of criminal involvement among crack users is particularly pronounced. Cross *et al*. reported that crack users—compared with non-crack users—were more likely to be involved in illegal activities, specifically property crime, as well as marginalized in the drug distribution economy [37]. Another US study found that street-involved crack users, compared to heroin users, indicated the highest level of criminal activities, particularly in the form of drug dealing [39]. Among polydrug users at treatment entry in London, UK, crack users reported the highest levels of criminal activity and drug expenditure [40]. Several US criminal justice and treatment samples found that prior crack/cocaine use before arrest significantly predicted a multiple history of previous arrests [41,42].

Crack users also often face disproportionate access barriers to social or health services, and thus lack key resources to protect their health [43–45]. A review of 33 studies of intervention programmes for street drug users in the United States indicated that only 21% recruited crack users (94% recruited IDUs), further illustrating the focal bias of interventions in favour of IDUs [46]. Both targeted prevention (e.g. analogous to NEPs for IDUs) and treatment (e.g. analogous to maintenance treatment for opioid users) specifically for crack users are generally non-existent [47,48]. Recent, sporadic exceptions are

initiatives for 'safer crack use kits' distribution occurring in some Canadian cities, which provide crack users with paraphernalia for 'safer crack use'; however, these initiatives are limited in reach and support, and their efficacy is unproven [10].

METHODS

Sample and design

Our analyses were performed on baseline data from the OPICAN cohort [49], a multi-site cohort study of regular illicit opioid and other drug users not in treatment at point of recruitment in the cities of Vancouver, Edmonton, Toronto, Montreal and Quebec City. The OPICAN study was established as part of an Interdisciplinary Health Research Team (IHRT) focusing on illicit opioid use epidemiology and treatment in Canada. Study participants were recruited locally by community-supported outreach and snowball methods, meaning that study recruitment posters and handouts were disseminated by research staff, community partners and drug users' peers among known street drug users. Study applicants called a toll-free study telephone line, undergoing a brief telephone screener to determine eligibility. If successful, they were invited for an anonymous assessment consisting of an interviewer-assisted questionnaire, a standardized depression instrument [Composite International Diagnostic Interview—Short Form (CIDI-SF)] and saliva antibody tests for HIV and HCV. Participants provided informed written consent and received an honorarium of $20. The study protocol was approved by local Research Ethics Boards (for detailed methods see [49]).

Baseline data reported in this paper were collected in 2002, with a base sample of $n = 677$. Due to the elimination of four subjects with indeterminate sex, and the listwise deletion of cases ($n = 46$) with missing data for variables examined, the analysis sample was reduced to $n = 627$. Missing data appeared to be scattered randomly throughout variables examined, with the exception of sex. Systematic comparisons of the deleted cases with the remaining analysis sample revealed no significant differences with respect to sex, age and crack use. The analysis sample varied only for HIV/HCV salivary antibody data, as this variable could not be collected in one site (Edmonton) due to ethical constraints. The analysis sample was divided into 'crack users' ($n = 344$) and 'crack non-users' ($n = 283$) on the basis of participants' responses to the dichotomous questionnaire item on 'crack use' (in last 30 days).

Statistical analysis

Bivariate analyses were performed to determine factors associated with oral crack use among the study sample. The socio-demographic, health and criminal justice characteristics analysed were age, sex, permanent housing (i.e. not transitional or homeless), legal sources of income (paid work), illegal sources of income (sex work, drug dealing, other criminal activities), physical health problems, depression (CIDI) HIV (antibody), HCV (antibody), having a criminal record, arrests and detention (both yes/no and in the last 12 months). Health service utilization (emergency room, walk-in clinic, regular doctor) and the use of other drugs [heroin, Dilaudid (hydromorphone), Tylenol 3 or 4 (codeine), cocaine and Valium (benzodiazepine)] in the last 30 days were also analysed. Bivariate associations for categorical variables and crack use were analysed using Pearson's χ^2 test; continuous variables were analysed using independent sample *t*-tests and analyses of variance (ANOVAs). All variables were considered statistically significant at the $P < 0.05$ level; however, marginally significant associations were also included as potential predictors in the stepwise multivariate model. Discriminant analysis was used to classify cases into the values of a categorical dependent, usually a dichotomy. In our example, it served mainly to assess the relative importance of the independent variables in classifying crack versus crack non-users, and to discard variables which show little relation to group distinctions. A sensitivity analysis was conducted with exclusion of site as predictor to test the stability of the solution. Analyses were conducted using SAS/STAT software, version 9.1 [50].

