

Role of Social Network Dimensions in the Transition to Injection Drug Use: Actions Speak Louder than Words

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Abstract The objective of this study was to examine the influences of social network factors, particularly social support and norms, in the transition from non-injection heroin and/or opiate use to heroin-injection, which is one of the leading causes of the spread of HIV/AIDS in China. Respondent-driven sampling was used to recruit young heroin and/or opiate users in an egocentric network study in Yunnan, China. Multivariate logistic regression using hierarchical combinations of candidate variables was used to analyze network factors for the injection transition. A total of 3,121 social network alters were reported by 403 egos with an average network size of eight. Fifty-eight percent of egos transitioned to heroin-injection from non-injection. This transition was associated with having a larger sex network size, a larger number of heroin injectors in one's network, and a higher network density. The findings enhance our understanding of the influence of social network dimensions on the transition to injection drug use. Accordingly, the development of interventions for heroin and/or opiate users in China should consider social network characteristics.

Keywords Social networks · Heroin · Transition · HIV/AIDS · China

Introduction

Currently, the HIV epidemic in China remains one of low prevalence overall, but with pockets of high infection among specific sub-populations and in some localities [1]. According to estimates of HIV prevalence in five sub-populations [2], the sub-population with the highest prevalence of HIV is injection drug users (between 6.7 and 13.4%), followed by men who have sex with men (0.57–2.17%) and commercial sex workers (0.33–0.94%). In some areas of China, HIV prevalence remains high. For example, the provincial average prevalence among injection drug users (IDUs) in 2007 was 28.4% in Yunnan [3]. Since a substantial proportion of IDUs engage in sexually risky behaviors, they may serve as a bridge to link HIV transmission from high-risk groups (e.g., injection drug users, or commercial sex workers) to low-risk populations (e.g., spouses) [4]. Historically, drug users in China smoked or snorted heroin or opium when they initiated drug use and then switched to heroin-injection. Heroin-use via injection is currently the most common drug-use mode in the country [5]. Therefore, a key challenge of HIV prevention efforts in China is to curtail the transition from non-injection drug use (NIDU) to IDU through interventions.

To be effective, interventions need to target individual and social factors that contribute to this transition. However, little research in China has focused on personal and interpersonal factors important for the transition. Extensive literature searches revealed only two preliminary studies. The first study, conducted among heroin users who had been detoxified at drug treatment centers, found that younger, more recent heroin users, and males were at a higher risk of transitioning to injection-use [6]. The second study, also conducted among heroin users in detoxification centers, found that age and the duration of heroin-use were

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associated with a drug user's time to first injection [7]. Both of these two studies used convenience samples to examine individual-centered factors, and did not include interpersonal network factors. Social networks play a crucial role in generating and disseminating social influence [8], and are particularly important in the context of Chinese collectivist culture which emphasizes loyalty and group goals or norms over individual goals [9, 10].

Social networks are defined as individuals who are linked by a particular behavior or interaction [11]. Egocentric networks include index persons or egos, and their ties or alters. Social networks are comprised of three main dimensions—network relations, network structures and network functions [12]. *Network relations* refer to the type of relationship between network members (for example, kin, sexual partners, and friends), as well the extent of trust and closeness between network members. *Network structures* characterize the relationships among the ego and two or more alters (for example, network size and density) [13].

As a central element of social networks, *network functions* include social support, and social norms that influence network members' adoption or maintenance of behaviors [14, 15]. Social support can take a number of forms, including tangible or emotional support [16]. Tangible support is the provision of financial aid, material resources, and needed services. Emotional support is the expression of positive affect of one person toward another, the affirmation or endorsement of another person's ideas or behaviors. The influence of social support on network members may stem from consensus, as well as from coercion, depending on the type and sources of social support and the characteristics of the relationship in which it occurs among network peers [13]. Social support has been reported to be associated with HIV risk behavior [17, 18].

