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The different administration of synthetic drugs and heroin have effects on sexual behaviours among people who inject drugs in Southwest China: a cross-sectional study

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Abstract

Objective: To describe differences in sexual practices among individuals with different drug administration patterns.

Setting: One largest detoxification centre in Southwest China, belonging to Chinese national sentential surveillance sites for blood-borne viral and sexually transmissible infections (BBVSTIs) was recruited.

Participants: A total of 610 newly enrolled people who inject drugs (PWID) in the past one week were included in this study.

Primary and secondary outcome measures: Self-reported sexual activities, drug-related practices and laboratory-confirmed BBVSTIs tests.

Results

Of the 610 PWID, 295 (48.4%) used heroin only, 277 (45.4%) poly-drug users reported the mixed use of synthetic drugs (SDs) with heroin, and 38 (6.2%) used SDs only. The average daily drug injection frequency for poly-drug users (3.3±1.2 times) was highest, followed by heroin-only (2.2±0.8 times) and SDs-only users (1.2±0.4 time). SDs-only drug users reported the highest proportion (86.8%) of engaging in sexual activities in the previous month, with more than half (54.5%) reporting any condomless sex. A higher frequency of daily injecting in heroin-only users was significantly correlated with the less likelihood of sex, condomless sex in the past month, having sex with fixed partners, condomless commercial sex in the previous twelve months (all $p<0.01$). In poly-drug users, those who injected drugs two times per day was associated with the highest proportion of people who engaged in sex and commercial sex ($p<0.05$). For SDs-only users, increased drug use was not associated with reducing sexual risk ($p>0.05$). Different patterns of BBVSTIs prevalence rates were shown among the PWID depending on the roles and length of exposure.

Conclusions

The daily drug injecting frequency of heroin-only and poly-drug users was negatively associated with sexual activities, but SDs-only users kept a persistent sexual arousal under the influence of drugs. The existing interventions for BBVSTIs need to adapt to these characteristics of the drug users.

Key words: synthetic drugs; heroin; poly-drug use; intravenous drug users; drug dependence; sexually transmitted infections

Strengths and limitations of this study

Strengths:

a. A study that comprehensively compares the demographic characteristics, drug-related practices, sexual practices and infection status among synthetic drug only users, heroin-only users, and poly-drug users in a national surveillance setting.

b. The results identify that sexual activities including condom use are subject to the type of drugs used and daily injection frequencies between the users.

c. It explores the underlying reasons for users having different sexual behaviours due to the different administration of drugs.

d. It shows the status of people injecting synthetic drugs and adds to the evidence for harm reduction and sexually transmitted infections prevention in drug users with increasing use of synthetic drugs.

Limitations:

a. A potential recall bias may exist in the study since drug-related behaviours and sexual behaviours were from the participants self-report.

b. For the poly-drug user group, where respondents only reported injection of both heroin and SDs, we could not ascertain whether drugs were consumed concurrently in one dose or through a sequence of different injections.

c. The number of respondents who only injected SDs was small, which will reduce statistical power regarding analysis.

Background

Recreational drug use is a significant public health concern worldwide, and those who inject drugs may experience severe health consequences from the drug harms, blood-borne infections due to sharing of contaminated injection equipment and inequity in accessing healthcare services [1 2]. While the size of this population has continued to grow during the recent decade, access to health services underpinned by harm reduction principles has remained low (about one in six in this population) [3]. Consequently, specific disease burdens in this population are disproportionally high globally: in 2015, approximately 13.3% people who inject drugs are living with human immunodeficiency virus (HIV), and 50.8% are living with chronic hepatitis C (HCV) infection [3].

In China, since the 21st century, unsafe drug use, especially heroin use, has contributed to surging epidemics of blood-borne infections, such as HCV and HIV [4]. In the last decade, synthetic drug (SD) use increased throughout China. In 2015, the use of SD in China exceeded heroin use for the first time. The most common SD, such as methamphetamines, have strong euphoric effects, and have been associated with prolonged sexual activity [5-8]. The combination of sexual risk and injecting drug use creates a complex with the mixture of exposure that may facilitate the spread of blood-borne viral and sexually transmissible infections (BBVSTIs) [8-11]. Moreover, drug users in China generally consume SD via snorting, but currently, drug users have shown an increasing trend on injecting SD for a more intense high, which is consistent with the reports in other countries [12 13]. Though compared with heroin, SD injection is still used on a small scale, this intake method is estimated to bring more unpredicted harm than previous way. Furthermore, it has been documented that 30-40% of heroin users in China nowadays also use SD and some SD users inject heroin at the same time as well to maximise pleasure, with the proportion expected to grow rapidly in the next few years [14 15]. This poly-drug use is associated with more harmful drug effects and high-risk behaviours. As different drugs act on bodies in various ways to cause sedation, the drug effects would be magnified through using multiple drugs. So the same dose intake of poly-drug can cause stronger sexual stimulus than the sole drug use, the users are more likely to have condomless sex, and group sex [16 17]. However, the specific effects of how these various drug-using patterns facilitate the BBVSTIs transmission remain unknown in China.

Yuxi, located in central area of Yunnan Province is renowned for its drug trafficking and consumption in China, which may result in some of the highest rates of sexually transmitted infections and HCV in China [18]. Specifically, from 2005 to 2016, a total of 3,092 unique HIV-positive people were diagnosed in this region, accounting for 0.13% of its total local population, with 326 being classified as newly infected in 2016. Further, 763 newly infected syphilis cases and 470 HCV-positive cases were notified in this area in 2016 [19 20]. Thus, Yuxi is a proper study setting to investigate the relationship between BBVSTIs transmission and PWID, especially in the era of the constant emergence of new SDs. This study aims to identify the characteristics among different drug users and assess if different pattern and doses in drug use were associated with sexual practice of drug users.

Methods

A cross-sectional survey was conducted in the largest detoxification centre in Yuxi, which is also one of the Chinese national BBVSTIs sentential surveillance sites that routinely collect data from designated priority populations. The eligibility criteria included the following: 1) recent injection of recreational drugs in the previous week, 2) being 18 years of age or older, 3) residing in Yuxi in the previous three months and 4) provision of written informed consent. This paper reports findings from our secondary data analysis (stripped of any personal identifier) of these local routinely collected bio-behavioural surveillance data, which was approved by the Monash University Human Research Ethics Committee (CF16/942 - 2016000495).

Data were collected between January 2015 and December 2015. On the first day of their admission to the detoxification centre, all participants were offered to self-complete a paper survey, with 15 minutes average completion time. The questionnaire covered key socio-demographic characteristics, recent drug consumption patterns (a standard list of traditional and emerging SDs, frequency, and route of use, etc.), and impact of drug use including engagement in sex categorized by recent sexual activities (previous one month), commercial sexual acts (involving in commercial sex service in the previous twelve months), and having sex with fixed partner (previous twelve months). We differentiated 'poly-drug users' as those who used both heroin and any SDs concurrently from heroin-only users and SDs-only users. The participants were classified into three categories according to their drug use. The comparison of demographic characteristics, drug-related behaviours, sexual practice and infection status, was conducted between three groups. The relationship between sexual practice and drug injection frequency was explored within the each drug group.

Each survey participant also undertook linked blood and urine test. Serological detection of HIV, HCV and syphilis followed standard Chinese national diagnostic guidelines in which: HIV-positivity was confirmed by enzyme-linked immunosorbent assay (ELISA) screening and Western Blot (WB) validation [21]; HCV-positivity was confirmed by detection of HCV antibodies through repeated, independent ELISA testing [22]; and syphilis-positivity was confirmed by rapid plasma reagin (RPR) circle card test screening with Treponema pallidum particle agglutination assay (TPPA) validation. Laboratory-confirmed HIV, HCV or positive syphilis cases were notified and referred, following the standard clinical referral pathways. The urine detection results of drug residuals were used to corroborate with self-reported drug consumption in the previous week.

Statistical analysis

All data analyses were conducted on SAS 9.4 (Cary, NC: SAS Institute Inc.). Descriptive and subsequent inferential analyses were performed. Comparisons across three subgroups were conducted using Wald X^2 test. Two multivariable linear regression models were built to assess the relationship between drug use frequencies and sexual practices among drug users. Variables with p-value <0.2 in the univariate analysis were included in the multivariate regression. A p-value of less than 0.05 was considered significant in the final model.

Results

A total of 610 eligible participants out of the 848 new entrants at the detoxification centre in Yuxi in 2015 were enrolled. The majority were male (551, 90.3%) and the rest were female (59,
9.7%). The mean age of the whole sample was 34.4±8.3 years old. The majority of drug users received junior high school or below education (564, 92.5%) and unmarried (385, 63.1%). The three subgroups of drug users include heroin-only users (295, 48.4%), poly-drug users (277,
45.4%), and SDs-only users (38, 6.2%). Poly-drug users (33.8±7.8 years) and heroin-only users
(35.1±8.3 years) were significantly older than SDs-only users (29.1±7.2 years) (p=0.03). Of the three groups, poly-drug users had the highest daily drug injecting frequency (3.3±1.2 times/day), followed by heroin-only users (2.2±0.8 times/day) and SDs-only users (1.2±0.4 times/day, p<0.01). The syringe sharing rate was lower in heroin-only users (107, 36.3%) than the poly-drug users (145, 52.3%) and SDs-only users (21, 55.3%) (p<0.01). No significant differences are observed in gender distribution, married status and education levels among three groups (Table 1).

Estimated 33 (86.8%) participated SDs-only users had sex in the previous month, in contrast, only 132 (44.7%) heroin-only users and 176 (63.5%) poly-drug users reported so. SDs-only users had a higher rate of condomless sex in the previous month (18, 54.5%, p=0.01) compared with heroin-only users (47, 35.6%) and poly-drug users (34, 19.3%). Similarly, the proportion of SDs-only users (29, 76.3%) who solicited commercial sex in the past 12 months was also higher than poly-drug users (165, 59.6%) and heroin-only users (103, 34.9%, p<0.01), and so was condomless rate during commercial sex (SDs-only users [15, 51.7%], versus heroin-only users [39, 37.9%] and poly-drug users [56, 33.9%]) (p<0.05). However, no significant differences were found in the sexual behaviours with fixed partners over the last twelve months among heroin-only (89, 78.8%), poly-drug (72, 76.6%) and SDs-only users (13, 72.2%), but condomless sex rate was the highest in SDs-only users (12, 92.3%), compared with heroin-only users (67, 75.3%) and poly-drug users (66, 91.7%, p<0.01).

BBVSTI positivity rates were substantially different between the three groups. HCV positivity was the highest in heroin-only users (210, 71.2%), followed by poly-drug users (183, 66.1%) and the lowest among SDs-only users (15, 39.5%, p<0.01). In contrast, HIV infection was the highest among poly-drug users (37, 13.4%, p=0.02) and then heroin-only users (27, 9.2%), but no HIV cases were found in SDs-only users. Notably, syphilis positivity was the highest among SDs-only users (3, 7.9%, p<0.01), compared with poly-drug users (6, 2.2%) and heroin-only users (4, 1.3%) (Table 1).

The multivariable linear regression model demonstrated that in both the heroin-only users and poly-drug users higher frequency of daily drug injection were correlated with lower likelihood of having had sex or any condomless sex (Figure 1a and 1b). Among heroin-only users, every additional injection per day was associated with a 4.6% reduction in sex activities

(p<0.01) and a 7.3% reduction condomless sex in the previous month (p<0.01). The likelihood of sex in the past month decreased sharply from the peak 53.3% to 30.0%, and condomless sex rate decreased from the peak 37.5% to 0% when the injection frequencies rose from one to six or more injections a day (Figure 1a). There was also an 11.5% reduction in the reported rate of condomless commercial sex in the past 12 months for every additional injection (p<0.01) (Figure 1a). Ceiling effects were reached earlier for the poly-drug users with two or more daily injections, being associated with reduced sex activities in the previous month (decreased from the peak 69.0% to 35.7%, p<0.01) and commercial sex in the previous 12 months (decreased from peak 64.0% to 42.9%, p<0.01, Figure 1b). The frequency of daily injection and the rate of sex with fixed partners also showed a negative relationship, namely, every extra daily injection reduced 10.4% likelihood of having sex with a fixed partner (p<0.01). In contrast to other two groups, no significant reduction in sexual risk was seen with more frequent drug injecting among SDs-only users (Figure 1c).

Discussion

To our best knowledge, this is the first study in China to demonstrate strong associations between daily injection frequencies and sexual behaviours and patterns of recreational drug use. The findings suggest heroin use is associated with reduced sexual risk, and SDs use is associated with higher sexual risk. Furthermore for those who use heroin (alone or with SDs use) increased daily injection frequencies were associated with decreases in both sexual activities and condomless sex. Conversely, increased drug injecting frequency among SDs-only users was not associated with reductions in sexual risk.

Several explanations are relevant to the dosage effects from drug consumption and sexual behaviours. For heroin-only users, it has been documented that high doses of heroin suppress libido and increase the likelihood of erectile dysfunction [23-26], leading to reduced sexual activity after drug consumption. In contrast, common SDs (e.g., methamphetamine) are sexual stimulants. Only a few studies have linked SDs with erectile dysfunction with no clear indication of a potential threshold that could reverse 'stimulating effect' [27-29]. This may explain the consistently high frequent sexual activities observed among SDs-only users. There has been evidence of orally ingested cocaine at 0mg (placebo group), 125mg and 250mg once a day leading to increased sexual desire that was linear to drug dosage [30]. However, in our study, intravenous injection of SDs from one to four times (approximately 100mg each injection) per day did not show linear effects on sexual arousal. The difference may be due to the SDs participants in our study are all PWID and have developed strong dependence of drugs. So most of them probably have reached drug-induced climax through their high dosage intake. The finding is consistnet with the previous results that injecting SD pose a higher risk on sexual impulsivity than otherwise [31]. Thus, we cannot determine a clear dose-effect in the result.