RESULTS

Table 1 provides an overview of the prevalance of crack use in the study cohort by city site (i.e. the proportion of crack users and number of crack use days by users). Vancouver is home to the largest proportion of crack users compared to other study sites. Overall, the vast majority (93.9%; data not shown) of study participants who were identified as crack users reported crack use by way of 'smoking' (i.e. oral administration).

Tables 2 and 3 provide the analyses of bivariate associations of key indicators with crack use for the total sample. Crack users (all in comparison to non-crack users) were slightly older on average (35.6 versus 34.0 years of age), less likely to be permanently housed (34.0% versus 58.0%) and had no paid work in the last 30 days (15.4% versus 26.1%). However, crack users were more likely to report illegal activities for income (including sex work, drug dealing and other criminal income). Crack users reported a higher prevalence of physical health problems (78.2% versus 64.7%) and HCV (56.4% versus 46.6%), but were less likely to indicate depressive symptoms (43.7% versus 51.2%). Crack smokers also featured differences in drugs used in the last

Table 1 Prevalence of crack use (last 30 days) in sample (n = 627) by city.*

Variable	*Edmonton*	*Montreal*	*Quebec City*	*Toronto*	*Vancouver*
Crack users (last 30 days) % (n)†	66.7 (62)	26.1 (37)	3.6 (3)	66.7 (80)	86.2 (162)
Mean number of days of crack use (SD)‡††	9.7 (9.2)	8.1 (9.2)	2.0 (1.0)	14.2 (11.0)	24.3 (9.4)

*Based on self-report.
†Prevalence of crack use differs significantly among all cities.
‡For those reporting crack use (n = 344).
††Vancouver is significantly higher in number of days of crack use from all other cities; Toronto is different from Montreal (Bonferonni test for multiple comparisons).

30 days; specifically, they were more likely to have used heroin and Tylenol 3 or 4 as well as benzodiazepines; they were less likely to have used hydromorphone and had a lower number of alcohol-use days in the last 30 days. Regarding health services utilization, crack users were more likely to have used walk-in clinics (53.5% versus 41.7%). Finally, crack users indicated a higher prevalence of arrests (59.6% versus 39.6%), with arrests for both drug offences and property offences more common in this group, and criminal detention (51.3% versus 31.9%) in the past year.

Table 4 presents the discriminant analysis model fit summary statistics (adjusted for age). The partial *R*-square shows that overall, among the cities, Quebec City and Montreal (with reference to Vancouver) accounted for the most variance explained between crack users and crack non-users (0.17 and 0.20, respectively); for non-demographic indicators, drug dealing and sex work accounted for a substantial portion of the variance (0.05 and 0.05, respectively), followed by arrest, the site variables of Edmonton and Toronto and unstable housing. Sex did not discriminate between the two groups; however, age did discriminate, and was thus retained in the model for adjustment. The average squared canonical correlation (ASCC) shows the degree of increase in the overall trend as further indicators were added to the model (see Table 4 for order). These indicators were all significant at the $P < 0.0001$ level (using the Wilks's lambda statistic); ASCC values were significant at the same level. In order to assess the stability of the solution and the degree to which it depended on inclusion of site variables, a stepwise discriminant analysis was conducted excluding site variables for sensitivity purposes. Results yielded the same predictor variables as the model including site variables: drug dealing income, sex work income, arrests and permanent housing (data not shown). In addition, the inclusion of the 'physical health problem' variable proved significant, albeit explaining only 1% of the variance. The results of the sensitivity analysis thus indicated that the inclusion of site variables did not bias unduly the results of the discriminant analysis.

