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Sexual transmissibility of HIV among opiates users with concurrent sexual partnerships: An egocentric network study in Yunnan, China

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Abstract

Aims—To investigate the patterns of concurrent sexual partnerships among young opiate users and sexual transmissibility of HIV in concurrent sexual partnerships in drug-use and sexual networks.

Design—Cross-sectional design.

Participants—426 young opiate users in Yunnan, China.

Measurement—Respondent-driven sampling (RDS) was used to recruit participants. Multiple logistic regressions were performed to analyze the relationships of concurrent sexual partnerships with egocentric social network components, risky sexual behavior for HIV, and drug-use practices.

Findings—The RDS-adjusted prevalence of concurrent sexual partners was 42.9% among opiate users. Opiate users with concurrent sexual partnerships were more likely to engage in risky HIV-related sexual behavior, compared to those without. Specifically, they were more likely to report having had four or more sexual partners (26.3% vs. 2.0%), having had a spouse or boy/girl friends who also had concurrent sexual partnerships (28.1% vs. 8.2%), having exchanged drug for sex (12.4% vs. 3.8%), having had sexual partners who were non-injection drug users (22.6% vs. 10.1%), having had sexual partners who were injection drug users (25.3% vs. 13.5%), and having used club drugs (26.3% vs. 13.5%). There were no significant differences in consistent condom use between opiate users with sexual concurrency and those without. The same proportion (25.8%) of opiate users in the two groups reported having consistently used condoms when having sex with regular partners, and 46.3% of opiate users with sexual concurrency and 36.4% of those without such concurrency consistently used condoms with non-regular partners.

Conclusion—The expansion of the HIV epidemic from high risk populations to the general population in China may be driven by concurrent sexual partnerships. Behavioral interventions targeting safer sex should be integrated into harm reduction programmes.

Keywords

opiate use; concurrent sexual partnership; HIV; China

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INTRODUCTION

The units of HIV sexual transmission are individuals and partnerships in sexual networks [1]. There are basically two forms of partnerships in sexual networks: sequential monogamy and concurrency. As defined by Morris, “concurrent sexual partnerships are partnerships that overlap in time, rather than follow one another sequentially and disjointedly” [2]. The results of mathematical models suggest that concurrent partnerships can accelerate the spread of HIV transmission through a sexual network faster than the same number of sequential partnerships without overlap [3]. The associations between concurrent sexual partnerships and sexual risk for HIV infection has been documented in studies conducted among African-American adults, women and young adults in the United States [4–6], among general population samples in Africa [7, 8], and among men who have sex with men in China [9].

One important aspect of concurrent sexual partnerships is that concurrency is a particular risk for the partners of the individual who has concurrent sexual partnership. As illustrated by Morris [2, 10], a man's concurrency can put his monogamous female partner at risk of acquiring HIV from him, especially when his concurrent partners include sex workers or drug users who share injecting equipment with others. This monogamous female partner is exposed to the possibility of disease transmission, not by her own behavior, but by her male partner's concurrency. For the non-monogamous male partner, the risk comes simply from having multiple partners. Therefore, his concurrency status puts himself at an elevated risk to transmit HIV to his partners. If the male possesses other HIV-related risks (e.g., having multiple sexual partners, or sharing needles), the probability of transmission of HIV to his partners will be greatly increased.

Risky sexual behavior is an important determinant of HIV transmission or acquisition for drug users and their sexual partners. Through risky sexual behavior, drug users, especially injecting drug users (IDUs), can increase the speed of HIV transmission to other drug users and those who do not use drugs [11]. Concurrent partnerships may be as important as needle sharing in amplifying the spread of HIV among IDUs. By being exposed to both needle sharing and sexual concurrency, the risk of HIV transmission may increase greatly in both drug-use networks and sexual networks. Although a number of studies have investigated the proportions of drug users who reported concurrent partnerships and their association with HIV infection among drug users [12, 13], few studies have been conducted to address the social network aspects of concurrent sexual partnerships and to investigate HIV transmissibility of concurrent sexual partnerships in developing countries, especially in China where the sexual transmission of HIV has been rapidly increasing among drug users [14, 15].