Closely related to social support are social norms, which refer to the validation and enforcement of beliefs and behaviors in social networks. By observing alters' behaviors or being encouraged by peers to engage in specific activities, egos are provided with positive or negative role models, which influences the ego's adoption/non-adoption of behaviors. Two types of social norms have been reported: subjective and descriptive. *Subjective norms* are derived from beliefs about what people who matter to an individual think this individual should do, and also from the motivation to comply with these beliefs [19]. They refer to people's perceptions of social pressure from significant others such as network members. *Descriptive norms* refer to one's perceptions of other people's behaviors [20]. The actions of significant others provide information that people may use in deciding how to behave. Research shows that both types of social norms are associated with behaviors such as condom use among heterosexuals, although descriptive norms have a stronger

influence compared with subjective norms [21]. In a study conducted among injection drug users, researchers found that perceived peer behavior, rather than verbal persuasion, was more likely to influence drug use practices such as needle sharing and cleaning [22].

Previous research has found associations between network relations and structures and drug users' decisions to transition from non-injection drug use to injection drug use [12, 23, 24]. With regards to network functions, a study conducted among heroin users in New York City examined the influence of communication promoting drug injecting on the transition to injection-use. Results from that study demonstrated that among never-injectors and former-injectors, factors related to communication promoting injection were associated with both the initial transition to injection-use among never-injectors, and a return to injection-use among former-injectors [24]. With the exception of this study, there has been little other research in this area, particularly in the context of the Chinese collectivist culture.

In this egocentric social network study of transitioned injecting and non-transitioned heroin and/or opiate users in Yunnan, China, we first compared the three major social network dimensions between the two groups of transitioned and non-transitioned heroin and/or opiate users. We then assessed which social network dimensions were most strongly associated with the transition to injecting heroin. Finally we tested the hypothesis that network functions, particularly social support from heroin injectors and social norms relating to heroin injection, were associated with an ego's transition to injection use from non-injection use.

Methods

Study Site and Subjects

This study was conducted in two contiguous small counties in Yunnan in 2009. Yunnan is a southwestern province of China bordering Myanmar, Laos and Vietnam. One of the primary routes through which heroin and opium enter China is from Myanmar to Yunnan [25]. Yunnan is also an area highly affected by HIV/AIDS in China. The first case of an HIV-infected drug user in China was reported in Yunnan in 1989. The province is also ranked as having the highest number of people living with HIV and AIDS (PLWHA) in China [2].

The eligibility criteria for non-transitioned heroin and/or opiate users included: (1) between the ages of 18 and 35 years and resided in either one of the two counties; (2) smoked or snorted heroin or opium at least once a week in the 30 days prior to the interview; and (3) no history of injection drug use at the time of the interview. To

determine if participants started using heroin or opium via non-injection methods, they were each asked what mode of use they employed at the first time of drug use. For transitioned heroin injectors, the eligibility criteria included: (1) between the ages of 18 and 35 years and resided in either one of the two counties; (2) transitioned to injecting heroin from non-injection (smoking or snorting), and (3) injected heroin at least once a week in the 30 days prior to the interview. Heroin-injection was defined as intravenous (into the veins), intramuscular (into the muscles), or subcutaneous (under the skin only). The study protocol was approved by the Institutional Review Boards of Virginia Commonwealth University and Yunnan Institute of Drug Abuse.

Respondent-Driven Sampling

Respondent-driven sampling (RDS), a network-based sampling approach, was used to recruit participants. In order to select productive seeds, we conducted in-depth interviews among 28 heroin and/or opium users and held focus-group discussions among those who had experience in conducting outreach among heroin and opium users, including public health staff and outreach volunteers who were also heroin and/or opium users. The major topics included suggestions on the selection of seeds, the participants' perspectives on recruitment of their network alters, the amount of incentives, and the selection of interview sites. Based on the findings of the qualitative studies and with the help of outreach volunteers, we selected a group of 14 seeds. These seeds were diverse in modes of heroin and/or opiate use (injection or non-injection), gender, ethnicity, marital status, and resided in either of the two counties. The seeds received an explanation of the study purpose and procedures, and three coupons to recruit up to three heroin and/or opiate users from their network peers. The unique serial number on each coupon linked each subject to his or her recruits. Three recruitment and interview sites were set up in the two small contiguous counties. The selection of the sites was based on two conditions: study participants had easy access (less than 1 hour travel time and site open on the weekends), and the sites allowed for the protection of participants' confidentiality. Twelve seeds out of 14 successfully recruited other drug users. A total of 77 recruitment waves were generated by the 12 seeds, the average number of waves of about 6 (77/12). Two seeds, one male and one female, produced a recruitment chain longer than 10 waves and recruited 54% of the RDS sample. Our evaluation of the RDS sample indicated its success in reaching the convergence of RDS compositions and including a broad cross-section of this hidden population.