We found that condom use depends on the dose and type of drug. It is well documented that a positive association exists between the SDs including crystal methamphetamine, ketamine, and ecstacy and high-risk sexual practices such as condomless sex, both in China and globally

[32-35]. Conversely, our study demonstrated that a declining rate of condomless sex is associated with increases in drug injecting frequency among poly-drug users and heroin-only users but not in SDs-only users. Interestingly, an existing literature on cocaine effects demonstrated that under ideal circumstances where condoms are always available, condomless sex does not associate with cocaine use, which is in contrast to case group who lacked immediate access to condoms [30]. The latter demonstrates a trend of reduced condom use following the consumption of cocaine with dose-response effects. These results highlight the critical role of condom availability for drug users.

Regarding BBVSTI prevalence, SD-only group had the highest syphilis positivity rate, the heroin-only group had the highest HCV positivity rate, and mixed user group had the highest HIV infection rate. This partly reflects the divergence of HIV, HCV and STI epidemics and chronological impacts on different priority populations in China. Heroin-only users have the lowest syringe sharing rate within the past twelve months among three groups in our study. However, the higher prevalence of HCV may be due to accumulative risk of infection from a longer duration of injecting drug use. As heroin has been available for more than three decades, SD have only become popular among Chinese youth last five years [4 14]. It concurs that the mean age of heroin users is significantly greater than the SD users in our study. Thus, for the younger Chinese generation, who may have a relatively shorter drug use (or mix-use) history of SD, BBVSTI prevention should be the foremost priority. Some effective interventions for previous drug harm reduction could be implemented on a wide scale, for example, needle-syringe exchange programs, originally targeting heroin users [36], should be extended to SD users to prevent blood-borne disease transmission [37]. Also, proactive intervention strategies need to be put in place in response to the imminent transition from non-injection to injection routes, as seen in other countries [38 39], which is expected to further increase BBVSTI burden.

Several limitations should be noted. First, except for laboratory results, self-report drug use and sexual behaviours were from the participants; therefore, recall bias may exist in this study. Second, the number of respondents who only injected SD was small, which will reduce statistical power regarding analysis. Third, for the poly-drug user group where respondents only reported injection of both heroin and SDs, we could not ascertain whether drugs were consumed concurrently in one dose or through a sequence of different injections. Despite this, our study shows the first attempt to explore the drug injection frequency effects on sexual behaviours. These findings are not limited to contributing to the harm reduction of drug consumption in China, but they also add evidence for easing the BBVSTI burden brought by drug use in other countries. As rampant recreational drugs consumption is common worldwide, the issue needs global corporation to eliminate the negative influences.

Conclusions

This study underscores that sexual activities including condom use are subject to the type of drugs used and dosage between PWID. Elevated risk of unsafe sexual behaviours have been established among a generation of SD injection users. BBVSTI prevention and treatment programs targeting priority subgroups of PWID in China should be promoted.

Data Sharing

Due to privacy and ethical concerns, supporting data cannot be made openly available. Please contact the authors for the access of the original data.

Competing interests statement

The authors declare no conflict of interest.

Author contributions

Lei Zhang, Feng Cheng and Limin Mao conceived and designed the study; Shunxiang Li, Jinxian Zhao, Shifu Li and Liang Chen collected and cleaned the data; Shu Su, Lei Zhang, and Limin Mao analyzed the data; Shu Su wrote the paper; Shunxiang Li, Jun Jing, Christopher Kincaid Fairley, Limin Mao and Lei Zhang revised the manuscript. All authors approved the final manuscript.

Figure legends

Figure 1. The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among PWID in Southwest China

Table 1. Key socio-demographic characteristics, drug-related practices, sexual activities following drug consumption and prevalence of confirmed HIV, HCV and syphilis infections among PWID in Southwest China

Drug type	Heroin only	Poly-drug use	SDs only	P-value
	295	277	38	
Demographic characteristics				
Gender				0.42
Male	270 (91.5%)	249(89.9%)	32 (84.2%)	
Female	25(8.5%)	28 (10.1%)	6 (15.8%)	
Mean age	35.1 ± 8.3	33.8 ± 7.8	29.1 ± 7.2	0.03
Married status				0.12
Single/Divorced	182(61.7%)	183(66.1%)	20 (52.6%)	
Married/Cohabitation	113(38.3%)	94(33.9%)	18(47.4%)	
Education				0.41
Junior high or below	268(90.8%)	261(94.2%)	35(92.1%)	
Senior high or above	27(9.2%)	16(5.8%)	3(7.9%)	
Drug-related practices				
Injection frequency (times/day)	2.2 ± 0.8	3.3 ± 1.2	1.2 ± 0.4	<0.01
Percentage of syringe sharing				<0.01
Yes	107(36.3%)	145(52.3%)	21(55.3%)	
No	188(63.7%)	132(47.7%)	17(44.7%)	
Sexual activities associated with drug consumption				
Any sexual acts (previous 1 month)				0.01
Yes	132(44.7%)	176(63.5%)	33(86.8%)	
No	163(55.3%)	101(36.5%)	5(13.2%)	
Consistent condom usage in any sexual acts (previous 1 month)				0.01
Yes	85(64.4%)	142(80.7%)	15(45.5%)	
No	47(35.6%)	34(19.3%)	18(54.5%)	
Commercial sexual acts (previous 12 months)				<0.01
Yes	103(34.9%)	165(59.6%)	29(76.3%)	
No	192(65.1%)	112(40.4%)	9(23.7%)	
Consistent condom use in commercial sexual acts (previous 12 months)				<0.01
Yes	64(62.1%)	109(66.1%)	14(48.3%)	
No	39(37.9%)	56(33.9%)	15(51.7%)	

Having sex with fixed partner (previous 12 months)				0.29
Yes	89(78.8%)	72(76.6%)	13(72.2%)	
No	24(21.2%)	22(23.4%)	5(27.8%)	
Consistent condom use with fixed partner (previous 12 months)				<0.01
Yes	22(24.7%)	6(8.3%)	1(7.7%)	
No	67(75.3%)	66(91.7%)	12(92.3%)	
Confirmed infections				
HIV infection				0.02
Positive	27(9.2%)	37(13.4%)	0(0.0%)	
Negative	268(90.8%)	240(86.6%)	38(100.0%)	
HCV infection				<0.01
Positive	210(71.2%)	183(66.1%)	15(39.5%)	
Negative	85(28.8%)	94(33.9%)	23(60.5%)	
Syphilis infection				<0.01
Positive	4 (1.3%)	6 (2.2%)	3 (7.9%)	
Negative	291 (98.7%)	271(97.8%)	35 (92.1%)	

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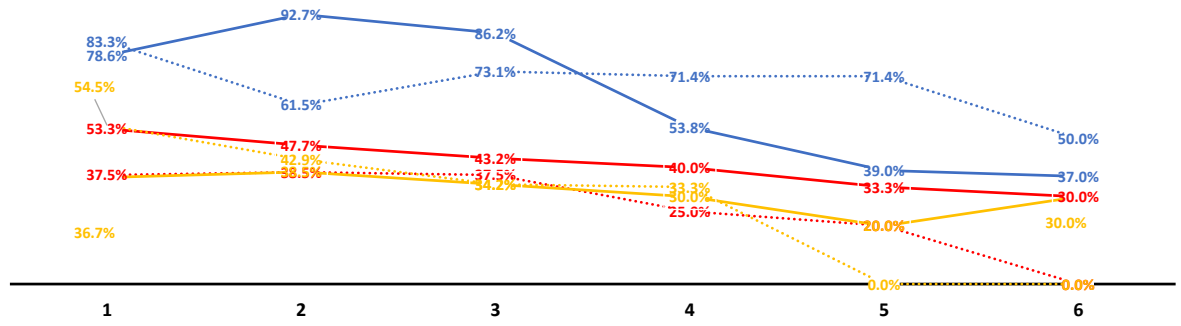
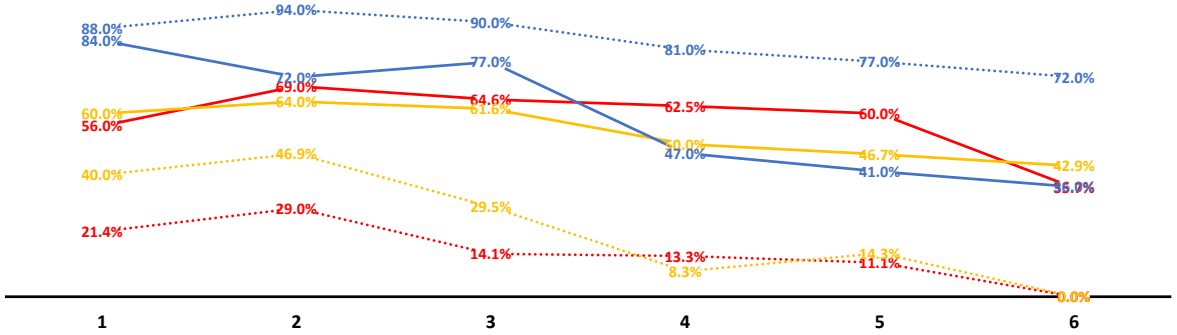
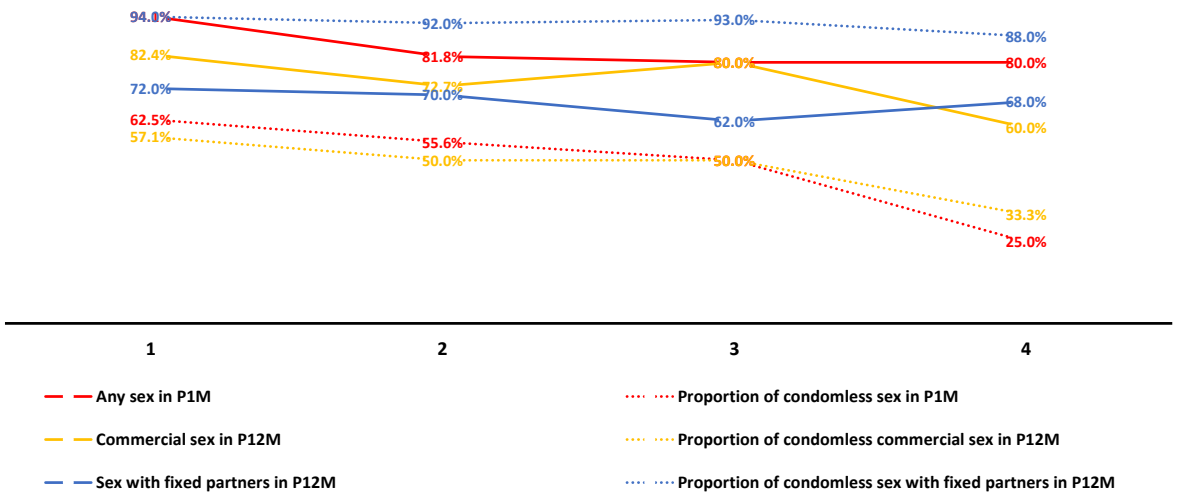
Panel a.



Panel b.



Panel c.



STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No (Reported on page #)	Recommendation
Title and abstract (✓)	1 (1)	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (✓)		
Background/rationale	2 (4)	Explain the scientific background and rationale for the investigation being reported
Objectives	3 (4)	State specific objectives, including any prespecified hypotheses
Methods (✓)		
Study design	4 (5)	Present key elements of study design early in the paper
Setting	5 (5)	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 (5)	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 (5)	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*(5)	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 (not applicable)	Describe any efforts to address potential sources of bias
Study size	10 (5)	Explain how the study size was arrived at
Quantitative variables	11(5)	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12(5)	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

		(*e*) Describe any sensitivity analyses

Continued on next page

Results (✓)		
Participants	13*(6)	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*(6)	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*(6)	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 (6-7)	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 (not applicable)	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (✓)		
Key results	18 (7)	Summarise key results with reference to study objectives
Limitations	19 (8)	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 (7-8)	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21(8)	Discuss the generalisability (external validity) of the study results
Other information (✓)		
Funding	22 (not applicable)	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Association between recreational drug use and sexual practices among people who inject drugs in Southwest China: a cross-sectional study

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Association between recreational drug use and sexual practices among people who inject drugs in Southwest China: a cross-sectional study

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Abstract

Objective: To describe the differences in sexual practices among individuals with various drug administration patterns.

Setting: A detoxification centre in Southwest China, a part of the Chinese national sentential surveillance network for hepatitis C (HCV), human immunodeficiency virus (HIV) and syphilis infections, was recruited.

Participants: A total of 610 newly enrolled injection drug users (IDU) from detoxification centre were included during 2015.

Primary and secondary outcome measures: Self-reported sexual activities, drug-related practices and laboratory-confirmed HCV, HIV and syphilis infection status were collected.

Results

Of the 610 IDU, 295 (48.4%) used heroin only, 277 (45.4%) poly-drug users reported the mixed use of synthetic drugs (SDs) with heroin, and 38 (6.2%) used SDs only. The average daily drug injection frequency for poly-drug users (3.3±1.2 times) was the highest, followed by heroin-only (2.2±0.8 times) and SDs-only users (1.2±0.4 time). SDs-only drug users reported the highest proportion (86.8%) of engaging in sexual activities in the previous month, with more than half (54.5%) reporting any condomless sex. A higher frequency of daily injecting in heroin-only users was significantly correlated with the less likelihood of sex, condomless sex in the past month, having sex with fixed partners, condomless commercial sex in the previous twelve months (all $p<0.01$). In poly-drug users, who injected drugs two times/day was associated with the highest proportion of people who engaged in sex and commercial sex ($p<0.05$). For SDs-only users, increased drug use was not associated with reducing sexual risk ($p>0.05$). Different patterns of HCV, HIV, and syphilis infections prevalence rates were shown among the IDU depending on the roles and length of exposure.