The objectives of the present study were to investigate the patterns of concurrent sexual partnerships among young opiate users and to examine sexual transmissibility of HIV in concurrent sexual partnerships in their drug-use and sexual networks. Based on the above review of previous research on the influence of social networks on engagement in sexual risk, we hypothesized that that drug users with concurrent sexual partnerships were more likely to engage in risky sexual behavior and have a higher level of sexual transmissibility of HIV than drug users without such concurrency.

METHODS

Study site and subjects

This cross-sectional study was conducted in two contiguous counties in Yunnan province in 2009. Yunnan province, adjacent to the Golden Triangle of drug trafficking, has been the

center of the HIV epidemic in China. The eligibility criteria included individuals who: (1) were 18–35 years old and resided in either of the two counties, and (2) used heroin or/and opium (smoked, snorted, or injected) at least once a week in the past 30 days prior to the interview. The study protocol was approved by the Institutional Review Boards of the Virginia Commonwealth University and the Yunnan Institute of Drug Abuse.

Respondent-driven sampling

Respondent-driven sampling (RDS) was used to recruit participants [16]. Briefly, in order to select productive seeds, we conducted in-depth interviews among 28 drug users and held focus-group discussions among those who had experience in working with drug users, including local public health staff and outreach volunteers who were drug users. Based on the findings of the qualitative studies and with the help of the outreach volunteers, we selected a group of 14 seeds. These seeds were diverse in modes of drug use [IDUs or non-injection drug users (NIDUs)], gender, ethnicity (majority or minorities), marriage status, and residence in the two counties. These seeds received an explanation of the study purpose and procedures and were given three coupons to recruit up to three drug users from their network peers. All new recruits in subsequent waves were also offered three coupons, creating a chain of referrals from each original seed. Our evaluation of this RDS sample indicated its success in reaching the convergence of RDS compositions and including a broad cross-section of the hidden population.

Interview

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

Measures

Concurrent sexual partnerships—As documented in in-depth interviews among 28 young drug users, the majority of young drug users had regular sexual partners (i.e., spouses or boy/girl friends). We defined the concurrent sexual partnerships as “Having any other sexual partners during an individual's sexual relationship with his/her regular sexual partners”. Subjects were asked whether they had any other sexual partners during their sexual relationship with their regular sexual partners. Those with a positive answer were categorized as “having concurrent sexual partnerships”.

Egocentric social networks—An individual egocentric network consists of an index person (i.e., ego) and his /her network members (i.e., alters). The Chinese Social Network Questionnaire (CSNQ) was used to define three types of social networks: support network, drug use network, and sex network [17]. To measure the size of an individual's support network, name-generating questions were used to ask respondents (network egos) to list, by giving their first names or pseudonyms, others (alters) who could provide support for them in two supporting domains, e.g., emotional and tangible support. The relationship between an ego and his/her alters was investigated (e.g., family member, friend, sex partner, drug user, coworker or villager). Each of the two support functions was operationalized with three items [18]. Respondents (egos) rated the possibility (0 to 4; not possible at all, not sure, somewhat possible, quite possible, quite sure) of social support that they perceived to be available from each of their network alters. Egos were asked to list alters who would provide tangible support, including (1) lending the ego 100 Chinese Yuan (equivalent to USD15), accompanying the ego to see a doctor, or giving immediate help if the ego needed it; (2)

taking care of the ego if the ego was confined to bed for 2–3 weeks; and (3) helping or advising the ego if the ego had problems regarding family or personal issues, or health concerns. Emotional support was measured by listing alters who would (1) agree with or support the ego's actions or thought; (2) make the ego feel respected or admired; and (3) make the ego confide in the alter. The Cronbach's reliability alpha was 0.89 for tangible support and 0.88 for emotional support. In addition, egos were asked to list individuals who were their sex partners (sexual network) and individuals with whom they used drugs together or shared needles (drug-use network).

Support network size was the sum of alters who could provide tangible or emotional support. *Sexual network size* and *drug-use network size* were calculated separately from the sum of alters with whom the egos had sexual contact and used drug together. The levels of *emotional and tangible support* were measured by summing these item scores.

HIV risk behaviors—*Number of sex partners* Participants were asked to provide the total number of sex partners in the last 12 months.

Regular sex partners' concurrency Participants were asked to report whether they believed that their regular partners (spouses or boy/girl friends) had other partners during their sexual relationship.