Interviews

Eligible subjects recruited by the seeds and new recruits in subsequent waves participated in a face-to-face anonymous interview in a private room. All interviewers received training in interviewing techniques, developing rapport, ensuring confidentiality, and answering questions raised by subjects. The questionnaire was pilot-tested among five heroin and opium users.

Measures

Egos were asked to provide socio-demographic information such as their birth date, years of formal education (that is, total number of years spent in school), ethnicity (majority Han ethnicity or minority ethnic groups), and employment status (currently employed or unemployed). For the purpose of identification of potential social network factors potentially associated with the transition to heroin-injection, exposures to these factors were measured in the period 30 days prior to respondents' transition to injecting heroin. Exposures to the same factors were measured for non-transitioned heroin and/or opiate users in the time frame of 30 days prior to the interview.

Several approaches were used to reduce recall bias. For example, if respondents had difficulty in recalling these activities and social network factors potentially associated with the transition, interviewers prompted them with important personal events (e.g., birthday, marriage date, the date for their first job) or salient public events (e.g., national holidays, such as Spring Festival, which in China is equivalent to Christmas in the West) as a reminder of other queried events occurring around that time. Studies have documented that activities surrounding initiation into drug use have been vividly recalled by injection drug users [26, 27] and current and retrospective self-reporting of high risk behaviors have been shown to be valid and reliable in drug using populations [28–30].

Social Network Dimensions

The Chinese Social Network Questionnaire (CSNQ) was used to define three types of social networks: support network, drug-use network, and sex network [31]. To measure the size of an individual's support network, name-generating questions were used to ask respondents (network egos) to list, by giving their first names or pseudonyms, alters who could provide support in two supporting domains, e.g., emotional and tangible support. These alters might be egos' family members, friends, villagers, co-workers, other heroin and/or opiate users, sexual partners, or others who could provide each of the two types of support. In addition, egos were asked to list individuals who were their sexual partners

(sex network) and individuals with whom they used heroin or opium together or shared needles (drug-use network).

Network Relations

The type of relationship between egos and alters was measured by asking respondents to indicate which of their network members were family members (includes spouses and kin), friends and sexual partners. Then, to assess trust that egos had for their network alters, respondents were asked, “To what extent do you trust each of the alters?” (scored from 0 = no trust at all to 6 = trust very much). To measure ego’s closeness to alters, respondents were asked, “How close are you to each of the alters who can provide support?” (scored from 0 = not close at all to 4 = very close). Scores of closeness and trust were summed for all alters listed by an ego.

Network Structures

Network structural characteristics assessed included: network density and sizes of support networks and sex networks. Density refers to the proportion of ties in a network relative to the total number of possible ties. Respondents (egos) were given a matrix with the names of their network members (alters) shown on both dimensions, and then were asked to indicate the alters in their personal network who knew each other. Density was calculated as the total number of actual ties or connections divided by the total number of possible ties.

Network Support

Each of the two support functions was operationalized with three items [32]. Respondents (egos) rated the possibility (0–4; not possible at all, not sure, somewhat possible, quite possible, quite sure that the alter could provide the support) of social support that they perceived to be available from each of their network alters. Egos were asked to list alters who would provide tangible support, including (1) lending the ego \$100 Chinese dollars (\$15 US dollars), accompanying the ego to see a doctor, or giving immediate help if the ego needed it; (2) taking care of the ego if the ego was confined to bed for 2–3 weeks; and (3) helping or advising the ego if the ego had problems regarding family or personal issues, or health concerns. Emotional support was measured by listing alters who would (1) agree with or support the ego’s actions or thoughts; (2) make the ego feel respected or admired; and (3) make the ego confide in the alter. The total score for each type of social support was calculated by summing all item scores. Reliability measured by Cronbach’s coefficient alpha is 0.88 for emotional support and 0.89 for tangible support. Total scores of

each functional support that an ego perceived to receive from his alters were calculated by summing the three item scores.