Conclusions

The daily drug injecting frequency of heroin-only and poly-drug users was negatively associated with sexual activities, but SDs-only users kept a high frequent engagement in sex. The interventions for relevant diseases should adapt to characteristics of IDU.

Key words: synthetic drugs; heroin; poly-drug use; intravenous drug users; drug dependence; sexually transmitted infections

Strengths and limitations of this study

Strengths:

a. A study that comprehensively compares the demographic characteristics, drug-related practices, sexual practices and infection status among synthetic drug only users, heroin-only users, and poly-drug users in a national sentential surveillance setting.

b. It explores the underlying associations between users having different administration of drugs use and sexual behaviours.

c. It shows the status of people injecting synthetic drugs and adds to the evidence for harm reduction and sexually transmitted infections prevention in drug era with increasing numbers of synthetic drug users.

Limitations:

a. A potential recall bias may exist in the study since drug-related behaviours and sexual behaviours were from the participants self-report.

b. The number of respondents who only injected SDs was small, which will reduce statistical power regarding analysis.

Background

Recreational drug use is a significant public health concern worldwide, and those who inject drugs may experience severe health consequences from the drug harms, blood-borne infections due to sharing of contaminated injection equipment and inequity in accessing healthcare services [1 2]. While the size of this population has continued to grow during the recent decade, access to health services underpinned by harm reduction principles has remained low (about one in six in this population) [3]. Consequently, specific disease burdens in this population are disproportionally high globally: in 2015, approximately 13.3% people who inject drugs are living with human immunodeficiency virus (HIV), and 50.8% are living with chronic hepatitis C (HCV) infection [3].

In China, since the 21st century, unsafe drug use, especially heroin use, has contributed to surging epidemics of blood-borne infections, such as HCV and HIV [4]. In the last decade, synthetic drug (SD) use increased throughout China. In 2015, the use of SD in China exceeded heroin use for the first time. The most common SD, such as methamphetamines, have strong euphoric effects, and have been associated with prolonged sexual activity [5-8]. The combination of sexual risk and injecting drug use creates a complex with the mixture of exposure that may facilitate the spread of blood-borne viral and sexually transmissible infections [8-11]. Moreover, drug users in China generally consume SD via snorting, but currently, drug users have shown an increasing trend on injecting SD for a more intense high, which is consistent with the reports in other countries [12 13]. Though compared with heroin, SD injection is still used on a small scale, this intake method is estimated to bring more unpredicted harm than previous way. Furthermore, it has been documented that 30-40% of heroin users in China nowadays also use SD and some SD users inject heroin at the same time as well to maximise pleasure, with the proportion expected to grow rapidly in the next few years [14 15]. This poly-drug use is associated with more harmful drug effects and high-risk behaviours. As different drugs act on bodies in various ways to cause sedation, the drug effects would be magnified through using multiple drugs. For example, concurrent use of cocaine and heroin (the mixture being dubbed as a 'speedball') has a synergistic impact on reducing norepinephrine release and reuptake [16]. Hence, poly-drug intake, albeit at the same dosage as a single drug, can cause much stronger sexual stimulus [17 18]. However, the specific effects of how these various drug-using patterns facilitate blood-borne viral and sexually transmissible infections transmission mainly including HCV, HIV and syphilis infections remain unknown in China.

Yuxi, located in central area of Yunnan Province is renowned for its drug trafficking and consumption in China, which may result in some of the highest rates of HIV, syphilis and HCV infections in China [19]. Specifically, from 2005 to 2016, a total of 3,092 unique HIV-positive people were diagnosed in this region, accounting for 0.13% of its total local population, with 326 being classified as newly infected in 2016. Further, 763 newly infected syphilis cases and 470 HCV-positive cases were notified in this area in 2016 [20 21]. Thus, Yuxi is a proper study setting to investigate the relationship between HCV, HIV and syphilis infections transmission and IDU, especially in the era of the constant emergence of new SDs.

This study aims to identify the characteristics among different drug users and assess if different pattern and doses in drug use were associated with sexual practice of drug users.

Methods

A cross-sectional survey was conducted in the largest detoxification centre in Yuxi, which is also one of the Chinese national HCV, HIV and syphilis infections sentential surveillance sites that routinely collect data from designated priority populations. The eligibility criteria included the following: 1) recent injection of recreational drugs in the previous week, 2) being 18 years of age or older, 3) residing in Yuxi in the previous three months and 4) provision of written informed consent. This paper reports findings from our secondary data analysis (stripped of any personal identifier) of these local routinely collected bio-behavioural surveillance data, which was approved by the Monash University Human Research Ethics Committee (CF16/942 - 2016000495).

Data were collected between 26th January 2015 and 11st December 2015. On the first day of their admission to the detoxification centre, all participants were offered to self-complete a paper survey, with 15 minutes completion time on average. The questionnaire was used by the Chinese CDC as part of their routine sentential surveillance system nationally, which include all sites in Yunnan province. It covered key socio-demographic characteristics, patterns of latest drug consumption and a range of sexual practices. Specifically, the list of recreational drugs under investigation included heroin, cocaine, methamphetamine, ketamine and ecstasy. The routes of drug administration were intravenous, smoking, snorting and oral ingestion. Inquiries into sexual activities were assessed by six questions (with a yes/no answer). The first set of two questions were "Did you have any sex in the previous month?" and if yes, whether condoms were used for sex in the same period. The second set of questions were: "Did you engage in any commercial sexual activities in the previous twelve months?" and if yes, whether condoms were used for commercial sex in the same period. The third set of questions were: "Did you have sex with a fixed/regular partner in the previous twelve months?" and if yes, whether condoms were used for sex with the partner in the same period.

We differentiated 'poly-drug users' as those who used both heroin and any SDs concurrently from heroin-only users and SDs-only users. The participants were classified into three categories according to their drug use. The comparison of demographic characteristics, drug-related behaviours, sexual practice and infection status, was conducted between three groups. The relationship between sexual practice and drug injection frequency was explored within the each drug group.

Each survey participant also undertook linked blood and urine test. Serological detection of HIV, HCV and syphilis infections followed standard Chinese national diagnostic guidelines in which: HIV-positivity was confirmed by enzyme-linked immunosorbent assay (ELISA) screening and Western Blot (WB) validation [22]; HCV-positivity was confirmed by detection of HCV antibodies through repeated, independent ELISA testing [23]; and syphilis-positivity was confirmed by rapid plasma reagin (RPR) circle card test screening with Treponema pallidum particle agglutination assay (TPPA) validation. Laboratory-confirmed HIV, HCV or positive

syphilis cases were notified and referred, following the standard clinical referral pathways. The urine detection results of drug residuals were used to corroborate with self-reported drug consumption in the previous week.

Statistical analysis

All data analyses were conducted on SAS 9.4 (Cary, NC: SAS Institute Inc.). Descriptive and subsequent inferential analyses were performed. Comparisons across three subgroups were conducted using Wald X^2 test. Two multiple linear regression models were built to assess the relationship between drug use frequencies and sexual practices in each category of drug users. Dependent variable of two regression models were drug users having sexual activities and drug users having condomless sexual behaviours, respectively. Sexual activities in the model were defined by having sex in the previous one month, engaging in any commercial sexual activities in the previous twelve months and having sex with a fixed/regular partner in the previous twelve months. Accordingly, condomless sexual behaviours were defined by having condomless sex in the previous one month, having condomless sex during commercial sexual activities in the previous twelve months, having condomless sex with a fixed/regular partner in the previous twelve months. Demographic and drug-related variables with p-value <0.2 in the simple linear regression were included as the independent variable in the multiple linear regression. A p-value of less than 0.05 was considered significant in the final model.

Results

A total of 610 (71.9%) eligible registrants out of the 848 new entrants at the YuXi Detoxification Centre in 2015 were included, where 191 (22.5%) non-injection drug users, 34 (4.0%) non-current drug injection users (not in the previous week prior to entry) and 13 (1.5%) non-residents were excluded. The majority were male (551, 90.3%) and the rest were female (59, 9.7%). The mean age of the whole sample was 34.4±8.3 years old. The majority of drug users received junior high school or below education (564, 92.5%) and unmarried (385, 63.1%). The three subgroups of drug users include heroin-only users (295, 48.4%), poly-drug users (277, 45.4%), and SDs-only users (38, 6.2%). Poly-drug users (33.8±7.8 years) and heroin-only users (35.1±8.3 years) were significantly older than SDs-only users (29.1±7.2 years) (p=0.03). Of the three groups, poly-drug users had the highest daily drug injecting frequency (3.3±1.2 times/day), followed by heroin-only users (2.2±0.8 times/day) and SDs-only users (1.2±0.4 times/day, p<0.01). The syringe sharing rate was lower in heroin-only users (107, 36.3%) than the poly-drug users (145, 52.3%) and SDs-only users (21, 55.3%) (p<0.01). No significant differences are observed in gender distribution, married status and education levels among three groups (Table 1).

Estimated 33 (86.8%) participated SDs-only users had sex in the previous month, in contrast, only 132 (44.7%) heroin-only users and 176 (63.5%) poly-drug users reported so. SDs-only users had a higher rate of condomless sex in the previous month (18, 54.5%, p=0.01) compared with heroin-only users (47, 35.6%) and poly-drug users (34, 19.3%). Similarly, the proportion of SDs-only users (29, 76.3%) who solicited commercial sex in the past 12 months was also higher than poly-drug users (165, 59.6%) and heroin-only users (103, 34.9%,

p<0.01), and so was condomless rate during commercial sex (SDs-only users [15, 51.7%], versus heroin-only users [39, 37.9%] and poly-drug users [56, 33.9%]) (p<0.05). However, no significant differences were found in all the sexual behaviours with fixed partners over the last twelve months among heroin-only (89, 78.8%), poly-drug (72, 76.6%) and SDs-only users (13, 72.2%), but condomless sex rate during the sexual activities with fixed/regular partners was the highest in SDs-only users (12, 92.3%), compared with heroin-only users (67, 75.3%) and poly-drug users (66, 91.7%, p<0.01).

HCV, HIV and syphilis infections positivity rates were substantially different between the three groups. HCV positivity was the highest in heroin-only users (210, 71.2%), followed by poly-drug users (183, 66.1%) and the lowest among SDs-only users (15, 39.5%, p<0.01). In contrast, HIV infection was the highest among poly-drug users (37, 13.4%, p=0.02) and then heroin-only users (27, 9.2%), but no HIV cases were found in SDs-only users. Notably, syphilis positivity was the highest among SDs-only users (3, 7.9%, p<0.01), compared with poly-drug users (6, 2.2%) and heroin-only users (4, 1.3%) (Table 1).

The multivariable linear regression model demonstrated that in both the heroin-only users and poly-drug users. Higher frequency of daily drug injection were correlated with lower likelihood of having had sex or condomless sex (Figure 1a and 1b). Among heroin-only users, every additional injection per day was associated with a 4.6% reduction in sex activities (p<0.01) and a 7.3% reduction condomless sex in the previous month (p<0.01). The likelihood of sex in the past month decreased sharply from the peak 53.3% to 30.0%, and condomless sex rate decreased from the peak 37.5% to 0% when the injection frequencies rose from one to six or more injections a day (Figure 1a). There was also an 11.5% reduction in the reported rate of condomless commercial sex in the past 12 months for every additional injection (p<0.01) (Figure 1a). Regarding the poly-drug users, ceiling effects were reached earlier with two or more daily injections, being associated with reduced sex activities in the previous month (decreased from the peak 69.0% to 35.7%, p<0.01) and commercial sex in the previous 12 months (decreased from peak 64.0% to 42.9%, p<0.01, Figure 1b). The frequency of daily injection and the rate of sex with fixed partners also showed a negative relationship, namely, every extra daily injection reduced 10.4% likelihood of having sex with a fixed partner (p<0.01). In contrast to other two groups, no significant reduction in any sexual practices in the previous one or twelve months was seen with more frequent drug injecting among SDs-only users (Figure 1c).

Discussion

To our best knowledge, this is the first study in China to demonstrate strong associations between daily injection frequencies and sexual behaviours and patterns of recreational drug use. The findings suggest heroin use is associated with reduced sexual risk, and SDs use is associated with higher sexual risk. Furthermore for those who use heroin (alone or with SDs use) increased daily injection frequencies were associated with decreases in both sexual activities and condomless sex in short-term and long-term. Conversely, increased drug injecting frequency among SDs-only users was not associated with reductions in sexual risk.

Several explanations are relevant to the dosage effects from drug consumption and sexual behaviours. For heroin-only users, it has been documented that high doses of heroin suppress libido and increase the likelihood of erectile dysfunction [24-27], leading to reduced sexual activity after drug consumption. In contrast, common SDs (e.g., methamphetamine) are sexual stimulants. Only a few studies have linked SDs with erectile dysfunction with no clear indication of a potential threshold that could reverse 'stimulating effect' [28-30]. This may explain the consistently high frequent sexual activities observed among SDs-only users. There has been evidence of orally ingested cocaine at 0mg (placebo group), 125mg and 250mg once a day leading to increased sexual desire that was linear to drug dosage [31]. However, in our study, intravenous injection of SDs from one to four times (approximately 100mg each injection) per day did not show linear effects on sexual arousal. The difference may be due to the SDs participants in our study are all IDU and have developed serious drug dependence. It is possible that once these people reach the peak of drug-induced effects, further increases in drug injection frequency may have no extra impact on their sexual practices [32]. The finding is consistent with the previous results that injecting SD pose a higher risk on sexual impulsivity than otherwise [33]. Thus, we cannot determine a clear dose-effect in the result.