Condom use Condom use with regular partners (spouse or boy/girl friends) and non-regular partners was measured by asking respondents about condom use with these partners during the last 12 months. Consistent condom use was defined as using condoms in most or every sex act.

Exchange for sex or drugs Participants were asked whether they had ever exchanged sex for drugs or money over their life time. A second question asked whether participants had ever used drugs to buy sex.

Using club drugs Participants were asked whether they had ever used club drugs including crystal methamphetamine, ecstasy, and ketamine over their life time.

Current drug use modes Participants who currently snorted or smoked drugs were defined as NIDUs. Those who currently injected drugs were defined as IDUs.

Data analysis

Respondent Driven Sampling Analysis Tool (RDSAT, version 6.0.1) was used to estimate the RDS-adjusted prevalence of concurrent sexual partnerships among drug users. RDSAT was designed to estimate overall sampling weights based on recruitment weights and network degree [19]. These weights were applied to bivariate and multiple logistic regression analyses. SAS procedures that are designed for analysis of survey data were used in analyses (version 9.2, SAS Institute, Cary, NC) [20, 21]. Relationships of concurrent sexual partnership with network factors, sexual behavior, and drug-use practices were analyzed in multiple logistic regression models (`proc surveylogistic'), controlling for demographic variables (gender, age, ethnicity, education, marital status, and job). Because modeling techniques for analyzing RDS data are still under development, a sensitivity analysis was performed to compare two sets of outcomes generated from weighted and un-weighted logistic regression models [21].

RESULTS

RDS-adjusted prevalence of concurrent sexual partnerships

A total of 426 subjects, including 14 seeds, were recruited over a period of approximately two months. Twelve seeds out of 14 successfully recruited other drug users. The average number of recruitment waves that a seed generated was 6 (12 seeds generated 77 recruitment waves).

Thirty two respondents were excluded in this analysis because they reported having never had sex. Among 394 subjects, 192 switched to heroin injection from smoking and 42 changed to injection from smoking. Of current drug users, 211 subjects currently injected heroin and 183 smoked heroin or opium. Measured over life time, 2.4% of IDUs shared needles for half or more episodes of injecting and 68% occasionally shared them. Over the last 30 days, only 10.4% drug users had shared needles.

The RDS-adjusted prevalence of concurrent sexual partners was 42.9% among drug users. Compared to non-concurrent drug users, drug users who engaged in concurrent sexual partnerships were more likely to be male, young, and single (Table 1).

Relationships between concurrent sexual partnerships and social networks

The 394 egos named a total of 3,127 alters. Table 2 presents the distributions of social network components among opiate users with and without concurrent sexual partners. Drug users who engaged in concurrent sexual partnerships reported larger sizes of support networks, sexual networks, and drug-use networks than those who did not. Drug users with concurrent sexual partnerships perceived themselves to receive higher levels of tangible and emotional support from their sex-partner alters, but lower levels of the two kinds of support from family-member alters than drug users without concurrent sexual partnerships. Concurrent sexual partnerships were not statistically associated with support from drug-use alters or friend alters.

Associations between concurrent sexual partnerships and HIV risk behavior

Crude and multivariate analyses document that drug users with concurrent sexual partnerships were more likely to engage in HIV-related sexual behaviors, compared to those without (Table 3). Specifically, more drug users with concurrent sexual partnerships than those without reported having had four or more sexual partners (26.3% vs. 2.0%), having had regular sex partners who also had concurrent sexual partnerships (28.1% vs. 8.2%), having used drugs to exchange for sex (12.4% vs. 3.8%), having had sex partners who were non-IDUs (22.6% vs. 10.1%), having had sex partners who were IDUs (25.3% vs. 13.5%), and having used club drugs (26.3% vs. 13.5%). There were no significant differences in consistent condom use between opiate users having concurrent sexual partners and those without. The same proportion (25.8%) of opiate users in the two groups reported having consistently used condoms when having sex with regular partners, and 46.3% of opiate users with concurrent sexual partners and 36.4% of those without such partners consistently used condoms with non-regular partners. There was no significant difference in concurrent sexual partnerships between current IDUs and NIDUs.