Subjective and Descriptive Norms Relating to Injection-Use

Two types of subjective norms were measured: positive and negative subjective norms. To measure positive subjective norms, egos were asked to indicate which alters in their social network had ever encouraged them to not inject heroin (0–2: never, have ever but not often, often). Similarly, for negative subjective norms, egos were asked to indicate which alters in their social network had ever encouraged them to inject heroin. One item was used to measure the level of descriptive norms: “Among your network alters, who do you believe is an injector?” The levels of these three norms were calculated by summing up individual scores of all network alters who have ever encouraged or discouraged egos to inject heroin, and all network members who were listed as heroin injectors.

Analysis

Bivariate and multiple logistic regression analyses were performed to determine the differences in social network dimensions among transitioned heroin injectors and non-transitioned heroin and/or opiate users, and to estimate the crude (OR) and adjusted odds ratios (aOR), and the 95% confidence intervals (95% CI) of factors that were possibly associated with the transition, using SAS 9.2 (SAS Institute, Cary, NC). In order to examine the inter-relationships between social network dimensions and the transition to injection-use, and explore the differential changes in associations to the transition when different combinations of social network variables are added to logistic regression models, hierarchical combinations of candidate variables were used to model the associations with the transition, controlling for egos’ socio-demographic characteristics (ego’s age in years, his/her total number of years of formal schooling, ethnicity, and employment status). Model 1 included only network-relation variables. In model 2, network-structure variables were added to model 1. Model 3 was the full model including all candidate variables of the three social network dimensions. All possible interaction effects were also tested. Data were weighted to account for potential sampling bias in the respondent-driven sampling, since egos with larger networks and egos who recruit others like themselves (homophily) tend to be overrepresented [33]. This was done by weighting the outcome variable in bivariate and multivariate analyses, and using the “proc surveylogistic” procedure in SAS. The weight for the outcome variable was calculated using the

Respondent Driven Sampling Analysis Tool (RDSAT, version 6.0.1, RDS Incorporated, Ithaca, NY). A sensitivity analysis was also conducted to compare results from the weighted multivariate regression with results from the unweighted multivariate regression [34]. In addition, to examine the possible influence of recall bias on the study results, another sensitivity analysis was conducted to determine if there were substantial differences between the results obtained for the whole sample and results from a sub-sample that included all non-transitioned heroin and/or opiate users, and heroin injectors who had injected the drug for 5 years or less.

Results

Descriptive Statistics

Table 1 presents a profile of the study sample. There were a total of 426 heroin and/or opiate users in our sample. Twenty-three of these drug users reported having injected heroin at the first time of drug use, and thus were excluded from all subsequent analyses. Fifty-eight percent of 403 participants were transitioned heroin injectors and 42% were non-injection heroin and/or opiate users. The majority of drug users were male: 91.1% of injectors were male, and 93.5% of non-injectors were also male. Han ethnicity was reported by 65% of injectors and 48% of non-injectors. The mean age for injectors was 30.9 years; for non-injectors, the mean age was 25.7 years. The median duration of injection was 9 years (range 1–17 years), from the transition dates to the dates when injectors were interviewed. On

Table 1 Socio-demographic characteristics of injectors and non-injectors

Characteristic	Injectors (n = 235)		Non-injectors (n = 168)	
	n	%	n	%
Gender				
Male	214	91.06	157	93.45
Female	21	8.94	11	6.55
Ethnicity				
Han	153	65.11	81	48.21
Minority	82	34.89	87	51.79
Employment status				
Employed	83	35.32	87	51.79
Unemployed	152	64.68	81	48.21
	Mean (SD)	Median	Mean (SD)	Median
Years of formal schooling	7.59 (2.60)	8	7.18 (2.51)	8
Ego's age (years)	30.87 (4.00)	32	25.71 (5.77)	26

SD standard deviation

average, injectors had about 7.6 years of formal schooling, while non-injectors had 7.2 years. About 65% of injectors were unemployed; however, less than half (48%) of non-injectors were unemployed.

