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ORIGINAL PAPER

Drug and HIV-Related Risk Behaviors After Geographic Migration Among a Cohort of Injection Drug Users

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Abstract To determine whether migration impacted on drug use and HIV-related risk behaviors among injection drug users (IDU), we identified participants in a prospective cohort of IDU (Vancouver Injection Drug User Study) who had reported migrating out of Greater Vancouver between May 1996 and November 2005. We compared risk behaviors before and after a move for individuals who migrated (movers) and for a similar period for non-movers using linear growth curve analyses. In total, 1,122 individuals were included, including 430 (38.3%) women and 331 (29.5%) Aboriginal participants. Among these, 192 (17.1%) individuals reported migrating out of Greater Vancouver between 1996 and 2005 while 930 (82.9%) did not. Movers were significantly younger than non-movers: 32.0 (Interquartile Range [IQR]: 24.3–39.2) and 34.6 (IQR: 26.9–40.8) respectively. A significant decrease in those reporting unstable housing, frequent heroin and cocaine injection occurred only in movers. Our findings suggest that, in this setting, risk-taking among IDU declines following periods of migration out of Greater Vancouver.

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Introduction

Injection drug users (IDU) are a high-risk group for both the acquisition and transmission of HIV and other blood-borne or sexually transmitted infections (STI). Transmission of infectious disease occurs largely through syringe sharing and through the use of other contaminated injection equipment (Freeman et al. 1999; Hamers et al. 1997; Strathdee et al. 1998; Wood et al. 2001), although IDU are also known to transmit HIV to their sexual partners, including those who do not inject drugs (Gyarmathy and Neaigus 2005; Hamers et al. 1997). While most research focuses on drug use in large settings, particularly large cities, injection drug use is not solely an urban phenomenon and there is evidence that suggests many IDU live in and/or travel to smaller communities, often rural or semi-rural settings, located outside the metropolitan areas (Haw and Higgins 1998).

Indeed, population movement is thought to be one social factor contributing to the geographic spread of HIV, as mobile individuals act as "bridging" populations linking infectious diseases from high-risk to low-risk individuals as well as from areas of high seroprevalence into regions with low seroprevalence (White 2003; Williams et al. 2005). While the majority of literature suggests that mobile populations, including migrant workers, generally exhibit greater risk-taking compared to less mobile individuals (Brindis et al. 1995; Cooper et al. 2005; Denner et al. 2005; Deren et al. 2003; Freeman et al. 1999; Magis-Rodriguez et al. 2004; Paschane and Fisher 2000; Williams et al. 2005), some have proposed that the situations

surrounding migration (e.g., reason for mobility) as well the individual characteristics of those involved, actually determines whether risk-taking is exacerbated or improved (Soskolne and Shtarkshall 2002).

While research on the migratory patterns of drug users in Canada has not been well studied, there is evidence to suggest that Canadian IDU are a mobile population. Data from the I-Track study monitoring risk behavior among Canadian IDU, for example, noted that while the majority of participants cited the cities and communities where surveyed as their current residence, approximately 26% had lived elsewhere during the 6-month period prior to being interviewed (Health Canada 2004). However, while spatial bridging has been a factor in introducing HIV to networks of IDU in lower prevalence cities in the U.S. (Williams et al. 2005), whether this same potential exists for Canadian IDU has yet to be evaluated.

Furthermore, while it has been demonstrated repeatedly in North America that IDU generally have poor access to prevention programs, addiction treatment, and medical care, migration away from key services often based in the urban centers, may create additional barriers for those seeking care, likely contributing to poor health outcomes including HIV infection (Wood et al. 2002a, 2004). For example, in Vancouver, difficulty accessing syringes has been previously identified as a predictor of syringe sharing (Wood et al. 2002a, b).

In a recent study, Maas et al. (2007) demonstrated that living in Vancouver's Downtown Eastside (DTES), Canada's poorest postal code, was an independent risk factor for HIV seroconversion among local IDU. As in other disadvantaged urban neighborhoods, homelessness, extreme poverty, high crime rates, and high levels of alcohol and drug abuse characterize the DTES (Buxton 2005). Consequently, we sought to explore the impact of migrating out of the DTES and surrounding Greater Vancouver area (GV) on HIV-related risk behavior among participants enrolled in the Vancouver Injection Drug Users Study (VIDUS). We hypothesized, given the concentrated drug scene situated in the DTES and surrounding Vancouver area that in this analysis, migration would result in identifiable changes in drug use and HIV-related risk behaviors.