We found that condom use depends on the dose and type of drug. It is well documented that a positive association exists between the SDs including crystal methamphetamine, ketamine, and ecstacy and high-risk sexual practices such as condomless sex, both in China and globally [34-37]. Conversely, our study demonstrated that a declining rate of condomless sex is associated with increases in drug injecting frequency among poly-drug users and heroin-only users but not in SDs-only users. Interestingly, an existing literature on cocaine effects demonstrated that under ideal circumstances where condoms are always available, condomless sex does not associate with cocaine use, which is in contrast to case group who lacked immediate access to condoms [31]. The latter demonstrates a trend of reduced condom use following the consumption of cocaine with dose-response effects. These results highlight the critical role of condom availability for drug users.

Regarding HCV, HIV and syphilis infections prevalence, SD-only group had the highest syphilis positivity rate, the heroin-only group had the highest HCV positivity rate, and mixed user group had the highest HIV infection rate. This partly reflects the divergence of HIV, HCV and STI epidemics and chronological impacts on different priority populations in China. Heroin-only users have the lowest syringe sharing rate within the past twelve months among three groups in our study. However, the higher prevalence of HCV may be due to accumulative risk of infection from a longer duration of injecting drug use. As heroin has been available for more than three decades, SD have only become popular among Chinese youth last five years [4 14]. It concurs that the mean age of heroin users is significantly greater than the SD users in our study. Thus, for the younger Chinese generation, who may have a relatively shorter drug use (or mix-use) history of SD, HCV, HIV and syphilis infections prevention should be the foremost priority. Some effective interventions for previous drug harm reduction could be implemented on a wide scale, for example, needle-syringe exchange programs, originally targeting heroin users [38], should be extended to SD users to prevent

blood-borne disease transmission [39]. Also, proactive intervention strategies need to be put in place in response to the imminent transition from non-injection to injection routes, as seen in other countries [40 41], which is expected to further increase HCV, HIV and syphilis infections burden.

Several limitations should be noted. First, except for laboratory results, self-report drug use and sexual behaviours were from the participants; therefore, recall bias may exist in this study. Second, the number of respondents who only injected SD was small, which will reduce statistical power regarding analysis. Third, for the poly-drug user group where respondents only reported injection of both heroin and SDs, we could not ascertain whether drugs were consumed concurrently in one dose or through a sequence of different injections. Despite this, our study shows the first attempt to explore the drug injection frequency effects on sexual behaviours. These findings are not limited to contributing to the harm reduction of drug consumption in China, but they also add evidence for easing the HCV, HIV and syphilis infections burden brought by drug use in other countries. As rampant recreational drugs consumption is common worldwide, the issue needs global corporation to eliminate the negative influences.

Conclusions

This study underscores that sexual activities including condom use are subject to the type of drugs used and dosage between IDU. Elevated risk of unsafe sexual behaviours has been established among a generation of SD injection users. HCV, HIV and syphilis infections prevention and treatment programs targeting priority subgroups of IDU in China should be promoted.

Data sharing statement

Due to privacy and ethical concerns, supporting data cannot be made openly available. Please contact the authors for the access to the original data.

Competing interests statement

The authors declare no conflict of interest.

Author contributions

Lei Zhang, Feng Cheng and Limin Mao conceived and designed the study; Shunxiang Li, Jinxian Zhao, Shifu Li and Liang Chen collected and cleaned the data; Shu Su, Lei Zhang, and Limin Mao analyzed the data; Shu Su wrote the paper; Shunxiang Li, Jun Jing, Christopher Kincaid Fairley, Limin Mao and Lei Zhang revised the manuscript. All authors approved the final manuscript.

Figure legends

Figure 1. The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

Table 1. Key socio-demographic characteristics, drug-related practices, sexual activities following drug consumption and prevalence of confirmed HIV, HCV, and syphilis infections among IDU in Southwest China

Drug type	Heroin only	Poly-drug use	SDs only	P-value
	295	277	38	
Demographic characteristics				
Gender				0.42
Male	270 (91.5%)	249(89.9%)	32 (84.2%)	
Female	25(8.5%)	28 (10.1%)	6 (15.8%)	
Mean age	35.1 ± 8.3	33.8 ± 7.8	29.1 ± 7.2	0.03
Married status				0.12
Single/Divorced	182(61.7%)	183(66.1%)	20 (52.6%)	
Married/Cohabitation	113(38.3%)	94(33.9%)	18(47.4%)	
Education				0.41
Junior high or below	268(90.8%)	261(94.2%)	35(92.1%)	
Senior high or above	27(9.2%)	16(5.8%)	3(7.9%)	
Drug-related practices				
Injection frequency (times/day)	2.2 ± 0.8	3.3 ± 1.2	1.2 ± 0.4	<0.01
Percentage of syringe sharing				<0.01
Yes	107(36.3%)	145(52.3%)	21(55.3%)	
No	188(63.7%)	132(47.7%)	17(44.7%)	
Sexual activities associated with drug consumption				
Any sexual acts (previous 1 month)				0.01
Yes	132(44.7%)	176(63.5%)	33(86.8%)	
No	163(55.3%)	101(36.5%)	5(13.2%)	
Consistent condom usage in any sexual acts (previous 1 month)				0.01
Yes	85(64.4%)	142(80.7%)	15(45.5%)	
No	47(35.6%)	34(19.3%)	18(54.5%)	
Commercial sexual acts (previous 12 months)				<0.01
Yes	103(34.9%)	165(59.6%)	29(76.3%)	
No	192(65.1%)	112(40.4%)	9(23.7%)	
Consistent condom use in commercial sexual acts (previous 12 months)				<0.01
Yes	64(62.1%)	109(66.1%)	14(48.3%)	
No	39(37.9%)	56(33.9%)	15(51.7%)	
Having sex with fixed partner (previous 12 months)				0.29
Yes	89(78.8%)	72(76.6%)	13(72.2%)	

No	24(21.2%)	22(23.4%)	5(27.8%)	
Consistent condom use with fixed partner (previous 12 months)				<0.01
Yes	22(24.7%)	6(8.3%)	1(7.7%)	
No	67(75.3%)	66(91.7%)	12(92.3%)	
Confirmed infections				
HIV infection				0.02
Positive	27(9.2%)	37(13.4%)	0(0.0%)	
Negative	268(90.8%)	240(86.6%)	38(100.0%)	
HCV infection				<0.01
Positive	210(71.2%)	183(66.1%)	15(39.5%)	
Negative	85(28.8%)	94(33.9%)	23(60.5%)	
Syphilis infection				<0.01
Positive	4 (1.3%)	6 (2.2%)	3 (7.9%)	
Negative	291 (98.7%)	271(97.8%)	35 (92.1%)	

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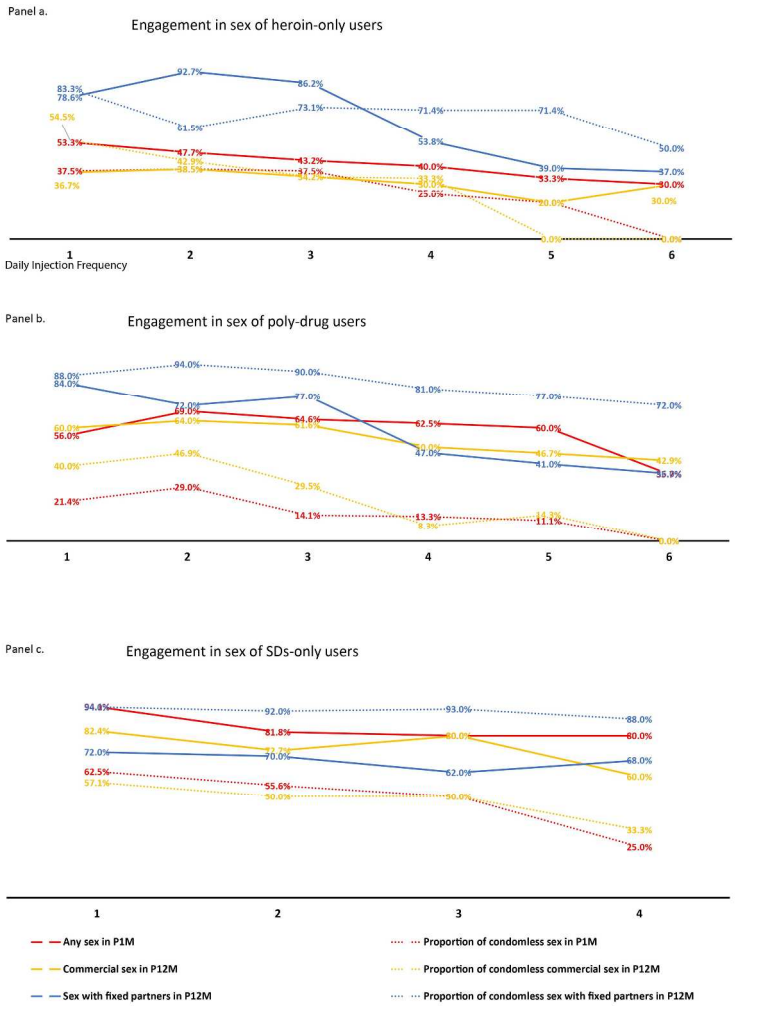

*Significant factors associated with risk sexual behaviours, based on a multiple linear regression analysis. Factors associated with any sexual activities in the previous month includes, injection frequency (-4.6%; 95%CI -5.5, -3.7%) and age (-0.9%; -1.6, -0.2%) among heroin-only users. Factors associated with condomless sexual activities in the previous month includes, injection frequency (-7.3%; -11.3, -3.3%) and education status (Senior high or above vs. Junior high or below) (4.5%; 2.1, 6.9%) among heroin-only users; injection frequency (-5.1%; -8.2, -2.0%) and age (-1.4%; -1.8, -1.0%) among poly-drug users. Factors associated with commercial sex in the past twelve months includes, injection frequency (-2.6%; -4.7, -0.5%), age (-1.1%; -1.6, -0.6%) and married status (unmarried vs. married) (5.7%; 4.3, 7.1%) among poly-drug users. Factors associated with condomless commercial sex in the previous twelve months includes, injection frequency (-11.5%; -12.8 , -10.2%) among heroin-only users; injection frequency (-7.1%; -9.2, -5.0%) and gender (male vs. female) (3.6%; 1.1, 6.1%) among poly-drug users. Factors associated with having sex with fixed partner in the previous twelve months includes, injection frequency (-6.1%; -11.9, -2.0%) and age (-1.4%; -3.1, -0.3%) among heroin-only users; injection frequency (-10.4%; -17.2 , -3.6%) among poly-drug users. Factors associated with condomeless sex with fixed partner in the previous twelve months includes, injection frequency (-1.8%; -2.7, -0.9%) and education status (Senior high or above vs. Junior high or below) (3.9%; 3.1, 4.7%) among poly-drug users.

Caption : Figure 1 The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

256x390mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No (Reported on page #)	Recommendation
Title and abstract (✓)	1 (2)	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (✓)		
Background/rationale	2 (4)	Explain the scientific background and rationale for the investigation being reported
Objectives	3 (4-5)	State specific objectives, including any prespecified hypotheses
Methods (✓)		
Study design	4 (5)	Present key elements of study design early in the paper
Setting	5 (5)	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 (5)	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 (5-6)	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*(5)	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 (not applicable)	Describe any efforts to address potential sources of bias
Study size	10 (5)	Explain how the study size was arrived at
Quantitative variables	11(5)	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12(6)	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

		(*e*) Describe any sensitivity analyses

Continued on next page

Results (✓)		
Participants	13*(6)	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*(6-7)	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*(7)	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 (6-7)	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 (not applicable)	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (✓)		
Key results	18 (7)	Summarise key results with reference to study objectives
Limitations	19 (9)	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 (8)	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21(8-9)	Discuss the generalisability (external validity) of the study results
Other information (✓)		
Funding	22 (not applicable)	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Association between recreational drug use and sexual practices among people who inject drugs in Southwest China: a cross-sectional study

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Association between recreational drug use and sexual practices among people who inject drugs in Southwest China: a cross-sectional study

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Abstract

Objective: To describe the differences in sexual practices among individuals with various drug administration patterns.

Setting: A detoxification centre in Southwest China, a part of the Chinese national sentential surveillance network for hepatitis C (HCV), human immunodeficiency virus (HIV) and syphilis infections, was recruited.

Participants: A total of 610 newly enrolled injection drug users (IDU) from detoxification centre were included during 2015.

Primary and secondary outcome measures: Self-reported sexual activities, drug-related practices and laboratory-confirmed HCV, HIV and syphilis infection status were collected.

Results

Of the 610 IDU, 295 (48.4%) used heroin only, 277 (45.4%) poly-drug users reported the mixed use of synthetic drugs (SDs) with heroin, and 38 (6.2%) used SDs only. The average daily drug injection frequency for poly-drug users (3.3±1.2 times) was the highest, followed by heroin-only (2.2±0.8 times) and SDs-only users (1.2±0.4 time). SDs-only drug users reported the highest proportion (86.8%) of engaging in sexual activities in the previous month, with more than half (54.5%) reporting any condomless sex. A higher frequency of daily injecting in heroin-only users was significantly correlated with the less likelihood of sex, condomless sex in the past month, having sex with fixed partners, condomless commercial sex in the previous twelve months (all $p<0.01$). In poly-drug users, who injected drugs two times/day was associated with the highest proportion of people who engaged in sex and commercial sex ($p<0.05$). For SDs-only users, increased drug use was not associated with reducing sexual risk ($p>0.05$). Different patterns of HCV, HIV, and syphilis infections prevalence rates were shown among the IDU depending on the roles and length of exposure.

Conclusions

The daily drug injecting frequency of heroin-only and poly-drug users was negatively associated with sexual activities, but SDs-only users kept a high frequent engagement in sex. The interventions for relevant diseases should adapt to characteristics of IDU.