The 403 egos named a total of 3,121 alters, of which 29% were female alters and 71% were male alters. The median number of male alters in the personal networks of transitioned injectors was 6, while that for their non-transitioned counterparts was 4. With regards to age, 23.9% of network alters were aged 18–25 years, 53.1% were aged 26–35 years, and 23% were older than 35 years. Injectors had a median of 3 alters with a middle-school education or above in their personal networks, while non-injectors had a median of 4 alters with a middle-school education or above. A median of two network alters in the personal networks of both injectors and non-injectors were single/not married.

Differences in Social Network Factors Between Injectors and Non-Injectors

Network Relations

Compared with non-injectors, injectors were more likely to have a higher number of friends within their networks (OR = 1.01; 95% CI = 1.01, 1.21; $P < 0.05$), and more likely to have a larger sex network size (OR = 1.51; 95% CI = 1.14, 1.99; $P < 0.01$). There was no significant difference between the mean amount of trust in and closeness to alters between the two groups (Table 2).

Network Structures

Injectors were more likely to have a higher mean total network size, as compared with non-injectors (OR = 1.14; 95% CI = 1.06, 1.23; $P < 0.01$). However, the mean network density was similar in both groups.

Network Functions

Compared to non-injectors, injectors were more likely to perceive receiving more tangible support from other heroin-injecting alters (OR = 1.08; 95% CI = 1.03, 1.13; $P < 0.01$), sex-partner alters (OR = 1.03; 95% CI = 1.01, 1.06; $P < 0.05$), and friend alters (OR = 1.02; 95% CI = 1.003, 1.03; $P < 0.01$). Similarly, injectors were also more likely to perceive receiving more emotional support from other heroin-injecting alters (OR = 1.08; 95% CI = 1.04, 1.13; $P < 0.01$), sex-partner alters (OR = 1.04; 95% CI = 1.01, 1.07; $P < 0.01$), and friend alters (OR = 1.02; 95% CI = 1.002, 1.03; $P < 0.05$). There were no significant differences between the two groups for both tangible and emotional support received from family member alters.

Table 2 Bivariate analysis showing differences in social network dimensions among injectors and non-injectors

Variable	Injectors		Non-injectors		OR	95% CI
	Mean (SD)	Median	Mean (SD)	Median		
Network relations						
Number of family member alters	1.26 (1.45)	1	1.53 (1.58)	1	0.89	(0.78, 1.01)
Number of friend alters	4.34 (3.38)	4	3.38 (3.04)	3	1.01	(1.01, 1.21)*
Number of sex partner alters	0.54 (0.95)	0	0.28 (0.67)	0	1.51	(1.14, 1.99)**
Trust in alters	3.98 (1.10)	4.09	4.02 (1.18)	4	0.97	(0.81, 1.15)
Closeness to alters	2.40 (0.82)	2.29	2.50 (0.83)	2.50	0.86	(0.68, 1.10)
Network structures						
Total network size	8.43 (3.50)	8	6.81 (3.59)	6	1.14	(1.06, 1.23)**
Network density	0.61 (0.31)	0.60	0.60 (0.32)	0.60	1.09	(0.57, 2.08)
Network functions						
Tangible support						
From injecting heroin-user alters	8.44 (10.55)	5	2.76 (7.58)	0	1.08	(1.03, 1.13)**
From sex partner alters	8.88 (8.41)	9	6.95 (7.38)	7	1.03	(1.01, 1.06)*
From family member alters	11.56 (12.98)	11	13.24 (13.71)	10	0.99	(0.98, 1.01)
From friend alters	29.11 (27.45)	24	20.65 (21.93)	15	1.02	(1.003, 1.03)**
Emotional support						
From injection drug user alters	8.84 (10.46)	6	2.99 (7.86)	0	1.08	(1.04, 1.13)**
From sex partner alters	8.14 (7.78)	8	6.14 (6.63)	6	1.04	(1.01, 1.07)**
From family member alters	9.58 (11.71)	7	11.46 (12.75)	8	0.99	(0.97, 1.004)
From friend alters	28.92 (27.35)	23	20.82 (21.62)	15	1.02	(1.002, 1.03)*
Social norms relating to injection-use						
Total number of network alters who encouraged egos to inject drugs (subjective norms)	1.33 (1.74)	1	0.67 (1.31)	0	1.35	(1.12, 1.63)**
Total number of network alters who encouraged egos to not inject drugs (subjective norms)	3.56 (3.26)	3	3.20 (3.67)	3	1.03	(0.97, 1.10)
Total number of alters who are injection drug users (descriptive norms)	2.42 (2.15)	2	0.83 (1.63)	0	1.59	(1.33, 1.91)**