A similar result was found among 253 subjects who ever injected heroin in their life (42 switched, later on, to smoking) and 141 never injected heroin (only smoked heroin or opium). Forty-two percent of ever-injectors and 44% never-injectors reported having such concurrency ($\chi^2 = 0.09$, $p > 0.05$). Results from the sensitivity analysis indicated that results generated from the RDS-weighted univariate and multivariate analyses did not substantially differ from the results estimated in un-weighted analyses.

DISCUSSION

The findings of the study document that concurrent sexual partnerships were common among both IDUs and NIDUs. Coupled with other cofactors (larger sizes of sexual and drug-use networks and higher sexual risk), drug users with concurrent sexual partnerships have an elevated risk to transmit HIV to their regular and non-regular sex partners. Intervention programs that curb the HIV epidemic among drug users should take the role of sexual concurrency on HIV transmission into consideration.

The findings revealed that drug users with concurrent sexual partnerships had a larger number of sex partners and drug users in their social networks, indicating that these drug users may have more opportunities to either acquire HIV if they are HIV-negative or transmit HIV if they are positive to others by exposing themselves to larger sex networks and drug-use networks. Another important finding is that drug users who engaged in concurrent sexual partnerships perceived themselves to receive more emotional or tangible support from their sex-partner alters, but less from their family-member alters. This result may have its roots in Chinese collectivistic culture which emphasizes loyalty to families and spousal relationships [22] and conservative attitudes towards sex. While drug use may be culturally accepted in drug-use areas in Yunnan [23], concurrent sexual partnerships are largely unaccepted and stigmatized. Thus, individuals known to have multiple partners would be less acceptable to their families. This may be the reason that study subjects reported turning to sex-partner alters to seek support or have sex with them.

Compared with drug users who did not have concurrent sexual partnerships, drug users with such partnerships possessed a higher sexual risk for HIV transmission. The elevated sexual risks include having a larger number of sex partners, having regular sex partners who had other concurrent sex partners, using drugs to exchange for sex, and having sex partners who were either IDUs or NIDUs. In addition, drug users with sexual concurrency were more likely to use club drugs (e.g., Methamphetamines, MAMD, or ketamine). Studies have demonstrated that the use of club drugs increases sexual desire and unprotected sexual activity [24, 25]. According to Morris' model of sexual concurrency, concurrent sexual partnerships are a risk behavior resulting in transmission of HIV to sex partners from the individuals who engage in sexual concurrency [2]. The sexual transmission of HIV can be prevented if drug users with concurrent sexual partnerships consistently use condoms when having sex with their concurrent partners and monogamous partners. However, as documented in this study, the level of condom use among drug users with concurrency was too low to impede HIV transmission. Therefore, drug users with concurrent sex partners may serve as a bridging group to transmit HIV to their sex partners. Equally important, we found that about half of NIDUs engaged in concurrent sexual partnerships, but their condom use was also low. These findings imply that NIDUs may also play an important bridging role in sexually linking HIV infection from high HIV risk groups to low risk groups. In almost all Chinese provinces where the HIV epidemic was initially localized among drug users, the epidemic has spread via sexual contacts to both risk populations (drug users and commercial sex workers) and the general population [15, 26]. It is probable that concurrent sexual partnerships have catalyzed the process of generalizing the HIV epidemic in China.

Compared to drug users' sexual risk for HIV infection, drug users' current parenteral risk is relatively low. For example, only 10.4% drug users reported having ever shared needles in the last 30 days. The proportion of needle sharing was much lower than was reported in 2003 (an average of 45 % of IDUs shared needles in China) [27]. The difference between the proportions of needle sharing may be due to the government supported harm-reduction programs or different methods to measure needle sharing. In Yunnan, HIV transmission through needle-sharing has decreased from 100% in 1989 to 42.5% in 2007. In contrast,

sexual contact transmission accounted for 47.4% in 2007 [28, 29]. Central and local government policies on harm reduction for drug users include establishment of methadone maintenance treatment programs and needle exchange programs which have been implemented in Yunnan province [29, 30]. Because few harm reduction programs were designed to target behavioral changes [29, 31, 32], especially changes of sexual risk for HIV infection, the prevalence of sexual risk among drug users remains unchanged [33]. Theory-driven behavioral intervention programs that target both parenteral risk and sexual risk for HIV should be developed and evaluated among drug users in China.