Key words: synthetic drugs; heroin; poly-drug use; intravenous drug users; drug dependence; sexually transmitted infections

Strengths and limitations of this study

Strengths:

a. A study that comprehensively compares the demographic characteristics, drug-related practices, sexual practices and infection status among synthetic drug only users, heroin-only users, and poly-drug users in a national sentential surveillance setting.

b. It explores the underlying associations between users having different administration of drugs use and sexual behaviours.

c. It shows the status of people injecting synthetic drugs and adds to the evidence for harm reduction and sexually transmitted infections prevention in drug era with increasing numbers of synthetic drug users.

Limitations:

a. Potential recall bias may exist in the study since drug-related behaviours and sexual behaviours were from the participants self-report.

b. The number of respondents who only injected SDs was small, which will reduce statistical power regarding analysis.

Background

Recreational drug use is a significant public health concern worldwide, and those who inject drugs may experience severe health consequences from the drug harms, blood-borne infections due to sharing of contaminated injection equipment and inequity in accessing healthcare services [1 2]. While the size of this population has continued to grow during the recent decade, access to health services underpinned by harm reduction principles has remained low (about one in six in this population) [3]. Consequently, specific disease burdens in this population are disproportionally high globally: in 2015, approximately 13.3% people who inject drugs are living with human immunodeficiency virus (HIV), and 50.8% are living with chronic hepatitis C (HCV) infection [3].

In China, since the 21st century, unsafe drug use, especially heroin use, has contributed to surging epidemics of blood-borne infections, such as HCV and HIV [4]. In the last decade, synthetic drug (SD) use increased throughout China. In 2015, the use of SD in China exceeded heroin use for the first time. The most common SD, such as methamphetamines, have strong euphoric effects, and have been associated with prolonged sexual activity [5-8]. The combination of sexual risk and injecting drug use creates a complex with the mixture of exposure that may facilitate the spread of blood-borne viral and sexually transmissible infections [8-11]. Moreover, drug users in China generally consume SD via snorting, but currently, drug users have shown an increasing trend on injecting SD for a more intense high, which is consistent with the reports in other countries [12 13]. Though compared with heroin, SD injection is still used on a small scale, this intake method is estimated to bring more unpredicted harm than previous way. Furthermore, it has been documented that 30-40% of heroin users in China nowadays also use SD and some SD users inject heroin at the same time as well to maximise pleasure, with the proportion expected to grow rapidly in the next few years [14 15]. This poly-drug use is associated with more harmful drug effects and high-risk behaviours. As different drugs act on bodies in various ways to cause sedation, the drug effects would be magnified by using multiple drugs. For example, concurrent use of cocaine and heroin (the mixture being dubbed as a 'speedball') has a synergistic impact on reducing norepinephrine release and reuptake [16]. Hence, poly-drug intake, albeit at the same dosage as a single drug, can cause much stronger sexual stimulus [17 18]. However, the specific effects of how these various drug-using patterns facilitate blood-borne viral and sexually transmissible infections transmission mainly including HCV, HIV and syphilis infections remain unknown in China.

Yuxi, located in central area of Yunnan Province is renowned for its drug trafficking and consumption in China, which may result in some of the highest rates of HIV, syphilis and HCV infections in China [19]. Specifically, from 2005 to 2016, a total of 3,092 unique HIV-positive people were diagnosed in this region, accounting for 0.13% of its total local population, with 326 being classified as newly infected in 2016. Further, 763 newly infected syphilis cases and 470 HCV-positive cases were notified in this area in 2016 [20 21]. Thus, Yuxi is a proper study setting to investigate the relationship between HCV, HIV and syphilis infections transmission and IDU, especially in the era of the constant emergence of new SDs.

This study aims to identify the characteristics among different drug users and assess if different pattern and doses in drug use were associated with the sexual practice of drug users.

Methods

A cross-sectional survey was conducted in the largest detoxification centre in Yuxi, which is also one of the Chinese national HCV, HIV and syphilis infections sentential surveillance sites that routinely collect data from designated priority populations. As China has harsh anti-narcotics policies, if drug users are arrested by the police or reported by the community they should be put in the detoxification center compulsively for quitting drugs. Currently, China has 700 detoxification centers, and these centers housing a total of 350,000 people [22], so the population from detoxification center can represent the general drug users in China. The eligibility criteria included the following: 1) recent injection of recreational drugs in the previous week, 2) being 18 years of age or older, 3) residing in Yuxi in the previous three months and 4) provision of written informed consent. This paper reports findings from our secondary data analysis (stripped of any personal identifier) of these local routinely collected bio-behavioural surveillance data, which was approved by the Monash University Human Research Ethics Committee (CF16/942 - 2016000495).

Data were collected between 26th January 2015 and 11st December 2015. On the first day of their admission to the detoxification centre, all participants were offered to self-complete a paper survey, with 15 minutes completion time on average. The questionnaire was used by the Chinese CDC as part of their routine sentential surveillance system nationally, which include all sites in Yunnan province. It covered key socio-demographic characteristics, patterns of latest drug consumption and a range of sexual practices. Specifically, the list of recreational drugs under investigation included heroin, cocaine, methamphetamine, ketamine and ecstasy, the participants reported whether they used one or more of them. The routes of drug administration were intravenous, smoking, snorting and oral ingestion. Inquiries into sexual activities were assessed by six questions (with a yes/no answer). The first set of two questions were “Did you have any sex in the previous month?” and if yes, whether condoms were used for sex in the same period. The second set of questions were: “Did you engage in any commercial sexual activities in the previous twelve months?” and if yes, whether condoms were used for commercial sex in the same period. The third set of questions were: “Did you have sex with a fixed/regular partner in the previous twelve months?” and if yes, whether condoms were used for sex with the partner in the same period.

We differentiated ‘poly-drug users’ as those who used both heroin and any SDs concurrently from heroin-only users and SDs-only users. Specifically, heroin-only users are people who only used heroin while SDs-only users are people who used one or more of drugs in cocaine, methamphetamine, ketamine and ecstasy. The participants were classified into three categories according to their drug use. The comparison of demographic characteristics, drug-related behaviours, sexual practice and infection status, was conducted between three groups. The relationship between sexual practice and drug injection frequency was explored within each drug group.

Each survey participant also undertook linked blood and urine test. Serological detection of HIV, HCV and syphilis infections followed standard Chinese national diagnostic guidelines in which: HIV-positivity was confirmed by enzyme-linked immunosorbent assay (ELISA) screening and Western Blot (WB) validation [23]; HCV-positivity was confirmed by detection of HCV antibodies through repeated, independent ELISA testing [24]; and syphilis-positivity was confirmed by rapid plasma reagin (RPR) circle card test screening with Treponema pallidum particle agglutination assay (TPPA) validation. Laboratory-confirmed HIV, HCV or positive syphilis cases were notified and referred, following the standard clinical referral pathways. The urine detection results of drug residuals were used to corroborate with self-reported drug consumption in the previous week.

Statistical analysis

All data analyses were conducted on SAS 9.4 (Cary, NC: SAS Institute Inc.). Descriptive and subsequent inferential analyses were performed. Comparisons across three subgroups were conducted using Wald X^2 test. Two multiple linear regression models were built to assess the relationship between drug use frequencies and sexual practices in each category of drug users. Dependent variable of two regression models were drug users having sexual activities and drug users having condomless sexual behaviours, respectively. Sexual activities in the model were defined by having sex in the previous one month, engaging in any commercial sexual activities in the previous twelve months and having sex with a fixed/regular partner in the previous twelve months. Accordingly, condomless sexual behaviours were defined by having condomless sex in the previous one month, having condomless sex during commercial sexual activities in the previous twelve months, having condomless sex with a fixed/regular partner in the previous twelve months. Demographic and drug-related variables with p-value <0.2 in the simple linear regression were included as the independent variable in the multiple linear regression. A p-value of less than 0.05 was considered significant in the final model.

Results

A total of 610 (71.9%) eligible registrants out of the 848 new entrants at the YuXi Detoxification Centre in 2015 were included, where 191 (22.5%, 133 were SDs-only, 23 were heroin-only users and 35 were poly-drug users) non-injection drug users, 34 (4.0%) non-current drug injection users (not in the previous week prior to entry) and 13 (1.5%) non-residents were excluded. The majority were male (551, 90.3%) and the rest were female (59, 9.7%). The mean age of the whole sample was 34.4±8.3 years old. The majority of drug users received junior high school or below education (564, 92.5%) and unmarried (385, 63.1%). The three subgroups of drug users include heroin-only users (295, 48.4%), poly-drug users (277, 45.4%), and SDs-only users (38, 6.2%). Poly-drug users (33.8±7.8 years) and heroin-only users (35.1±8.3 years) were significantly older than SDs-only users (29.1±7.2 years) (p=0.03). Of the three groups, poly-drug users had the highest daily drug injecting frequency (3.3±1.2 times/day), followed by heroin-only users (2.2±0.8 times/day) and SDs-only users (1.2±0.4 times/day, p<0.01). The syringe sharing rate was lower in heroin-only users (107, 36.3%) than the poly-drug users (145, 52.3%) and SDs-only users (21, 55.3%) (p<0.01). No significant differences are observed in gender distribution, married

status and education levels among three groups (Table 1).

Estimated 33 (86.8%) participated SDs-only users had sex in the previous month, in contrast, only 132 (44.7%) heroin-only users and 176 (63.5%) poly-drug users reported so. SDs-only users had a higher rate of condomless sex in the previous month (18, 54.5%, p=0.01) compared with heroin-only users (47, 35.6%) and poly-drug users (34, 19.3%). Similarly, the proportion of SDs-only users (29, 76.3%) who solicited commercial sex in the past 12 months was also higher than poly-drug users (165, 59.6%) and heroin-only users (103, 34.9%, p<0.01), and so was condomless rate during commercial sex (SDs-only users [15, 51.7%], versus heroin-only users [39, 37.9%] and poly-drug users [56, 33.9%]) (p<0.05). However, no significant differences were found among three groups in the sexual behaviours with fixed partners (p>0.05). Specifically, 78. 8% (89) of heroin-only users, 76.6%(72) of poly-drug and 72.2% (13) of SDs-only users had sex with fixed partners over the last twelve months. But condomless sex rate during the sexual activities with fixed/regular partners was the highest in SDs-only users (12, 92.3%), compared with heroin-only users (67, 75.3%) and poly-drug users (66, 91.7%, p<0.01).

HCV, HIV and syphilis infections positivity rates were substantially different between the three groups. HCV positivity was the highest in heroin-only users (210, 71.2%), followed by poly-drug users (183, 66.1%) and the lowest among SDs-only users (15, 39.5%, p<0.01). In contrast, HIV infection was the highest among poly-drug users (37, 13.4%, p=0.02) and then heroin-only users (27, 9.2%), but no HIV cases were found in SDs-only users. Notably, syphilis positivity was the highest among SDs-only users (3, 7.9%, p<0.01), compared with poly-drug users (6, 2.2%) and heroin-only users (4, 1.3%) (Table 1).

The multivariable linear regression model demonstrated that in both the heroin-only users and poly-drug users. Higher frequency of daily drug injection were correlated with lower likelihood of having had sex or condomless sex (Figure 1a and 1b). Among heroin-only users, every additional injection per day was associated with a 4.6% reduction in sex activities (p<0.01) and a 7.3% reduction condomless sex in the previous month (p<0.01). The likelihood of sex in the past month decreased sharply from the peak 53.3% to 30.0%, and condomless sex rate decreased from the peak 37.5% to 0% when the injection frequencies rose from one to six or more injections a day (Figure 1a). There was also an 11.5% reduction in the reported rate of condomless commercial sex in the past 12 months for every additional injection (p<0.01) (Figure 1a). Regarding the poly-drug users, ceiling effects were reached earlier with two or more daily injections, being associated with reduced sex activities in the previous month (decreased from the peak 69.0% to 35.7%, p<0.01) and commercial sex in the previous 12 months (decreased from peak 64.0% to 42.9%, p<0.01, Figure 1b). The frequency of daily injection and the rate of sex with fixed partners also showed a negative relationship, namely, every extra daily injection reduced 10.4% likelihood of having sex with a fixed partner (p<0.01). In contrast to other two groups, no significant reduction in any sexual practices in the previous one or twelve months was seen with more frequent drug injecting among SDs-only users (Figure 1c).

Discussion

To our best knowledge, this is the first study in China to demonstrate strong associations between daily injection frequencies and sexual behaviours and patterns of recreational drug use. The findings suggest heroin use is associated with reduced sexual risk, and SDs use is associated with higher sexual risk. Furthermore for those who use heroin (alone or with SDs use) increased daily injection frequencies were associated with decreases in both sexual activities and condomless sex in short-term and long-term. Conversely, increased drug injecting frequency among SDs-only users was not associated with reductions in sexual risk.

Several explanations are relevant to the dosage effects from drug consumption and sexual behaviours. For heroin-only users, it has been documented that high doses of heroin suppress libido and increase the likelihood of erectile dysfunction [25-28], leading to reduced sexual activity after drug consumption. In contrast, common SDs (e.g., methamphetamine) are sexual stimulants. Only a few studies have linked SDs with erectile dysfunction with no clear indication of a potential threshold that could reverse 'stimulating effect' [29-31]. This may explain the consistently high frequent sexual activities observed among SDs-only users. There has been evidence of orally ingested cocaine at 0mg (placebo group), 125mg and 250mg once a day leading to increased sexual desire that was linear to drug dosage [32]. However, in our study, intravenous injection of SDs from one to four times (approximately 100mg each injection) per day did not show linear effects on sexual arousal. The difference may be due to the SDs participants in our study are all IDU and have developed serious drug dependence. It is possible that once these people reach the peak of drug-induced effects, further increases in drug injection frequency may have no extra impact on their sexual practices [33]. The finding is consistent with the previous results that injecting SD pose a higher risk on sexual impulsivity than otherwise [34]. Thus, we cannot determine a clear dose-effect in the result.