Table 5 indicates the external validity of the discriminant model, i.e. to what degree the solution fits the sample examined. This cross-validation shows that of the subjects in the sample that were originally crack users, 16.6% were misclassified as non-crack users, whereas of the subjects that were originally crack non-users, 27.6% were misclassified as users. This results in an overall accuracy rate of 78.5% for the discriminant analysis model, considered good.

DISCUSSION

The use of crack has become increasingly prevalent among Canadian street drug users, as well as those in some other jurisdictions (e.g. some European cities, see [51]). Our study examined the specific characteristics of current crack users in a Canadian multi-site cohort of illicit opioid and other drug users (OPICAN) by comparing them to crack non-users in this sample.

Our study presented several interesting and important results. First, we found that the prevalence of crack use varies greatly between study sites within Canada. While the vast majority of cohort participants in Vancouver were crack-use involved, only about half of the Edmonton and Toronto samples were crack users, with even smaller minorities in Montreal and Quebec City. Thus, the prevalence of crack use in Canadian street drug use cultures must be considered a locally contingent phenomenon—as confirmed by other recent multi-site street drug user studies—although there are no obvious explanations for these stark prevalence differentials. Elsewhere we have suggested that these are driven probably by dynamics of local drug cultures or markets, which in themselves do not follow a clear-cut logic [49]. Similarly, there has been great difficulty in other jurisdictions to explain why crack is highly prevalent in some urban drug scenes, but not in others [52,53]. Clearly, this question requires more systematic inquiry into drug cultures and markets with appropriate (e.g. ethnographic) methods.

Besides the importance of local dynamics predicting crack use in our study population, our analyses demonstrated that crack users differed substantially from

Table 2 Comparison of crack users and crack non-users on select variables† in total sample (n = 627).

	Crack users (n = 344)	*Crack non-users (n = 283)*			
Variable	*% (n)*	*% (n)*	*F Statistic/t-square*	*Chi-square Statistic*	*Exact P value*
Demographics					
Mean age (SD)*	35.6 (9.0)	34.0 (9.5)	4.8	–	0.030
Permanent housing***	34.0 (117)	58.0 (164)	–	36.0	0.000
Sex (% male)	64.5 (222)	68.2 (193)	–	0.9	0.335
Income (last 30 days)					
Paid work***	15.4 (53)	26.1 (74)	–	11.1	0.001
Social assistance/welfare or disability	61.0 (210)	59.0 (167)	–	0.3	0.604
Sex work***	27.3 (94)	13.8 (39)	–	17.0	0.000
Drug dealing income***	39.0 (134)	12.0 (34)	–	57.4	0.000
Other criminal income	18.9 (65)	13.4 (38)	–	3.4	0.066
Health					
Physical health problem***	78.2 (269)	64.7 (183)	–	14.1	0.000
Depression‡***	43.7 (149)	51.2 (144)	–	17.8	0.000
HIV Positive†† (n = 538)	17.7 (47)	13.0 (32)	–	2.2	0.335
HCV positive†† (n = 495)*	56.4 (150)	46.6 (115)	–	6.7	0.036
Service utilization (last 6 months)					
Emergency room	48.0 (165)	49.8 (141)	–	0.2	0.643
Walk-in clinic***	53.5 (184)	41.7 (118)	–	8.6	0.003
Regular doctor	51.9 (161)	58.0 (164)	–	2.3	0.130

*$P < 0.05$, ***$P < 0.001$.
†Self-report unless otherwise stated.
‡Based on CIDI-SF.
††Based on saliva antibody test.

Table 3 Comparison of crack users and crack non-users on select variables in total sample (n = 627).