The proportions of needle sharing with alters was similar in drug users with concurrent sexual partners and drug users without. Because needle sharing with alters was measured over life time, current needle-sharing should be far less than the life-time measures. The similar proportion of needle sharing with alters in the two groups may due to the fact that (1) few alters were injectors in both groups or (2) sex-partner concurrency has more impact on engagement in sexual risk than needle sharing.

There are several limitations in our study. Given the nature of the cross-sectional design, our findings should not be interpreted beyond associations. At present, there is no consensus on the definition of concurrency or a universally accepted method of measurement. Concurrent sexual partnerships in this study were defined by directly asking if subjects had any other partners during their sexual relationship with their regular partners. Research has documented that this definition, compared with other definitions (e.g., overlapping dates of sexual relationships), captured the majority of individuals identified as concurrent, produced very few missing data, and had the least likelihood of misclassification [34]. When subjects were asked about sex-partner concurrency, the sexual relationship with their regular sexual partners was treated as a reference. Although it helped subjects to easily and correctly recall sex-partner concurrency, it is possible that some subjects might have concurrent sexual partners but did not have a regular sexual partner. Information about drug use and sexual behaviors were self-reported, and as such may suffer from reporting bias. We could not compare HIV prevalence between drug users with and without concurrent sexual partnerships because we did not collect bio-samples for testing HIV. The study participants were recruited from two counties in Yunnan Province, which are not representative of all areas in China.

In conclusion, the findings of the study suggest that expansion of the HIV epidemic from risk populations to the general population and the shift of HIV transmission mode to sexual contacts from needle sharing may be driven by concurrent sexual partnerships among drug users. Behavioral interventions targeting safer sex should be integrated into harm reduction programs in China. Since drug users who engaged in sexual risk were more likely to seek support from their sex partners, their sex partners could be selected from their sexual network and trained to work as popular opinion leaders in behavioral intervention programs [35].

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Table 1

Demographic characteristic of young opiate users with and without concurrent sexual partners

	Weighted (%)		OR[a]	95% CI[b]
	Concurrency	Non-concurrency		
Gender				
Female	5.4	11.5	1.00	
Male	94.6	88.5	2.30	**1.07–4.95** [c]
Age (years)				
26–35	71.5	83.2	1.00	
18–25	28.5	16.8	1.97	**1.21–3.20**
Ethnicity				
Others	33.9	42.3	1.00	
Han	66.1	57.7	1.43	0.95–2.16
Education				
No school or primary school	34.4	32.2	1.00	
Middle school	52.2	55.8	0.88	0.57–1.36
High school or college	13.4	12.0	1.05	0.54–2.01
Marital status				
Married	21.0	35.6	1.00	
Single	79.0	64.4	2.08	**1.32–3.28**
Occupation				
Employed	17.7	17.3	1.00	
Farmer	24.2	28.4	0.83	0.45–1.54
No job	58.1	54.3	1.04	0.61–1.80
Current drug use mode				
Non-injecting drug use	46.2	46.6	1.00	
Injecting drug use	53.8	53.4	1.02	0.68–1.51

[a] Odds ratio

[b] 95% confidence interval

[c] $P<0.05$ in bold

Table 2

Comparisons of social network components between young opiate users with and without concurrent sexual partners

	Weighted Median/Mean (IQR[a]/SD[b])		Crude		Adjusted[c]	
	Concurrency	Non-concurrency	OR[d]	95%CI[e]	OR	95%CI
Support network size	7 (5–10)	6 (4–9)	1.05	0.99–1.12	1.05	0.98–1.13
Sexual network size	1 (0–2)	1 (0–1)	1.71	**1.39–2.10**[f]	1.91	**1.52–2.39**
Drug-use network size	3 (2–5)	2 (1–4)	1.13	**1.04–1.23**	1.16	**1.03–1.27**
Tangible support from sex-partner alters	13.69 (8.40)	10.92 (4.81)	1.06	**1.03–1.10**	1.06	**1.02–1.11**
Emotional support from sex-partner alters	12.53 (8.03)	9.89 (4.74)	1.07	**1.02–1.10**	1.06	**1.02–1.11**
Tangible support from drug-use alters	14.25 (13.04)	12.15 (12.74)	1.01	0.99–1.03	1.02	0.99–1.04
Emotional support from drug-use alters	14.90 (12.96)	13.96 (13.02)	1.01	0.99–1.02	1.01	0.99–1.03
Tangible support from family-member alters	17.07 (9.42)	21.06 (13.52)	0.97	**0.95–0.99**	0.97	**0.95–0.99**
Emotional support from family-member alters	14.27 (8.52)	17.82 (13.76)	0.97	**0.95–0.99**	0.97	**0.95–1.00**
Tangible support from friend alters	29.05 (21.68)	29.10 (29.35)	1.00	0.99–1.01	1.00	0.99–1.01
Emotional support from friend alters	29.33 (21.10)	29.00 (29.99)	1.00	0.99–1.01	1.00	0.99–1.01