SD standard deviation, OR crude odds ratios, 95% CI 95% confidence intervals

* $P \leq 0.05$, ** $P \leq 0.01$

Injectors were more likely to have had a larger number of network alters who encouraged them to inject heroin (that is, higher levels of negative subjective norms) (OR = 1.35; 95% CI = 1.12, 1.63; $P < 0.01$) and were more likely to perceive having a larger number of heroin-injecting alters within their networks (that is, higher levels of descriptive norms relating to heroin injection) (OR = 1.59; 95% CI = 1.33, 1.91; $P < 0.01$). However there was no significant difference between the two groups regarding the levels of positive subjective norms (that is, the total number of network alters who encouraged injecting heroin users to not inject heroin).

Multivariate Logistic Regression

Model 1 shows the association between network relation variables only and injection transition, controlling for egos' socio-demographic characteristics (Table 3). Egos with

larger sex networks were 1.58 times more likely (95% CI = 1.13, 2.22; $P < 0.01$) to transition to heroin-injection, as compared with those with smaller sex networks. No other network relation variables are significant. With regards to non-network variables associated with transitioning to heroin injection, older egos were 1.25 times more likely (95% CI = 1.19, 1.32; $P < 0.01$) to transition to injection-use, as compared with younger egos. Egos with more years of formal education were also more likely to transition to injection-use (aOR = 1.12; 95% CI = 1.01, 1.24; $P < 0.05$). Being unemployed was also a risk factor for transitioning to injection-use: egos who had no jobs were 2.66 times more likely (95% CI = 1.55, 4.57; $P < 0.01$) to transition, as compared with egos who were employed.

Candidate variables in Model 2 included both network-relation variables and network-structure variables. Adding two factors of network structures (total network size and

Table 3 Association between social network dimensions and transition to injection-use from non-injection use

Variable	Model 1 ^a		Model 2 ^b		Model 3 ^c	
	aOR	95% CI	aOR	95% CI	aOR	95% CI
Network relations						
Number of family member alters	1.01	(0.85, 1.21)	0.93	(0.75, 1.16)	1.06	(0.70, 1.61)
Number of friend alters	1.07	(0.98, 1.16)	1.01	(0.88, 1.61)	1.04	(0.83, 1.31)
Number of sex partner alters	1.58	(1.13, 2.22)**	1.58	(1.05, 2.38)*	2.17	(1.26, 3.75)**
Trust in alters	1.19	(0.85, 1.68)	1.12	(0.79, 1.58)	1.22	(0.82, 1.82)
Closeness to alters	1.01	(0.66, 1.54)	1.08	(0.69, 1.69)	1.21	(0.74, 1.98)
Network structures						
Total network size			1.08	(0.95, 1.24)	0.94	(0.77, 1.16)
Network density			2.04	(0.82, 5.08)	2.54	(0.96, 6.73)
Network functions						
Tangible support						
From injection drug user alters					0.98	(0.93, 1.03)
From sex partner alters					0.96	(0.91, 1.01)
From family member alters					0.99	(0.95, 1.04)
From friend alters					1.01	(0.99, 1.03)
Social norms relating to injection drug use						
Total number of network alters who encouraged egos to inject drugs (subjective norms)					1.00	(0.76, 1.30)
Total number of network alters who encouraged egos to <i>not</i> inject drugs (subjective norms)					1.06	(0.97, 1.16)
Total number of network alters who are injection drug users (descriptive norms)					1.69	(1.24, 2.31)**
Socio-demographic characteristics						
Ego's age (years)	1.25	(1.19, 1.32)**	1.26	(1.19, 1.33)**	1.24	(1.17, 1.31)**
Total number of years spent in formal schooling	1.12	(1.01, 1.24)*	1.12	(1.01, 1.24)*	1.14	(1.02, 1.23)*
Han ethnicity	1.46	(0.88, 2.40)	1.42	(0.85, 2.36)	1.43	(0.83, 2.47)
Unemployed	2.66	(1.55, 4.57)**	2.67	(1.54, 4.65)**	2.33	(1.31, 4.15)**