We found that condom use depends on the dose and type of drug. It is well documented that a positive association exists between the SDs including crystal methamphetamine, ketamine, and ecstacy and high-risk sexual practices such as condomless sex, both in China and globally [35-38]. Conversely, our study demonstrated that a declining rate of condomless sex is associated with increases in drug injecting frequency among poly-drug users and heroin-only users but not in SDs-only users. Interestingly, an existing literature on cocaine effects demonstrated that under ideal circumstances where condoms are always available, condomless sex does not associate with cocaine use, which is in contrast to case group who lacked immediate access to condoms [32]. The latter demonstrates a trend of reduced condom use following the consumption of cocaine with dose-response effects. These results highlight the critical role of condom availability for drug users.

Regarding HCV, HIV and syphilis infections prevalence, SD-only group had the highest syphilis positivity rate, the heroin-only group had the highest HCV positivity rate, and mixed user group had the highest HIV infection rate. This partly reflects the divergence of HIV, HCV and STI epidemics and chronological impacts on different priority populations in China. Heroin-only users have the lowest syringe sharing rate within the past twelve months among

three groups in our study. However, the higher prevalence of HCV may be due to accumulative risk of infection from a longer duration of injecting drug use. As heroin has been available for more than three decades, SD has only become popular among Chinese youth last five years [4 14]. It concurs that the mean age of heroin users is significantly greater than the SD users in our study. Moreover, HCV prevalence rates in China among the general population have been estimated to be approximately 3.2% [39], which is higher than neighbour countries including India [40] and another developed country [41], this high background prevalence of HCV may contribute to HCV transmission among long-term heroin-only users as well. Thus, for the younger Chinese generation, who may have a relatively shorter drug use (or mix-use) history of SD, HCV, HIV and syphilis infections prevention should be the foremost priority. Some effective interventions for previous drug harm reduction could be implemented on a wide scale, for example, needle-syringe exchange programs, originally targeting heroin users [42], should be extended to SD users to prevent blood-borne disease transmission [43]. Also, proactive intervention strategies need to be put in place in response to the imminent transition from non-injection to injection routes, as seen in other countries [44 45], which is expected to further increase HCV, HIV and syphilis infections burden.

Several limitations should be noted. First, except for laboratory results, self-report drug use and sexual behaviours were from the participants; therefore, recall bias may exist in this study. Second, the number of respondents who only injected SD was small as the injection rate was lower in SD-only users compared with heroin-only users and poly-drug users, which will reduce statistical power regarding analysis. However, no previous studies have reported the issue of injection SDs in China, the population in this study still can represent the health situation of SD-only users who inject drugs, the finding also can be considered as an alarming for implementing suitable interventions on this population, as drug injection behaviour was estimated increasing among SD-only users in other countries [46]. Third, for the poly-drug user group where respondents only reported injection of both heroin and SDs, we could not ascertain whether drugs were consumed concurrently in one dose or through a sequence of different injections. Despite this, our study shows the first attempt to explore the drug injection frequency effects on sexual behaviours. These findings are not limited to contributing to the harm reduction of drug consumption in China, but they also add evidence for easing the HCV, HIV and syphilis infections burden brought by drug use in other countries. As rampant recreational drugs consumption is common worldwide, the issue needs global corporation to eliminate the negative influences.

Conclusions

This study underscores that sexual activities including condom use are subject to the type of drugs used and dosage between IDU. Elevated risk of unsafe sexual behaviours has been established among a generation of SD injection users. HCV, HIV and syphilis infections prevention and treatment programs targeting priority subgroups of IDU in China should be promoted.

Data sharing statement

Due to privacy and ethical concerns, supporting data cannot be made openly available. Please

contact the authors for the access to the original data.

Competing interests statement

The authors declare no conflict of interest.

Author contributions

Lei Zhang, Feng Cheng and Limin Mao conceived and designed the study; Shunxiang Li, Jinxian Zhao, Shifu Li and Liang Chen collected and cleaned the data; Shu Su, Lei Zhang, and Limin Mao analyzed the data; Shu Su wrote the paper; Shunxiang Li, Jun Jing, Christopher Kincaid Fairley, Limin Mao and Lei Zhang revised the manuscript. All authors approved the final manuscript.

Figure legends

Figure 1. The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

Table 1. Key socio-demographic characteristics, drug-related practices, sexual activities following drug consumption and prevalence of confirmed HIV, HCV, and syphilis infections among IDU in Southwest China

Drug type	**Heroin only**	**Poly-drug use**	**SDs only**	**P-value**
	295	277	38	
Demographic characteristics				
Gender				0.42
Male	270 (91.5%)	249(89.9%)	32 (84.2%)	
Female	25(8.5%)	28 (10.1%)	6 (15.8%)	
Mean age	35.1 ± 8.3	33.8 ± 7.8	29.1 ± 7.2	0.03
Married status				0.12
Single/Divorced	182(61.7%)	183(66.1%)	20 (52.6%)	
Married/Cohabitation	113(38.3%)	94(33.9%)	18(47.4%)	
Education				0.41
Junior high or below	268(90.8%)	261(94.2%)	35(92.1%)	
Senior high or above	27(9.2%)	16(5.8%)	3(7.9%)	
Drug-related practices				
Injection frequency (times/day)	2.2 ± 0.8	3.3 ± 1.2	1.2 ± 0.4	<0.01
Percentage of syringe sharing				<0.01
Yes	107(36.3%)	145(52.3%)	21(55.3%)	
No	188(63.7%)	132(47.7%)	17(44.7%)	
Sexual activities associated with drug consumption				
Any sexual acts (previous 1 month)				0.01

Yes	132(44.7%)	176(63.5%)	33(86.8%)	
No	163(55.3%)	101(36.5%)	5(13.2%)	
Consistent condom usage in any sexual acts (previous 1 month)				0.01
Yes	85(64.4%)	142(80.7%)	15(45.5%)	
No	47(35.6%)	34(19.3%)	18(54.5%)	
Commercial sexual acts (previous 12 months)				<0.01
Yes	103(34.9%)	165(59.6%)	29(76.3%)	
No	192(65.1%)	112(40.4%)	9(23.7%)	
Consistent condom use in commercial sexual acts (previous 12 months)				<0.01
Yes	64(62.1%)	109(66.1%)	14(48.3%)	
No	39(37.9%)	56(33.9%)	15(51.7%)	
Having sex with fixed partner (previous 12 months)				0.29
Yes	89(78.8%)	72(76.6%)	13(72.2%)	
No	24(21.2%)	22(23.4%)	5(27.8%)	
Consistent condom use with fixed partner (previous 12 months)				<0.01
Yes	22(24.7%)	6(8.3%)	1(7.7%)	
No	67(75.3%)	66(91.7%)	12(92.3%)	
Confirmed infections				
HIV infection				0.02
Positive	27(9.2%)	37(13.4%)	0(0.0%)	
Negative	268(90.8%)	240(86.6%)	38(100.0%)	
HCV infection				<0.01
Positive	210(71.2%)	183(66.1%)	15(39.5%)	
Negative	85(28.8%)	94(33.9%)	23(60.5%)	
Syphilis infection				<0.01
Positive	4 (1.3%)	6 (2.2%)	3 (7.9%)	
Negative	291 (98.7%)	271(97.8%)	35 (92.1%)	

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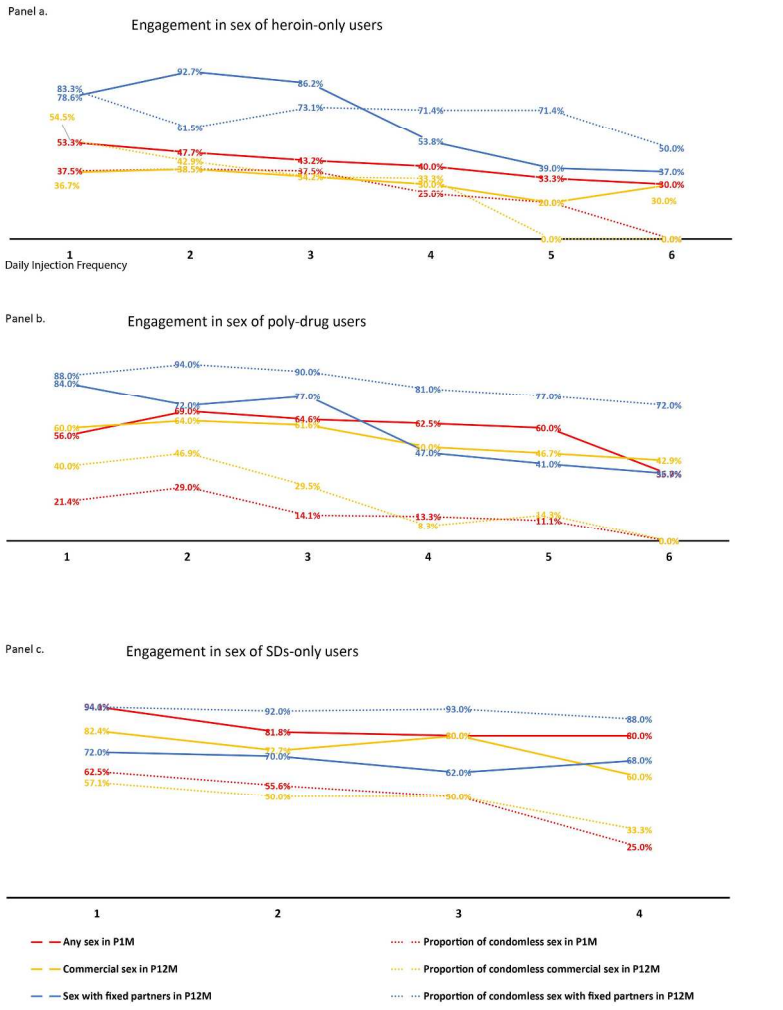

*Significant factors associated with risk sexual behaviours, based on a multiple linear regression analysis. Factors associated with any sexual activities in the previous month includes, injection frequency (-4.6%; 95%CI -5.5, -3.7%) and age (-0.9%; -1.6, -0.2%) among heroin-only users. Factors associated with condomless sexual activities in the previous month includes, injection frequency (-7.3%; -11.3, -3.3%) and education status (Senior high or above vs. Junior high or below) (4.5%; 2.1, 6.9%) among heroin-only users; injection frequency (-5.1%; -8.2, -2.0%) and age (-1.4%; -1.8, -1.0%) among poly-drug users. Factors associated with commercial sex in the past twelve months includes, injection frequency (-2.6%; -4.7, -0.5%), age (-1.1%; -1.6, -0.6%) and married status (unmarried vs. married) (5.7%; 4.3, 7.1%) among poly-drug users. Factors associated with condomless commercial sex in the previous twelve months includes, injection frequency (-11.5%; -12.8 , -10.2%) among heroin-only users; injection frequency (-7.1%; -9.2, -5.0%) and gender (male vs. female) (3.6%; 1.1, 6.1%) among poly-drug users. Factors associated with having sex with fixed partner in the previous twelve months includes, injection frequency (-6.1%; -11.9, -2.0%) and age (-1.4%; -3.1, -0.3%) among heroin-only users; injection frequency (-10.4%; -17.2 , -3.6%) among poly-drug users. Factors associated with condomeless sex with fixed partner in the previous twelve months includes, injection frequency (-1.8%; -2.7, -0.9%) and education status (Senior high or above vs. Junior high or below) (3.9%; 3.1, 4.7%) among poly-drug users.

Caption : Figure 1 The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

256x390mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No (Reported on page #)	Recommendation
Title and abstract (✓)	1 (2)	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (✓)		
Background/rationale	2 (4)	Explain the scientific background and rationale for the investigation being reported
Objectives	3 (4-5)	State specific objectives, including any prespecified hypotheses
Methods (✓)		
Study design	4 (5)	Present key elements of study design early in the paper
Setting	5 (5)	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 (5)	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 (5-6)	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*(5)	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 (not applicable)	Describe any efforts to address potential sources of bias
Study size	10 (5)	Explain how the study size was arrived at
Quantitative variables	11(5)	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12(6)	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

		(*e*) Describe any sensitivity analyses

Continued on next page

Results (✓)		
Participants	13*(6)	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*(6-7)	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*(7)	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 (6-7)	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 (not applicable)	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (✓)		
Key results	18 (7)	Summarise key results with reference to study objectives
Limitations	19 (9)	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 (8)	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21(8-9)	Discuss the generalisability (external validity) of the study results
Other information (✓)		
Funding	22 (not applicable)	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Association between recreational drug use and sexual practices among people who inject drugs in Southwest China: a cross-sectional study

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Abstract

Objective: To describe the differences in sexual practices among individuals with various drug administration patterns.

Setting: A detoxification centre in Southwest China, a part of the Chinese national sentential surveillance network for hepatitis C (HCV), human immunodeficiency virus (HIV) and syphilis infections, was recruited.

Participants: A total of 610 newly enrolled injection drug users (IDU) from detoxification centre were included during 2015.

Primary and secondary outcome measures: Self-reported sexual activities, drug-related practices and laboratory-confirmed HCV, HIV and syphilis infection status were collected.

Results

Of the 610 IDU, 295 (48.4%) used heroin only, 277 (45.4%) poly-drug users reported the mixed use of synthetic drugs (SDs) with heroin, and 38 (6.2%) used SDs only. The average daily drug injection frequency for poly-drug users (3.3±1.2 times) was the highest, followed by heroin-only (2.2±0.8 times) and SD-only users (1.2±0.4 time). SD-only drug users reported the highest proportion (86.8%) of engaging in sexual activities in the previous month, with more than half (54.5%) reporting any condomless sex. A higher frequency of daily injecting in heroin-only users was significantly correlated with the less likelihood of sex, condomless sex in the past month, having sex with fixed partners, condomless commercial sex in the previous twelve months (all $p<0.01$). In poly-drug users, who injected drugs two times/day was associated with the highest proportion of people who engaged in sex and commercial sex ($p<0.05$). For SD-only users, increased drug use was not associated with reducing sexual risk ($p>0.05$). Different patterns of HCV, HIV, and syphilis infections prevalence rates were shown among the IDU depending on the roles and length of exposure.