Methods

Participants

VIDUS is an open prospective cohort that has enrolled and followed 1,603 IDU recruited through self-referral or street outreach from Vancouver's DTES between May 1996 and November 2005. The cohort has been described elsewhere (Tyndall et al. 2003; Wood et al. 2001). In brief, individuals were eligible for participation if they were 14 years of age or older, had injected illicit drugs at least once in the month prior to enrollment, resided in Greater Vancouver, and provided written informed consent. At baseline and semi-annually, participants provide blood samples and complete and interviewer-administered questionnaire, which elicits demographic data including age, sex, place of residence, and information regarding injection and non-injection drug use, injection practices, sexual risk behaviors and enrollment into addiction treatment. Participants also provide venous blood samples, which are tested for HIV and hepatitis C virus (HCV) antibodies. All subjects receive a $20 stipend at each visit to compensate for their time and cover transportation costs to the study office.

Measures

Our analysis sought to determine whether migrating out of Greater Vancouver impacted on drug use and risk behaviors of study participants. Migration was defined as residing outside of Greater Vancouver during the follow-up period (i.e., May 1996–November 2005). All participants who had reported migrating out of Greater Vancouver during follow-up were initially identified. Among those, only participants who had at least one visit prior to moving and at least one visit after a move had been reported while still living outside Greater Vancouver were eligible for inclusion as 'movers' in this analysis. Individuals who moved as a result of incarceration were not included in the movers group.

By proportionally matching movers' visits, a control group consisting of non-movers was selected. As a first step, VIDUS participants who had never reported moving out of Greater Vancouver during follow-up were considered 'non-movers' and potential controls. For each follow-up where a move had been reported, non-movers with at least one follow-up data before and after that visit were randomly selected to match the same frequency of movers at that visit (e.g., if 10% of all movers report moving at that visit, then 10% of total non-movers were selected for that visit).

In the following, the "before" period refers to the most recent 6-month follow-up prior to when a move was reported while "after" refers to the participants' first available follow-up visit after a move. Variables of interest in this analysis included: age (per 1 year older), female gender (yes vs. no), Aboriginal ethnicity (yes vs. no), HIV (yes vs. no), HCV (yes vs. no), public injecting (yes vs. no), frequent heroin injection (yes vs. no), frequent cocaine injection (yes vs. no), frequent crack cocaine smoking (yes vs. no), syringe borrowing (yes vs. no), syringe lending (yes vs. no), requiring help injecting (yes vs. no), non-fatal overdose (OD) (yes vs. no) recent incarceration (yes vs. no), sex trade involvement (yes vs. no), alcohol use (yes vs.

no), current methadone treatment (yes vs. no), and any addiction treatment (yes vs. no). We also examined whether participants were living in unstable housing (yes vs. no). Unstable housing was defined as living in single room occupancy (SRO) hotels, hostels, recovery houses or being homeless, defined as having no-fixed address (NFA), living on the street, or in a shelter. Frequent heroin, cocaine, and crack use was defined as use equal to or greater than once daily. All behaviors refer to the 6-month period prior to the interview. All variable definitions have been used extensively and were identical to earlier reports (Tyndall et al. 2003).

Analyses

Changes in behaviors in the before and after period were also examined in both movers and non-movers (i.e., control group). Differences in reported risk factors were compared over time for both groups using McNemar's test. To formally test for differences over time and between movers and non-movers, we performed linear growth curve analyses. This method has been successfully used in IDU in the past, and models changes over time incorporating interaction terms to determine if changes over time differ significantly between groups (Hoffmann et al. 1997; Vlahov et al. 2001). By using generalized linear models with repeated measurements, models were constructed for each selected behavior with group (mover vs. non-mover) and period (before vs. after) as the explanatory variables. Then, each model was adjusted for age, gender, and aboriginal ethnicity (yes vs. no) and potential interactions were explored (i.e., for each risk behavior, mover vs. non-mover by time period). Models were only constructed for variables in which different trends emerged over time, between groups, after using McNemar's test. In this analyses, the slope represents the differences in outcome by group (mover vs. non-mover) over time (before vs. after), while the *P*-value represents the significance of the interaction term. The combined use of McNemar's test and the linear growth curve methods allowed us to first determine if differences within individuals were statistically significant (McNemar's) and then if this difference was statically different than a control group (growth curve method). All *P*-values are two sided. All statistical analyses were performed using SAS software version 8.0 (SAS, Cary, NC).