[a] Interquartile range

[b] Standard deviation

[c] Adjusted for gender, age, ethnicity, education, marital status and job.

[d] Odds ratio

[e] 95% confidence interval

[f] $P<0.05$ in bold

Table 3

Relationships between concurrent sexual partnership and HIV related risk behaviors among young opiate users

	Weighted %		Crude		Adjusted[a]	
	Concurrency	Non-concurrency	OR[b]	95% CI[c]	OR	95% CI
Number of sexual partners in the past 12 months						
0–1	26.9	86.5	1.00		1.00	
2–3	46.8	11.5	13.05	**7.51–22.68** [d]	14.40	**7.85–26.40**
4 or more	26.3	2.0	44.07	**15.10–128.61**	55.32	**15.56–196.72**
Spouse or boy/girl friends' concurrency						
No	71.9	91.8	1.00		1.00	
Yes	28.1	8.2	4.36	**2.15–8.85**	4.66	**2.04–10.62**
Condom use with regular partners in the last 12 months						
Consistent use	25.8	25.8	1.00		1.00	
Inconsistent use	74.2	74.2	1.00	0.59–1.69	0.86	0.48–1.55
Condom use with non-regular partners in the last 12 months	tis					
Consistent use	46.3	36.4	1.00		1.00	
Inconsistent use	53.7	63.6	0.66	0.26–1.71	0.54	0.19–1.54
Trading sex for drugs or money for drugs						
No	95.2	97.1	1.00		1.00	
Yes	4.8	2.9	1.71	0.60–4.92	2.09	0.77–5.70
Using drugs to exchange for sex						
No	87.6	96.2	1.00		1.00	
Yes	12.4	3.8	3.53	**1.53–8.11**	3.57	**1.47–8.70**
Having sex partners who were NIDUs						
No	77.4	89.9	1.00		1.00	
Yes	22.6	10.1	2.60	**1.47–4.59**	3.29	**1.79–6.05**
Having sex partners who were IDUs						
No	74.7	86.5	1.00		1.00	
Yes	25.3	13.5	2.17	**1.29–3.65**	3.75	**1.99–7.07**
Number of drug-use alters						
0–1	23.7	38.2	1.00		1.00	

	Weighted %		Crude		Adjusted[a]	
	Concurrency	Non-concurrency	OR[b]	95% CI[c]	OR	95% CI
2–4	48.4	40.6	1.92	**1.20–3.10**	1.97	**1.18–3.30**
5 or more	27.9	21.2	2.12	**1.23–3.67**	2.32	**1.26–4.29**
Sharing needles with others						
No	59.1	59.6	1.00		1.00	
Yes	40.9	40.4	1.02	0.68–1.53	1.01	0.64–1.60
Using club drugs						
No	73.7	86.5	1.00		1.00	
Yes	26.3	13.5	2.30	**1.37–3.85**	2.16	**1.23–3.78**
Current drug use mode						
Non-injecting drug use	46.2	46.6	1.00		1.00	
Injecting drug use	53.8	53.4	1.02	0.68–1.51	1.03	0.64–1.67
No risk	36.6	43.3	1.00		1.00	
Some risk	39.8	31.7	1.48	0.94–2.35	1.45	0.88–2.40
Definitely risk	23.6	25.0	1.12	0.67–1.87	1.10	0.63–1.89

[a] Adjusted for gender, age, ethnicity, education, marital status and job.

[b] Odds ratio

[c] 95% confidence interval

[d] $P<0.05$ in bold