Conclusions

The daily drug injecting frequency of heroin-only and poly-drug users was negatively associated with sexual activities, but SD-only users kept a high frequent engagement in sex. The interventions for relevant diseases should adapt to characteristics of IDU.

Key words: synthetic drugs; heroin; poly-drug use; intravenous drug users; drug dependence; sexually transmitted infections

Strengths and limitations of this study

Strengths:

a. A study that comprehensively compares the demographic characteristics, drug-related practices, sexual practices and infection status among synthetic drug only users, heroin-only users, and poly-drug users in a national sentential surveillance setting.

b. It explores the underlying associations between users having different administration of drugs use and sexual behaviours.

c. It shows the status of people injecting synthetic drugs and adds to the evidence for harm reduction and sexually transmitted infections prevention in drug era with increasing numbers of synthetic drug users.

Limitations:

a. Potential recall bias may exist in the study since drug-related behaviours and sexual behaviours were from the participants self-report.

b. The number of respondents who only injected SDs was small, which will reduce statistical power regarding analysis.

Background

Recreational drug use is a significant public health concern worldwide, and those who inject drugs may experience severe health consequences from the drug harms, blood-borne infections due to sharing of contaminated injection equipment and inequity in accessing healthcare services [1 2]. While the size of this population has continued to grow during the recent decade, access to health services underpinned by harm reduction principles has remained low (about one in six in this population) [3]. Consequently, specific disease burdens in this population are disproportionally high globally: in 2015, approximately 13.3% people who inject drugs are living with human immunodeficiency virus (HIV), and 50.8% are living with chronic hepatitis C (HCV) infection [3].

In China, since the 21st century, unsafe drug use, especially heroin use, has contributed to surging epidemics of blood-borne infections, such as HCV and HIV [4]. In the last decade, synthetic drug (SD) use increased throughout China. In 2015, the use of SD in China exceeded heroin use for the first time. The most common SD, such as methamphetamines, have strong euphoric effects, and have been associated with prolonged sexual activity [5-8]. The combination of sexual risk and injecting drug use creates a complex with the mixture of exposure that may facilitate the spread of blood-borne viral and sexually transmissible infections [8-11]. Moreover, drug users in China generally consume SD via snorting, but currently, drug users have shown an increasing trend on injecting SD for a more intense high, which is consistent with the reports in other countries [12 13]. Though compared with heroin, SD injection is still used on a small scale, this intake method is estimated to bring more unpredicted harm than previous way. Furthermore, it has been documented that 30-40% of heroin users in China nowadays also use SD and some SD users inject heroin at the same time as well to maximise pleasure, with the proportion expected to grow rapidly in the next few years [14 15]. This poly-drug use is associated with more harmful drug effects and high-risk behaviours. As different drugs act on bodies in various ways to cause sedation, the drug effects would be magnified by using multiple drugs. For example, concurrent use of cocaine and heroin (the mixture being dubbed as a 'speedball') has a synergistic impact on reducing norepinephrine release and reuptake [16]. Hence, poly-drug intake, albeit at the same dosage as a single drug, can cause much stronger sexual stimulus [17 18]. However, the specific effects of how these various drug-using patterns facilitate blood-borne viral and sexually transmissible infections transmission mainly including HCV, HIV and syphilis infections remain unknown in China.

Yuxi, located in central area of Yunnan Province is renowned for its drug trafficking and consumption in China, which may result in some of the highest rates of HIV, syphilis and HCV infections in China [19]. Specifically, from 2005 to 2016, a total of 3,092 unique HIV-positive people were diagnosed in this region, accounting for 0.13% of its total local population, with 326 being classified as newly infected in 2016. Further, 763 newly infected syphilis cases and 470 HCV-positive cases were notified in this area in 2016 [20 21]. Thus, Yuxi is a proper study setting to investigate the relationship between HCV, HIV and syphilis infections transmission and injection drug users (IDU), especially in the era of the constant

emergence of new SDs. This study aims to identify the characteristics among different drug users and assess if different pattern and doses in drug use were associated with the sexual practice of drug users.

Methods

A cross-sectional survey was conducted in the largest detoxification centre in Yuxi, which is also one of the Chinese national HCV, HIV and syphilis infections sentential surveillance sites that routinely collect data from designated priority populations. As China has harsh anti-narcotics policies, if drug users are arrested by the police or reported by the community they should be put in the detoxification center compulsively for quitting drugs. Currently, China has 700 detoxification centers, and these centers housing a total of 350,000 people [22], so the population from detoxification center can represent the general drug users in China. The eligibility criteria included the following: 1) recent injection of recreational drugs in the previous week, 2) being 18 years of age or older, 3) residing in Yuxi in the previous three months and 4) provision of written informed consent. This paper reports findings from our secondary data analysis (stripped of any personal identifier) of these local routinely collected bio-behavioural surveillance data, which was approved by the Monash University Human Research Ethics Committee (CF16/942 - 2016000495).

Data were collected between 26th January 2015 and 11st December 2015. On the first day of their admission to the detoxification centre, all participants were offered to self-complete a paper survey, with 15 minutes completion time on average. The questionnaire was used by the Chinese CDC as part of their routine sentential surveillance system nationally, which include all sites in Yunnan province. It covered key socio-demographic characteristics, patterns of latest drug consumption and a range of sexual practices. Specifically, the list of recreational drugs under investigation included heroin, cocaine, methamphetamine, ketamine and ecstasy, the participants reported whether they used one or more of them. The routes of drug administration were intravenous, smoking, snorting and oral ingestion. Inquiries into sexual activities were assessed by six questions (with a yes/no answer). The first set of two questions were “Did you have any sex in the previous month?” and if yes, whether condoms were used for sex in the same period. The second set of questions were: “Did you engage in any commercial sexual activities in the previous twelve months?” and if yes, whether condoms were used for commercial sex in the same period. The third set of questions were: “Did you have sex with a fixed/regular partner in the previous twelve months?” and if yes, whether condoms were used for sex with the partner in the same period.

We differentiated ‘poly-drug users’ as those who used both heroin and any SDs concurrently from heroin-only users and SD-only users. Specifically, heroin-only users are people who only used heroin and did not use SD before. While SD-only users are people who used one or more of drugs in cocaine, methamphetamine, ketamine and ecstasy and did not use heroin before. The participants were classified into three categories according to their drug use. The comparison of demographic characteristics, drug-related behaviours, sexual practice and infection status, was conducted between three groups. The relationship between sexual practice and drug injection frequency was explored within each drug group.

Each survey participant also undertook linked blood and urine test. Serological detection of HIV, HCV and syphilis infections followed standard Chinese national diagnostic guidelines in which: HIV-positivity was confirmed by enzyme-linked immunosorbent assay (ELISA) screening and Western Blot (WB) validation [23]; HCV-positivity was confirmed by detection of HCV antibodies through repeated, independent ELISA testing [24]; and syphilis-positivity was confirmed by rapid plasma reagin (RPR) circle card test screening with Treponema pallidum particle agglutination assay (TPPA) validation. Laboratory-confirmed HIV, HCV or positive syphilis cases were notified and referred, following the standard clinical referral pathways. The urine detection results of drug residuals were used to corroborate with self-reported drug consumption in the previous week.

Statistical analysis

All data analyses were conducted on SAS 9.4 (Cary, NC: SAS Institute Inc.). Descriptive and subsequent inferential analyses were performed. Comparisons across three subgroups were conducted using Wald X^2 test. Two multiple linear regression models were built to assess the relationship between drug use frequencies and sexual practices in each category of drug users. Dependent variable of two regression models were drug users having sexual activities and drug users having condomless sexual behaviours, respectively. Sexual activities in the model were defined by having sex in the previous one month, engaging in any commercial sexual activities in the previous twelve months and having sex with a fixed/regular partner in the previous twelve months. Accordingly, condomless sexual behaviours were defined by having condomless sex in the previous one month, having condomless sex during commercial sexual activities in the previous twelve months, having condomless sex with a fixed/regular partner in the previous twelve months. Demographic and drug-related variables with a p-value <0.2 in the simple linear regression were included as the independent variable in the multiple linear regression. A p-value of less than 0.05 was considered significant in the final model.

Patient and public involvement

This paper conducts secondary data analysis (stripped of any personal identifier) of these local routinely collected bio-behavioural surveillance data, the patients and public were not involved in this study.

Results

A total of 610 (71.9%) eligible registrants out of the 848 new entrants at the YuXi Detoxification Centre in 2015 were included, where 191 (22.5%, 133 were SD-ly-only, 23 were heroin-only users and 35 were poly-drug users) non-injection drug users, 34 (4.0%) non-current drug injection users (not in the previous week prior to entry) and 13 (1.5%) non-residents were excluded. The majority were male (551, 90.3%) and the rest were female (59, 9.7%). The mean age of the whole sample was 34.4±8.3 years old. The majority of drug users received junior high school or below education (564, 92.5%) and unmarried (385, 63.1%). The three subgroups of drug users include heroin-only users (295, 48.4%), poly-drug users (277, 45.4%), and SD-only users (38, 6.2%). Poly-drug users (33.8±7.8 years) and

heroin-only users (35.1±8.3 years) were significantly older than SD-only users (29.1±7.2 years) (p=0.03). Of the three groups, poly-drug users had the highest daily drug injecting frequency (3.3±1.2 times/day), followed by heroin-only users (2.2±0.8 times/day) and SD-only users (1.2±0.4 times/day, p<0.01). The syringe sharing rate was lower in heroin-only users (107, 36.3%) than the poly-drug users (145, 52.3%) and SD-only users (21, 55.3%) (p<0.01). No significant differences are observed in gender distribution, married status and education levels among three groups (Table 1).

Estimated 33 (86.8%) participated SD-only users had sex in the previous month, in contrast, only 132 (44.7%) heroin-only users and 176 (63.5%) poly-drug users reported so. SD-only users had a higher rate of condomless sex in the previous month (18, 54.5%, p=0.01) compared with heroin-only users (47, 35.6%) and poly-drug users (34, 19.3%). Similarly, the proportion of SD-only users (29, 76.3%) who solicited commercial sex in the past 12 months was also higher than poly-drug users (165, 59.6%) and heroin-only users (103, 34.9%, p<0.01), and so was condomless rate during commercial sex (SD-only users [15, 51.7%], versus heroin-only users [39, 37.9%] and poly-drug users [56, 33.9%]) (p<0.05). However, no significant differences were found among three groups in the sexual behaviours with fixed partners (p>0.05). Specifically, 78. 8% (89) of heroin-only users, 76.6%(72) of poly-drug and 72.2% (13) of SD-only users had sex with fixed partners over the last twelve months. But condomless sex rate during the sexual activities with fixed/regular partners was the highest in SD-only users (12, 92.3%), compared with heroin-only users (67, 75.3%) and poly-drug users (66, 91.7%, p<0.01).

HCV, HIV and syphilis infections positivity rates were substantially different between the three groups. HCV positivity was the highest in heroin-only users (210, 71.2%), followed by poly-drug users (183, 66.1%) and the lowest among SD-only users (15, 39.5%, p<0.01). In contrast, HIV infection was the highest among poly-drug users (37, 13.4%, p=0.02) and then heroin-only users (27, 9.2%), but no HIV cases were found in SD-only users. Notably, syphilis positivity was the highest among SD-only users (3, 7.9%, p<0.01), compared with poly-drug users (6, 2.2%) and heroin-only users (4, 1.3%) (Table 1).

The multivariable linear regression model demonstrated that in both the heroin-only users and poly-drug users. Higher frequency of daily drug injection was correlated with lower likelihood of having had sex or condomless sex (Figure 1a and 1b). Among heroin-only users, every additional injection per day was associated with a 4.6% reduction in sex activities (p<0.01) and a 7.3% reduction condomless sex in the previous month (p<0.01). The likelihood of sex in the past month decreased sharply from the peak 53.3% to 30.0%, and condomless sex rate decreased from the peak 37.5% to 0% when the injection frequencies rose from one to six or more injections a day (Figure 1a). There was also an 11.5% reduction in the reported rate of condomless commercial sex in the past 12 months for every additional injection (p<0.01) (Figure 1a). Regarding the poly-drug users, ceiling effects were reached earlier with two or more daily injections, being associated with reduced sex activities in the previous month (decreased from the peak 69.0% to 35.7%, p<0.01) and commercial sex in the previous 12 months (decreased from peak 64.0% to 42.9%, p<0.01, Figure 1b). The frequency

of daily injection and the rate of sex with fixed partners also showed a negative relationship, namely, every extra daily injection reduced 10.4% likelihood of having sex with a fixed partner ($p<0.01$). In contrast to other two groups, no significant reduction in any sexual practices in the previous one or twelve months was seen with more frequent drug injecting among SD-only users (Figure 1c).

Discussion

To the best of our knowledge, this is the first study in China to demonstrate strong associations between daily injection frequencies and sexual behaviours and patterns of recreational drug use. The findings suggest heroin use is related to reduce sexual risk, and SDs use is associated with higher sexual risk. Furthermore for those who use heroin (alone or with SDs), increased daily injection frequencies were associated with decreases in both sexual activities and condomless sex over both short- and long-term. Conversely, increased drug injecting frequency among SD-only users was not associated with reductions in sexual risk.