aOR Adjusted odds ratios; 95%CI 95% confidence intervals; * $P \leq 0.05$; ** $P \leq 0.01$

^a Model 1 = Network relation variables only, adjusted for socio-demographic characteristics

^b Model 2 = Network relation and structural variables only, adjusted for socio-demographic characteristics

^c Model 3 = Final model containing network relation, structural and functional variables, adjusted for socio-demographic characteristics

network density) did not substantially change the results generated in Model 1. The two factors of network structure were not statistically significantly associated with the transition.

Model 3 (the full model that includes candidate variables of the three social network dimensions) documented the following statistically significant associations: (1) Egos with larger sex networks were more likely to transition to heroin-injection (aOR = 2.17; 95% CI = 1.26, 3.75; $P < 0.01$); (2) Egos who believed that a greater number of their network members were injectors (that is, higher levels of the descriptive norm) were nearly twice as likely to transition to heroin-injection (aOR = 1.69; 95% CI = 1.24, 2.31; $P < 0.01$). Although the statistically significant level was marginal, having a higher network density was also associated with the transition (aOR = 2.54; 95% CI = 0.96, 6.73; $P = 0.06$). No significant difference was found between the odds of transitioning to heroin injection

among egos who perceived receiving tangible support from the various types of network alters. Due to high collinearity between variables for tangible and emotional support (variance inflation factors greater than 10), only tangible support is included in Model 3. With the exception of the addition of network-function variables, there are few differences between the results obtained from the three models with regards to the association between social network variables and transitioning to injection-use. In Model 3, the only difference is that network density becomes marginally significant.

Results from the sensitivity analysis comparing the RDS-weighted and unweighted models (results not shown) showed that all the associations between social network dimensions and transitioning to heroin-injection held. The second sensitivity analysis documented that similar results were generated in the whole sample (including 168 non-injection drug users and 235 injectors) and in the

subsample (including all 168 non-injection drug users and 100 injectors who had injected heroin for five years or less). Recall bias might not be substantial in this study.

Discussion

This study has several strengths that will contribute to the existing literature. First, with the exception of Neaigus et al. [24], few studies have investigated the role of subjective norms in the transition from non-injection to injection drug use. Secondly, few have examined the influence of social network support factors in injection drug use transition. Thirdly, to the best of our knowledge, this is the first study that has examined the role of social network dimensions in injection drug use transition in the context of Chinese culture, which is unique due to its emphasis on collectivist culture.

The major findings from this study are that having a larger sex network size and the perception of a greater number of heroin injection users in an ego's social network strongly predict an ego's transition to injection drug use. Other social network dimensions, particularly social support from injectors, sex-partner and friend alters, and positive and negative subjective norms in the form of peers' encouragement to inject or not inject drugs, although significant at the bivariate level, may not play an independent role in the transition to injection drug use once all other social network components are taken into account. The associations between having a larger sex network, perceiving a greater number of injectors in one's social network and transitioning to injection-use are consistent with previous research conducted in other countries. One study found that among drug users in Amsterdam, having an injector as a sexual partner was positively associated with transitioning to injection drug use [35]. Another study also found that among drug users who have never injected drugs, greater exposure to current injection drug users was associated with transitioning to injection drug use [24]. The association between having a greater number of injectors in one's social network and the transition to injection is also consistent with the diffusion network model theory, which suggests that new behavior is initially adopted by some network members based on their own innovativeness and exposure to outside sources of influence. This new behavior then spreads throughout the social network through various ways such as observation. That is, those who have not yet adopted the new behavior may be influenced to do so by observing their peers engage in that particular behavior [36].