Results

In total there were 1,122 participants included in this analysis, including 430 (38.3%) women and 331 (29.5%) self-identified Aboriginal participants. Of the 1,122 participants, 192 (17.1%) individuals reported migrating out of Greater Vancouver (movers) while 930 (82.9%) participants never reported such a move (non-movers). Table 1 highlights that while there were no significant differences between groups with respect to gender and ethnicity, participants reporting a move were significantly younger than those who never moved (Student's *t*-test = 48.1, $P < 0.05$); the median ages in the mover and non-mover group were 32.0 (Interquartile Range [IQR]: 24.3–39.2) and 34.6 (IQR: 26.9–40.8) years respectively.

As Table 2 demonstrates, 5 movers (McNemar's test: 5.0, $P < 0.05$) and 18 non-movers (McNemar's test: 18.0, $P < 0.001$) sero-converted to a positive HIV status. A similar trend was observed for HCV status, with 5 movers (McNemar's test: 5.0, $P < 0.05$) and 30 non-movers (McNemar's test: 30.0, $P < 0.01$) sero-converting over time. Further, Table 2 indicates the proportion of movers and non-movers reporting drug use and selected risk behaviors in the before versus after period. Both groups demonstrated significant decreases in the proportion reporting syringe borrowing, syringe lending, requiring help injecting, having had a non-fatal overdose, having been recently incarcerated and having been sex trade involved. The proportion reporting alcohol use, current methadone use or any addiction treatment increased significantly in movers and non-movers in the before versus after period. Consequently none of the aforementioned variables were explored in further analyses. The proportion of participants who reported living in unstable housing, public injecting, frequent heroin or cocaine use and frequent crack smoking did differ between groups in the before versus after period and these variables were explored further in logistic growth curve analyses.

Table 1 Socio-demographic characteristics associated with those who had migrated out of Greater Vancouver versus those who had never moved between 1996 and 2005

Characteristics	Movers ($n = 192$)	Non-movers ($n = 930$)	χ^2 test (1 DF)
Gender (%)			
Male	117 (60.9)	575 (61.8)	0.053
Female	75 (39.1)	355 (38.2)	
Age			
Median (IQR)	32.0 (24.3–39.2)	34.6 (26.9–40.8)	48.1[a,*]
Ethnicity (%)			
Other	130 (67.7)	661 (71.1)	0.867
Aboriginal	62 (32.3)	269 (28.9)	

IQR = intequartile range; DF = degrees of freedom

[a] Student's *t*-test

* $P < 0.05$

Table 2 Proportion of movers ($n = 192$) and non-movers ($n = 930$) reporting risk behaviors between 1996 and 2005

Behavior	Before *n* (%)	After *n* (%)	McNemar's test (1 DF)
HIV serostatus			
Mover	47 (24.5%)	52 (27.1%)	5.0*
Non-mover	274 (29.5%)	292 (31.4%)	18.0**
HCV serostatus			
Mover	157 (81.8%)	162 (84.4%)	5.0*
Non-mover	785 (84.4)	815 (87.6)	30.0**
Public injecting			
Mover	40 (20.8)	28 (14.6)	3.1***
Non-mover	219 (23.6)	202 (21.7)	1.2
Unstable housing			
Mover	94 (49.0)	61 (31.8)	11**
Non-mover	465 (50.1)	464 (49.9)	0.01
Frequent heroin			
Mover	58 (30.2)	30 (15.6)	19.6**
Non-mover	368 (39.6)	343 (36.9)	2.8
Frequent cocaine			
Mover	53 (28.1)	24 (12.5)	19.6**
Non-mover	281 (30.2)	255 (27.4)	2.6
Frequent crack			
Mover	20 (10.4)	20 (10.4)	0.00
Non-mover	201 (21.6)	272 (29.2)	21.9**
Syringe borrowing			
Mover	46 (24.0)	27 (14.1)	7.4**
Non-mover	186 (20.0)	135 (14.5)	14.7**
Syringe lending			
Mover	45 (23.4)	21 (10.9)	12.0**
Non-mover	176 (18.9)	123 (13.2)	14.9**
Require help injecting			
Mover	47 (24.5)	24 (12.5)	16.0**
Non-mover	246 (26.5)	205 (22.0)	8.6**
Non-fatal OD			
Mover	38 (19.8)	10 (5.2)	17.8**
Non-mover	175 (18.8)	95 (10.2)	32.3**
Incarceration			
Mover	58 (30.2)	36 (18.8)	8.1**
Non-mover	291 (31.3)	226 (24.3)	17.1**
Sex trade involved			
Mover	31 (16.2)	16 (8.3)	8.3**
Non-mover	210 (22.6)	173 (18.6)	16.5**
Alcohol use			
Mover	79 (41.1)	100 (52.1)	5.6*
Non-mover	357 (38.4)	402 (43.2)	7.7**
Current methadone			
Mover	29 (15.1)	40 (20.8)	4.2*
Non-mover	196 (21.1)	251 (27.0)	19.8**
Any addiction treatment			
Mover	63 (32.8)	87 (45.3)	8.7**
Non-mover	300 (32.3)	373 (40.1)	20.9**