Variable	*Crack users (n = 344)* % (n)	*Crack non-users (n = 283)* % (n)	*F Statistic*	*Chi-square Statistic*	*Exact P value*
Infectious disease risks					
Ever injected	100.0 (344)	100.0 (283)	–	n/a	n/a
Inject (last 30 days)	85.5 (294)	86.2 (244)	–	0.1	0.788
Unprotected sex (last 30 days)*	51.6 (177)	59.9 (169)	–	4.3	0.037
Drug use (last 30 days)†					
Alcohol	64.0 (220)	66.1 (187)	–	0.3	0.579
Mean # of days used (SD)***	9.2 (10.0)	12.2 (10.8)	8.4	–	0.004
Cocaine	53.5 (184)	58.0 (164)	–	1.3	0.263
Mean # of days used (SD)	12.3 (11.1)	12.4 (11.4)	0.0	–	0.947
Dilaudid***	28.8 (99)	41.0 (116)	–	10.3	0.001
Mean # of days used (SD)***	8.2 (9.8)	16.8 (11.4)	34.3	–	0.000
Heroin*	72.1 (248)	63.6 (180)	–	5.2	0.023
Mean # of days used (SD)	22.8 (10.3)	20.9 (10.0)	3.7	–	0.056
Tylenol 3/4***	38.7 (133)	24.7 (70)	–	13.8	0.000
Mean # of days used (SD)	12.3 (11.4)	14.7 (12.5)	2.0	–	0.160
Valium	40.4 (139)	32.9 (93)	–	3.8	0.052
Mean # of days used (SD)	10.1 (10.8)	10.0 (10.7)	0.0	–	0.936
Overdose (last 6 months)	18.0 (62)	18.1 (51)	–	0.0	0.984
Drug treatment (last 12 months)	25.4 (87)	30.0 (85)	–	1.7	0.193
Criminal justice					
Arrested (last 12 months)***	59.6 (205)	39.6 (112)	–	24.9	0.000
Arrested for (of those arrested):					
Drug offense***	15.4 (53)	5.7 (16)	–	15.1	0.000
Property offense	47.5 (97)	36.6 (41)	–	3.5	0.061
Detention (last 12 months)***	51.3 (174)	31.9 (89)	–	23.6	0.000

n/a: no statistics are computed since this variable is a constant.
*$P < 0.05$, ***$P < 0.001$.
†Mean number of days used excludes those who did not report use of the drug (i.e., coded as 0 days used).

Table 4 Discriminant analysis of crack use vs. crack non-use (final model summary statistics with city).*

*Variable***	*Partial R-Square*	*Wilk's Lambda*	*Wilk's Lambda P-value*	*Average Squared Cannonical Correlation (ASCC)*
Quebec	0.17	0.83	< 0.0001	0.1724
Montreal	0.20	0.67	< 0.0001	0.3348
Drug dealing income (last 30 days)	0.05	0.63	< 0.0001	0.3660
Sex work income (last 30 days)	0.05	0.60	< 0.0001	0.3953
Arrested (last 12 months)	0.02	0.59	< 0.0001	0.4097
Edmonton	0.01	0.59	< 0.0001	0.4140
Toronto	0.01	0.58	< 0.0001	0.4215
Permanent housing	0.00	0.58	< 0.0001	0.4235

*Adjusted for age; sex was not significant in the model.
**Sites as predictors in the model.

crack non-users in two primary domains: social marginalization and health. As such, our findings confirmed results from studies elsewhere that crack users typically constitute a high-risk and problematic street drug user population characterized by severe health problems as well as extreme social disadvantages [54–57].