Paradoxically, results from our study indicate that while a strong significant association was found between having a larger number of injectors in one's social network (that is,

higher levels of the descriptive norm) and the transition to heroin injection, no significant association was found between positive and negative subjective norms and the transition. Results from our study may be explained by the nature of Chinese culture and society. "Talk doesn't cook rice" is a very popular saying in China, and highlights the importance of behavior, rather than words, to individuals and the society [37]. This saying is similar to the English expression, "actions speak louder than words", and implies that just saying something does not make it true or make it happen. In other words, people are more likely to believe their own observations of an individual's behavior, rather than what the person says. Norms can be developed and transferred through observing others' behaviors [38, 39], and our results show that Chinese drug users are more concerned with what they believe their peers are *doing*, rather than with what they are being told by network peers. This indicates that peer behavior is valued as a more accurate measure of what other drug users really think and feel.

Generally, behavior carries more weight than words since it is a far more reliable and valid measure of reality, and acts as evidence or proof of what an individual says [37]. Due to the collectivist nature of Chinese culture, which emphasizes the group approach, harmony, equality, and social commitment [40], young drug users, in an effort to be more like their peers and fit in with their network members, may be more likely to imitate other drug users' behaviors. Believing that many of one's peers are injection drug users may also be viewed as acceptance and/or approval of this risky behavior by network members (injunctive norms). Previous research has linked higher levels of injunctive norms to increased injection risk behaviors among male injectors [41], and the majority of drug users in this sample are male.

This study also found that network density was associated with transitioning to injection-use, although the statistically significant level is marginal. This finding is consistent with the "actions speak louder than words" concept among drug users in China, since the greater the proportion of an ego's network alters who know each other, the more likely there is to be a "domino effect" of specific behaviors within the network. That is, dense connections among alters in an ego's social network make it easier for egos to observe alters' behaviors, and thus they can be greatly influenced by the frequency of observations of others' practices. However, due to the marginal significance, further research to confirm the result is needed.

There are several limitations associated with this study. First, although approaches were used to assist subjects to recall needed information, injectors who transitioned to heroin injection 6 years or more ago might not accurately recall information about social networks. However, our

sensitivity analysis indicated that the bias might not be substantial. Second, since information for the three social network dimensions were collected in the 30 days prior to transition for injectors, and the 30 days prior to the interview for non-injectors, it is possible that there was a mismatch between social network factors that measured at the time of transition among injectors and those factors that were measured at the time when non-injection drug users were interviewed. Third, statistical methods for conducting multivariate analyses on RDS data are still being developed, which is why results from the RDS-weighted regression analysis were compared with those obtained from the unweighted regression analysis [42]. Further, since this is a cross-sectional study, no conclusions can be drawn about causation. Finally, study participants were recruited from Yunnan province and thus are not necessarily representative of all drug users in China.

Conclusions

Due to the role played by injection drug users in transmitting HIV to the general population in China, preventing the transition to injection drug use among non-injection drug users may be particularly important in curbing the spread of the disease in China. Results from this study emphasize that drug users are more strongly influenced by their beliefs about their peers' behavior than by their words. To reduce the transition to injection drug use among this population, behavioral intervention programs are essential and must target not only individual drug users, but also other drug users in their social network. Due to the strong influence of perceived peer behavior on the transition, the popular opinion leader (POL) intervention approach, based on the diffusion of innovation theory, may be effective in reducing the number of heroin and/or opiate users who transition to injection-use [43]. In this approach, drug-use peers who are popular or respected by others can be selected from social networks. They can be trained to endorse non-injection practices, and increase awareness about the risks involved with this transition in their social networks. Future research is needed to test the effectiveness of the POL intervention targeting the transition to heroin injection in China or other countries with similar settings.

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