* $P < 0.05$

** $P < 0.001$

*** $P < 0.1$

Figure 1 shows frequency tables representing the proportion of drug use practices and HIV-related risk behaviors at two visits (i.e., the most recent 6-month follow-up prior to and after a move) for non-movers (the first two bars for each behavior) and movers (second two bars for each behavior). Overall, all risk behaviors were initially lower (first two bars) among participants who had reported migrating when compared with those who did not. The proportion reporting public injecting decreased in both groups from 20.8% to 14.6% (McNemar's test: 3.1, $P < 0.1$) among movers and 23.6–21.7% (McNemar's test: 1.2, ns) among non-movers although these differences could be due to chance in both groups. The linear growth curve analysis adjusted for age, gender, and ethnicity demonstrate that the change in the proportion of participants reporting pubic injecting was not significant (slope for movers: −0.404, slope for non-movers: −0.64, ns). There was a significant decline among movers in the proportion living in unstable housing (49.0–31.8%; McNemar's test: 11.0, $P < 0.01$) while no change in housing status was observed among those who did not move (50.0–49.9%; McNemar's test: 0.01, ns). Linear growth curve analysis indicated that this difference was significant (slope for movers: −0.749, slope for non-movers: 0.006, $P < 0.01$). Among movers, the proportion reporting frequent heroin injection declined significantly after a move was reported (30.2–15.6%; McNemar's test: 19.6, $P < 0.01$), and while there was a slight decrease in frequent heroin use among non-movers (39.6–36.9%, McNemar's test: 2.8), the difference was not significant. The result of the linear growth curve analysis indicated that the difference between groups was significant (slope for movers: −0.823, slope for non-movers: −0.900, $P < 0.01$). There was a significant decrease in the proportion of movers reporting frequent cocaine injection from 28.1% to 12.5% (McNemar's test: 19.6, $P < 0.01$). The slight decline in frequent cocaine injection observed among non-movers (30.2–27.4%, McNemar's test: 2.6) was not significant. As Table 2 shows, the difference in slopes for frequent cocaine was significant (slope for movers: −0.971, slope for non-mov-

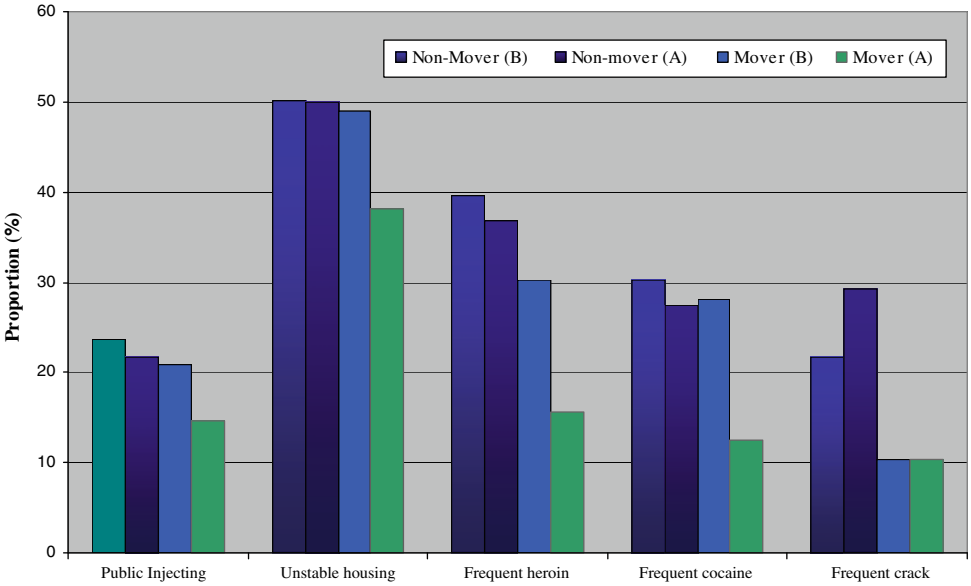

Fig. 1 Proportion reporting risk behaviors before and after a move was reported in movers versus non-movers in VIDUS (1996–2005)

ers: −0.136, $P < 0.01$). While the proportion of participants reporting frequent crack use increased among non-movers (21.6% vs. 29.2%, McNemar's test: 21.9, $P < 0.01$), no change was observed among movers (10.4% vs. 10.4%, ns). In the linear growth curve analysis for crack use, the difference in slopes was not significant (slope for movers: 0.056, slope for non-movers: 0.447).