Several explanations for the abovementioned results related to drug consumption and sexual behaviours are likely connected to the effects of dosage. For heroin-only users, it has been documented that high doses of heroin suppress libido and increase the likelihood of erectile dysfunction [25-28], leading to reduced sexual activity after drug consumption. In contrast, common SDs (e.g., methamphetamine) are stimulants. Only a few studies have linked SDs with erectile dysfunction with no clear indication of a potential threshold that could reverse 'stimulating effect' [29-31]. Although this study did not examine whether the motivation for synthetic drug use was to facilitate sex, the role of synthetic drugs in sexual activity is more complicated than that of heroin and may drive users to have sex. This might explain the consistently high frequency of sexual activity observed among SD-only users. There has been evidence of orally ingested cocaine at 0mg (placebo group), 125mg and 250mg once a day leading to increased sexual desire that was linear to drug dosage [32]. However, in our study, intravenous injection of SDs from one to four times (approximately 100mg each injection) per day did not show linear effects on sexual arousal. The difference may be due to the SDs participants in our study are all IDU and have developed serious drug dependence. It is possible that once these people reach the peak of drug-induced effects, further increases in drug injection frequency may have no additional impact on their sexual practices [33]. The finding is consistent with previous results that reported that injecting SDs raises the likelihood of sexual impulsivity [34]. Thus, we cannot determine a clear dose-effect in the result.

We found that condom use depends on the dose and type of drug. It is well documented that a positive association exists between the SDs including crystal methamphetamine, ketamine, and ecstasy and high-risk sexual practices such as condomless sex, both in China and globally [35-38]. Conversely, our study demonstrated that a declining rate of condomless sex was associated with increases in drug injecting

frequency among poly-drug users and heroin-only users but not in SD-only users. Interestingly, an existing literature on cocaine effects demonstrated that under ideal circumstances where condoms are always available, condomless sex does not associate with cocaine use, which is in contrast to case group who lacked immediate access to condoms [32]. The latter demonstrates a trend of reduced condom use following the consumption of cocaine with dose-response effects. These results highlight the critical role of condom availability for drug users.

Regarding HCV, HIV and syphilis infections prevalence, SD-only group had the highest syphilis positivity rate, the heroin-only group had the highest HCV positivity rate, and mixed user group had the highest HIV infection rate. This partly reflects the divergence of HIV, HCV and STI epidemics and chronological impacts on different priority populations in China. Heroin-only users had the lowest syringe sharing rate within the past twelve months among three groups in our study. However, the higher prevalence of HCV may be due to accumulative risk of infection from a longer duration of injecting drug use. As heroin has been available for more than three decades, SD has only become popular among Chinese youth last five years [4 14]. It concurs that the mean age of heroin users was significantly greater than the SD users in our study. Moreover, HCV prevalence rates in China among the general population have been estimated to be approximately 3.2% [39], which is higher than neighbour countries including India [40] and another developed country [41], this high background prevalence of HCV may contribute to HCV transmission among long-term heroin-only users as well. Thus, for the younger Chinese generation, who may have a relatively shorter drug use (or mix-use) history of SD, HCV, HIV and syphilis infections prevention should be the foremost priority. Some effective interventions for previous drug harm reduction could be implemented on a wide scale, for example, needle-syringe exchange programs, originally targeting heroin users [42], should be extended to SD users to prevent blood-borne disease transmission [43]. Also, proactive intervention strategies need to be put in place in response to the imminent transition from non-injection to injection routes, as seen in other countries [44 45], which is expected to further increase HCV, HIV and syphilis infections burden.

Several limitations of this study should be noted. First, except for laboratory results, participants engaged in self-reporting of drug use and sexual behaviours; therefore, recall bias may exist. Second, the number of respondents who only injected SDs was small as the injection rate was lower in SD-only users compared to heroin-only users and poly-drug users, which may reduce the statistical power of the analysis. However, as no previous studies have reported on the injection of SDs in China, the data in this study can serve as the basis for further research. Additionally, the finding should be considered alarming and drive the implementation of suitable interventions for this population, as drug injection behaviour is estimated to be increasing among SD-only users [46]. Third, for the poly-drug user group, where respondents only reported the injection of both heroin and SDs, we could not ascertain whether drugs were consumed concurrently in one dose or through a sequence of different injections.

Fourth, the proportion of female drug users (9.7% of total drug users) in this study was much smaller than that of male drug users, meaning this might not have been a representative sample from which to generalise drug use among females. Fifth, we did not identify the type of sexual behaviours and gender of sexual partners in the survey. As drug facilitating sex is more likely to occur among homosexuals than heterosexuals, sexual orientation may have an impact on the aim of drug use and subsequent sexual behaviours[47 48]. Despite this, our study shows the first attempt to explore the drug injection frequency effects on sexual behaviours. These findings are not limited to contributing to the harm reduction of drug consumption in China, but they also add evidence for easing the HCV, HIV and syphilis infections burden brought by drug use in other countries. As rampant recreational drugs consumption is common worldwide, the issue needs a global corporation to eliminate the negative influences.

Conclusions

This study underscores that sexual activities including condom use are subject to the type of drugs used and dosage between IDU. Elevated risk of unsafe sexual behaviours has been established among a generation of SD injection users. HCV, HIV and syphilis infections prevention and treatment programs targeting priority subgroups of IDU in China should be promoted.

Data sharing statement

Due to privacy and ethical concerns, supporting data cannot be made openly available. Please contact the authors for the access to the original data.

Competing interests statement

The authors declare no conflict of interest.

Author contributions

Lei Zhang, Feng Cheng and Limin Mao conceived and designed the study; Shunxiang Li, Jinxian Zhao, Shifu Li and Liang Chen collected and cleaned the data; Shu Su, Lei Zhang, and Limin Mao analyzed the data; Shu Su wrote the paper; Shunxiang Li, Jun Jing, Christopher Kincaid Fairley, Limin Mao and Lei Zhang revised the manuscript. All authors approved the final manuscript.

Figure legends

Figure 1. The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

Table 1. Key socio-demographic characteristics, drug-related practices, sexual activities following drug consumption and prevalence of confirmed HIV, HCV, and syphilis infections among IDU in Southwest China

Drug type	Heroin only	Poly-drug use	SD only	P-value
	295	277	38	
Demographic characteristics				
Gender				0.42
Male	270 (91.5%)	249(89.9%)	32 (84.2%)	
Female	25(8.5%)	28 (10.1%)	6 (15.8%)	
Mean age	35.1 ± 8.3	33.8 ± 7.8	29.1 ± 7.2	0.03
Married status				0.12
Single/Divorced	182(61.7%)	183(66.1%)	20 (52.6%)	
Married/Cohabitation	113(38.3%)	94(33.9%)	18(47.4%)	
Education				0.41
Junior high or below	268(90.8%)	261(94.2%)	35(92.1%)	
Senior high or above	27(9.2%)	16(5.8%)	3(7.9%)	
Drug-related practices				
Injection frequency (times/day)	2.2 ± 0.8	3.3 ± 1.2	1.2 ± 0.4	<0.01
Percentage of syringe sharing				<0.01
Yes	107(36.3%)	145(52.3%)	21(55.3%)	
No	188(63.7%)	132(47.7%)	17(44.7%)	
Sexual activities associated with drug consumption				
Any sexual acts (previous 1 month)				0.01
Yes	132(44.7%)	176(63.5%)	33(86.8%)	
No	163(55.3%)	101(36.5%)	5(13.2%)	
Consistent condom usage in any sexual acts (previous 1 month)				0.01
Yes	85(64.4%)	142(80.7%)	15(45.5%)	
No	47(35.6%)	34(19.3%)	18(54.5%)	
Commercial sexual acts (previous 12 months)				<0.01
Yes	103(34.9%)	165(59.6%)	29(76.3%)	
No	192(65.1%)	112(40.4%)	9(23.7%)	
Consistent condom use in commercial sexual acts (previous 12 months)				<0.01
Yes	64(62.1%)	109(66.1%)	14(48.3%)	
No	39(37.9%)	56(33.9%)	15(51.7%)	
Having sex with fixed partner (previous 12 months)				0.29
Yes	89(78.8%)	72(76.6%)	13(72.2%)	
No	24(21.2%)	22(23.4%)	5(27.8%)	
Consistent condom use with fixed partner (previous 12 months)				<0.01

Yes	22(24.7%)	6(8.3%)	1(7.7%)	
No	67(75.3%)	66(91.7%)	12(92.3%)	
Confirmed infections				
HIV infection				0.02
Positive	27(9.2%)	37(13.4%)	0(0.0%)	
Negative	268(90.8%)	240(86.6%)	38(100.0%)	
HCV infection				<0.01
Positive	210(71.2%)	183(66.1%)	15(39.5%)	
Negative	85(28.8%)	94(33.9%)	23(60.5%)	
Syphilis infection				<0.01
Positive	4 (1.3%)	6 (2.2%)	3 (7.9%)	
Negative	291 (98.7%)	271(97.8%)	35 (92.1%)	

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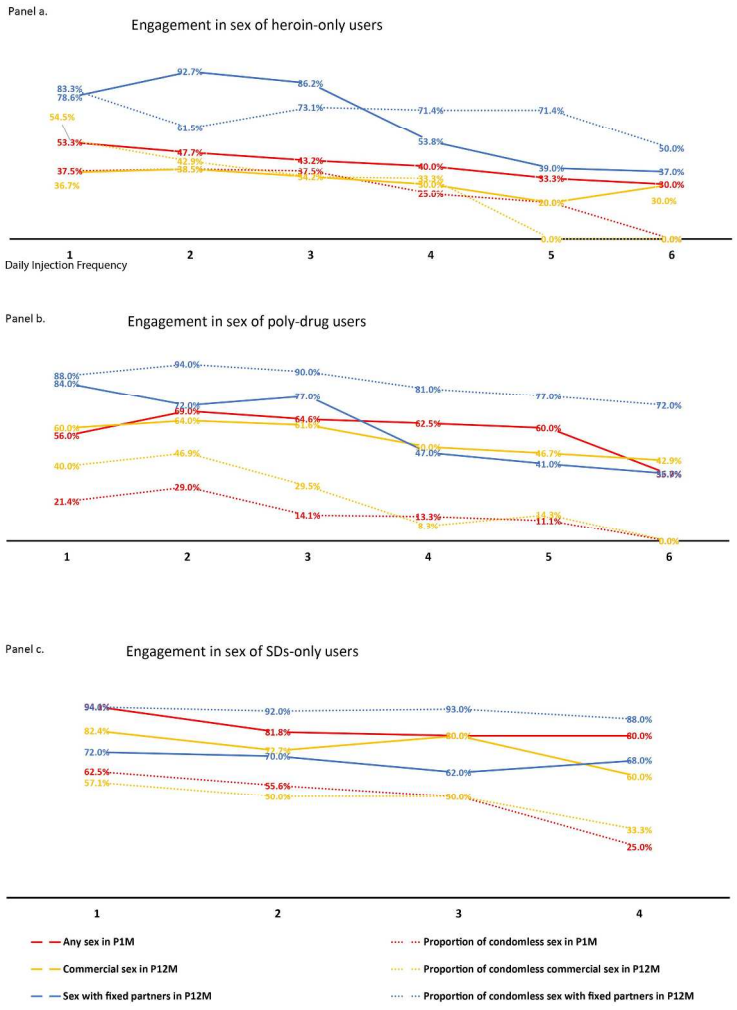

*Significant factors associated with risk sexual behaviours, based on a multiple linear regression analysis. Factors associated with any sexual activities in the previous month includes, injection frequency (-4.6%; 95%CI -5.5, -3.7%) and age (-0.9%; -1.6, -0.2%) among heroin-only users. Factors associated with condomless sexual activities in the previous month includes, injection frequency (-7.3%; -11.3, -3.3%) and education status (Senior high or above vs. Junior high or below) (4.5%; 2.1, 6.9%) among heroin-only users; injection frequency (-5.1%; -8.2, -2.0%) and age (-1.4%; -1.8, -1.0%) among poly-drug users. Factors associated with commercial sex in the past twelve months includes, injection frequency (-2.6%; -4.7, -0.5%), age (-1.1%; -1.6, -0.6%) and married status (unmarried vs. married) (5.7%; 4.3, 7.1%) among poly-drug users. Factors associated with condomless commercial sex in the previous twelve months includes, injection frequency (-11.5%; -12.8 , -10.2%) among heroin-only users; injection frequency (-7.1%; -9.2, -5.0%) and gender (male vs. female) (3.6%; 1.1, 6.1%) among poly-drug users. Factors associated with having sex with fixed partner in the previous twelve months includes, injection frequency (-6.1%; -11.9, -2.0%) and age (-1.4%; -3.1, -0.3%) among heroin-only users; injection frequency (-10.4%; -17.2 , -3.6%) among poly-drug users. Factors associated with condomeless sex with fixed partner in the previous twelve months includes, injection frequency (-1.8%; -2.7, -0.9%) and education status (Senior high or above vs. Junior high or below) (3.9%; 3.1, 4.7%) among poly-drug users.

Caption : Figure 1 The relationship between sexual practices in the previous one month, previous twelve months, and different drug administration patterns among IDU in Southwest China

256x390mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No (Reported on page #)	Recommendation
Title and abstract (✓)	1 (2)	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction (✓)		
Background/rationale	2 (4)	Explain the scientific background and rationale for the investigation being reported
Objectives	3 (4-5)	State specific objectives, including any prespecified hypotheses
Methods (✓)		
Study design	4 (5)	Present key elements of study design early in the paper
Setting	5 (5)	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6 (5)	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7 (5-6)	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*(5)	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9 (not applicable)	Describe any efforts to address potential sources of bias
Study size	10 (5)	Explain how the study size was arrived at
Quantitative variables	11(5)	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12(6)	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

		(*e*) Describe any sensitivity analyses

Continued on next page

Results (✓)		
Participants	13*(6)	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*(6-7)	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*(7)	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16 (7-8)	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17 (not applicable)	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion (✓)		
Key results	18 (8)	Summarise key results with reference to study objectives
Limitations	19 (9-10)	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20 (8)	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21(8-9)	Discuss the generalisability (external validity) of the study results
Other information (✓)		
Funding	22 (not applicable)	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.