Our prediction model of crack users demonstrated the major role of factors of socio-economic marginalization

Table 5 Discriminant analysis: Cross-validation of prediction accuracy.*

	Crack user		
Discriminant function result	*No*	*Yes*	*Total*
Percent classified correctly	72.4%	83.4%	77.9%
Percent misclassified	27.6%	16.6%	22.1%

*Including sites.

that differentiate crack from crack non-users, primarily expressed by illegal income generation, criminal justice involvement and housing. Other research has shown that crack users tend to be more involved in criminal activities than non-users [40,58]. In our sample, crack users presented a much stronger involvement in drug dealing, sex work or other criminal income generation activities. Consequently, the direct social burden of crack use is likely to be particularly high, as criminal justice costs constitute the lion's share of the economic impact of illicit drug use on society [2,59]. While the observed level of criminal activity among crack users can be explained in functional economic terms, it may also be that crack use is embedded in a distinct subculture in which, for example, criminal activity (e.g. drug dealing) may play a defining role [60,61]. These dynamics need to be investigated further by in-depth (e.g. qualitative) inquiries.

Given crack users' disproportionate involvement in crime, the demonstrated higher levels of arrest, specifically for drug offences and, to a lesser extent, property offences (e.g. theft, burglary, break-in), as these are predominantly illegal activities generating funds to buy drugs. While the functional dynamics of economic marginalization in spawning criminal activities are evident, crack users' particular social circumstances, e.g. high levels of homelessness and concentration in inner cities, probably also render them more exposed to law enforcement, especially in current contexts of aggressive urban 'zero tolerance' or disorder policing [62–64]. Finally, our data demonstrated that crack users were much less likely to be permanently or stably housed; this element of social disintegration has been also shown for crack user populations in other jurisdictions [56,65,66].

Overall, our data presented a picture of crack users being the socio-economically 'marginalized of the marginalized' among street drug users [49,67]. These findings are relevant not only because these wider socio-economic indicators describe the destitute characteristics of crack use in Canadian cities, but also because of the powerful negative impact of these social determinants on individual and public health. Concretely, homelessness, imprisonment and criminalization among street drug users are associated demonstrably with increased risks of risky drug use, infectious disease, emergency room utilization, as well as fatal and non-fatal overdose [68–70]. It is those potential morbidity and mortality consequences of the extreme socio-economic marginalization of crack users demonstrated in our sample that underscore the considerable public health impact—and urgent need for interventions—of crack use in Canadian cities.

With regard to health indicators *per se*, crack users indicated a high prevalence of self-reported physical health problems, including a higher rate of HCV (antibody) prevalence. While the former findings confirm the observation of highly compromised health among crack users [55,71], the latter reinforces the findings of recent studies suggesting crack users to be at elevated risk for HCV infection [15,17,33]. These observations have resulted in the essential question of whether crack use-specific risk behaviours (i.e. crack paraphernalia-sharing) may cause HCV transmission, or whether crack users are a population characterized distinctly by other key HCV transmission risks [10,72]. Our study's data may lend support to both views, but cannot offer conclusive evidence for either. Clearly, crack users in our sample indicated several key characteristics (e.g. sex work involvement, physical health problems, imprisonment) documented as risk factors for HCV exposure [70,73–75]. In terms of mental health, crack users indicated a lower prevalence of depressive symptoms compared to crack non-users in the bivariate analysis. This finding stands in opposition to other studies' findings [52,76–78]. Following the basic premises of the self-medication hypotheses, we may speculate that users indicating depressive symptoms might be more likely to inject cocaine (or combinations) rather than use crack as their preferred stimulant [79,80]. The association between crack use and depressive symptoms is one of the factors in our analysis driven heavily by the disproportionately large Vancouver crack user population. Previous analyses had already shown that the prevalence of depressive symptoms is comparably much lower in the Vancouver site population [49,81]. Further analysis will need to explore whether the above picture of lower levels of depressive symptoms in crack users holds true independently across sites, or will confirm the findings from other studies. In terms of health care, our analysis found that crack users relied more on walk-in clinics than on the use of a regular physician for health care, thus suggesting less stable health care access; however, this was not expressed by differential levels of emergency room utilization. We also did not find definitive differences regarding involvement in substance use treatment in the past year; future research needs to investigate to which extent crack users encounter differential health or treatment care access barriers.