Discussion

In this analysis, a substantial proportion of IDU reported moving out of the Greater Vancouver area and we observed statistically detectable declines in behaviors and other examined risk factors among IDU who had moved. For example, a significantly smaller proportion reported living in unstable housing and being frequent heroin and cocaine injectors after a move had occurred. While there were similar decreases in risk factors among non-movers, the differences over time were not significant.

Since injection drug use is rather collective in nature and shaped by various environmental and structural factors, the likelihood of engaging in specific behaviors is often influenced by the broader 'risk environment' that surrounds the individual (Atlani et al. 2000; Hoffmann et al. 1997; Organista et al. 2004; Rhodes 2002; Rhodes et al. 2005; Soskolne and Shtarkshall 2002). While movers in our cohort are slightly younger than non-movers as we have previously described (Rachlis et al. 2008), recent research has demonstrated that, in fact, younger populations of IDU are often relatively mobile (Hahn et al. 2001, 2008; Lankenau et al. 2008). While further research is needed to elucidate the reasons why this occurs in our setting, in one study of young, homeless IDU, individuals often moved along common traveling routes within and the across the U.S. for reasons related to drug use, money making opportunities, and law enforcement (Lankenau et al. 2008). Consistent with our earlier work (Rachlis et al. 2008), movers in this study were also more likely to migrate to non-urban settings. This is an important consideration for the findings of the present study. For example, while some VIDUS participants have reported moving to other metropolitan areas including Montreal and Toronto, more than half of the locations participants reported migrating to included smaller regions within British Columbia (Rachlis et al. 2008). As a result, decreases in risk-taking were expected, as in most cases, the new settings do not have concentrated and open drug scenes conducive to high rates of risky activity comparable to that of the DTES.

After extensive multivariate adjustment, migration out of Greater Vancouver in this analysis was associated with a decrease in the likelihood of living in unstable housing. This finding is important given that unstable housing is a key factor leading to heightened health risks particularly those related to injection drug use (Aidala et al. 2005; Buhrich et al. 2000; Latkin et al. 1994; Rhodes et al. 2006). Among Vancouver IDU, living in unstable housing is a demonstrated risk factor for syringe sharing (Corneil et al. 2006). Therefore, it is concerning that the proportion of VIDUS participants living in unstable housing remained fairly constant among non-movers, and suggests that this issue has yet to be adequately addressed. Interestingly, there was little change in the proportion reporting public injecting among participants who remained within Greater Vancouver, although given the evidence which highlights the interplay between housing status and public injecting (Klein and Levy 2003; Rhodes et al. 2005, 2006; Small et al. 2005), this finding was not surprising.

The proportion of participants reporting frequent heroin and frequent cocaine injection decreased in both movers and non-movers but the differences in the latter group was not significant. The overall decrease may reflect, at least to some degree, changing drug trends over time or the natural history of injection drug use trajectories. For example, a sustained decline in heroin use has been occurring among Vancouver IDU since 2000 (Wood et al. 2003). However, given that only significant differences in injection frequency occurred among movers, migration is likely a key factor. The reduced availability of particular drugs outside the urban centre may also explain the observed declines in frequent use, or the fact that participants who migrate may be actively attempting, through their move, to get away from heavy drug use. Regardless, the implications of this finding are clear given, that at the population level, the use of any injection drugs is a significant factor increasing risk for both HIV and HCV infection and transmission (Alter and Moyer 1998; Des Jarlais and Friedman 1998). The relationship between frequency of injection and HIV infection was established early with a U.S. study demonstrating a positive correlation between HIV prevalence and frequency of injection (Marmor et al. 1987). In VIDUS, the binge use of injection drugs (Miller et al. 2006) is independently associated with HIV seroconversion while frequent cocaine injection remains the strongest predictor influencing risk for HIV infection among participants (Tyndall et al. 2003). Cocaine use is characterized by a higher frequency of injections and high intensity use that profoundly influence risk (Magura et al. 1998). Furthermore, given that injection use of cocaine is associated with increased sexual activity (Rawson et al. 2002), the significant decline observed among movers suggests reduced vulnerability to both blood-borne and sexually transmitted infections as a result of migrating.

The findings of this analysis, however, also implies that there is still a proportion, albeit a smaller proportion, of participants who continue to be frequent injectors who live in rural or semi-rural settings outside of Greater Vancouver (Rachlis et al. 2008). This observation is concerning and suggests that appropriate HIV prevention and drug treatment services may still be needed in these settings. Our findings suggest that while high and medium threshold services should be available to ensure that individuals at a more stable level in their drug use have adequate access, lower threshold services including needle exchange programs (NEPs) are still needed (Canadian Centre for Substance Abuse (CCSA) 1996; Marlatt 1996). However, further research is still needed to elucidate both the reasons for mobility as well as the longer term impact of migration on risk. Interestingly, there was no association between migration and crack use in this analysis. In Canada, crack use has become increasingly prevalent among street drug users (Fischer et al. 2006); in VIDUS the proportion reporting crack use rose from 35% to 55% between 1998 and 2000 (Buxton 2003). While we did expect that non-movers would show an increase in crack use given its increasing popularity (Fischer et al. 2006), we were surprised that movers showed no change in use and further, that the difference in trends between groups was not significant. It is also notable that some level of syringe sharing persisted in both movers and non-movers, and these findings again suggest the need for the expansion of interventions that target this form of HIV risk behavior both within and outside of urban settings.

There were limitations in our study. VIDUS is not a random sample and therefore, findings from this analysis may not generalize to the wider population of IDU in our setting. Secondly, while VIDUS has maintained an exceptionally high follow-up rate ($\sim$90%), participants lost to follow-up are more likely to have migrated away from the region and so our calculation of the rate of migration may be underestimated and in fact, migrating has a stronger impact on risk-taking than measured. It is worth noting, however, that participants are able to complete their follow-up questionnaires via telephone or in various locations throughout the Greater Vancouver area; study staff also engages in extensive outreach efforts. Additionally, since we relied on self-report data regarding drug practices, our analysis could be subject to social desirability responding. Furthermore, given that movers are more likely to complete their follow-up interviews by phone, they may be less likely to over-report socially desirable responses (e.g., less syringe sharing) compared to participants who complete their interviews in-person (i.e., non-movers). Therefore, the true difference in risk-taking between groups may in fact be larger than observed, and the impact of migration in this analysis as a result may be underestimated. However, the exclusion of participants who moved out of Greater Vancouver but who did not have complete follow-up around the move, may bias our study population towards being more stable and thus the positive impact of migration may be overestimated. Additionally, the 'after' period for considering risk factors was limited to only the first available follow-up visit post-move and although we expected the effect of migration to be visible soon after a move had occurred, additional follow-up may be needed to provide a more comprehensive understanding of the effects of migration on levels of risk-taking. Although the overall length of time examined was the same for both movers and non-movers, given that the availability of follow-up data likely varied for each participant, the actual time periods considered may have differed both within and between groups. Further, while our current definition of 'unstable housing' covers a range of housing conditions including living in an SRO, we were limited in

our ability to determine if any participants' were 'couch surfing' or were living with family/friends. This is important, particularly given that homelessness frequently takes different forms outside of the urban areas where shelters are fewer in number (Goodfellow 1999). As a result, many homeless or marginally-housed individuals remain hidden, as they are often living with relatives (Craft-Rosenberg et al. 2000). Thus, we may have overestimated the positive effect of migration on housing status in the present analyses. Finally, unmeasured factors including reasons for moving and social network characteristics, may also contribute to the observed findings.

In summary, we demonstrated that migration outside of Greater Vancouver among IDU was associated with a decline in several risk factors for infectious disease transmission. While many examined variables decreased in both movers and non-movers over time, in the present analyses only movers showed a significant decrease in the proportion living in unstable housing and injecting heroin and cocaine frequently. Therefore, findings of this analysis suggest that migrating out of the Greater Vancouver area to non-urban areas in particular, is associated with decreased vulnerability among IDU to HIV/HCV infection and transmission.

Regardless, additional research which incorporates qualitative or mixed methods approaches to investigate the mechanisms by which migration, as a process, influences risk-taking among IDU is still needed. More specifically, having a more thorough understanding of the reasons for migration would likely help to elucidate the key push-pull factors that influence migration and the extent to which IDU move by choice in our setting.

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