In terms of substance use, our analyses suggested that crack users were involved more intensively in the use of

heroin and Tylenol 3 or 4, while crack use was associated negatively with hydromorphone and alcohol use. These observations were again largely city-specific, and thus potentially follow ecological rather than user choice-driven patterns. Our data did not support the suggestion from other analyses [49,51] that the use of crack and cocaine is relatively strictly separated by user groups. However, while our exploration of substance use patterns among crack users and non-users is limited to a general level, there is a strong need to examine the interactive dynamics between different substances used as well as administration routes in these populations. Concretely, further in-depth (as yet unpublished) analyses in the OPICAN cohort demonstrated that oral forms of crack use (e.g. crack smoking) occurred predominantly in conjunction with non-injection forms of opioid use, whereas injected forms of crack use occurred predominantly with injected heroin and cocaine use across the study sites. However, it is not clear to what extent these patterns are driven by ecological versus individual choice dynamics, yet a more systematic understanding of these dynamics in the context of widely prevalent polysubstance use among street drug users is urgently needed for needs-orientated intervention planning.

Our data clearly illustrated the high-risk profiles of urban crack user populations, resulting in an urgent need for both secondary (i.e. harm reduction) and tertiary (i.e. treatment) interventions. Few targeted interventions specifically for crack use are offered currently in either domain. As 'harm reduction' measures, the dissemination of 'safer crack use kits' for crack smokers has been initiated in some Canadian cities, aiming to prevent crack-paraphernalia sharing and thus possible HCV transmission [10]. However, it is currently unclear whether such transmissions may actually be related causally to crack smoking at all. The inclusion of a 'safer inhalation facility' for crack smokers into the Vancouver safe injection site (SIS)—akin to facilities in Europe [65,82]—has been rejected by federal authorities. Considering treatment interventions for crack use few, if any, proven effective interventions exist [67]. In addition, despite the large overlap between opioid and crack users, crack use often leads to difficult dynamics among users of methadone maintenance treatment (MMT) as the main treatment for illicit opioid use [52,83]: many MMT programmes respond to crack use with either punitive interventions (e.g. dose reductions, no take-homes) or even programme exclusion, while conversely it has been demonstrated that many MMT patients resort to crack use to balance the undesirable effects of MMT [83–85]. However, our paper underlines that the intervention needs for crack users go far beyond those aiming at substance use *per se*: the extreme degree of socio-economic marginalization—as linked to increased morbidity and mortality risks—among crack users emphasize strongly the need for targeted social support interventions for this population. Concretely, beyond targeted prevention and treatment measures, crack users in Canada urgently need to be housed and kept out of the ubiquitous stranglehold of criminal justice. Realizing these steps is a challenge for law and policy makers, and far extends beyond the addictions programming fields.

Our study has several limitations. Our study may have included bias, as it reported on data from a sample of primary opioid users, i.e. it did not present data from a primary crack use population (which may exist without opioid use). Secondly, because illicit drug users constitute a hidden study population, genuinely representative sampling, despite special recruitment efforts to overcome possible biases, is not feasible [86]. Our findings are thus not generalizable to other crack user populations or environments. Furthermore, except for virological tests and standardized psychiatric instruments, our study data were generated from non-standardized instruments and self-report. Regarding the latter, however, various studies have confirmed the high validity of self-report data for illicit drug user samples when collected appropriately [87,88]. Finally, parts of our data were clearly affected by strong differences in study sites. The role of site influences on variables examined was not investigated by individual site analyses, as this was beyond the scope of this paper; such will be executed in future analyses.

In summary, crack use—largely in the form of crack smoking—is increasingly prevalent among Canadian street drug users [9,10,89]. Our study documented that crack users in Canada are a socio-economically highly marginalized drug user population which is also characterized by distinct health risks. While current intervention and research efforts concentrate primarily on IDUs and/or opioid users, needs-based, concerted and effective efforts must be directed to the high-risk population of crack users in the interests of both public health and social justice.

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