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The Impact Of The Accuracy Of Hiv Risk Perception On Hiv Risk Behavior Changes Among Women With Substance Use Disorders In Treatment.

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Abstract

Studies involving women or women with SUDs for PrEP are limited even though in many areas of the world women remain at high-risk for HIV acquisition. This study is to evaluate the impact of accuracy of HIV risk perception on HIV risk behaviors changes over time among women with substance use disorders in treatment, including sexual and injecting risk behaviors. This is a secondary analysis based on a preference controlled un-blinded study. This study enrolled 165 cis- or trans-female volunteers ⩾18 years old who were self-reported HIV-uninfected, had diagnosed SUDs, and were presenting for or currently enrolled in drug treatment. 50.6% of participants (N=83) were categorized as underestimating their HIV risk while 49.4% (N=81) were categorized as accurately/over-estimating their HIV risk at baseline. We observed a positive association between underestimating HIV risk at baseline and reduction of HIV risk behaviors over time. Though women who underestimated their HIV risk did reduce their HIV risk behaviors to some extent over time, their HIV risk was still higher than women who accurately or overestimated HIV risk at each subsequent visit. Some high-risk behaviors persisted. The greatest impact of underestimating personal HIV risk on the self-reported HIV risk behaviors was initially after baseline with reduced behavioral change over time, indicating this impact on the change of HIV risk behaviors may be short-lived and fade away if no other intervention is delivered. Though there was a sharp decrease in condomless sex over time among the "underestimate" group, the proportion was above 50% throughout the period of observation, which may be attributed to other determinants that affect women's decisions of whether to use condom, such as inability to negotiate with sexual partners. Studies collecting more detailed HIV risk behaviors information and considering about other confounders, such as IPV, are needed to research the intensity and duration of the effect of underestimating HIV risk on behavior changes.

Key words

Accuracy of HIV risk perception; HIV risk behaviors change; Women with substance use disorders (SUDs); Chronic Disease Epidemiology

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Introduction

Pre-exposure prophylaxis (PrEP), or the use of antiretroviral medications to prevent HIV infection, is one of the promising tools to reduce HIV risk for HIV-uninfected individuals. Many placebo-controlled clinical trials have demonstrated the efficacy of oral PrEP in reducing the risk of HIV transmission among men who have sex with men (MSM) (Grant et al., 2010), serodiscordant heterosexual couples (Baeten et al., 2012; Thigpen et al., 2012) and people who inject drugs (PWIDs) (Choopanya et al., 2013). One theoretical concern about using PrEP as HIV prevention is the potential for risk

disinhibition or sexual risk compensation (Cassell, Halperin, Shelton, & Stanton, 2006; Pinkerton, 2001). Concerns derived from the possibility that people would have an excessive optimism about the protective effect of PrEP, and that will lead to increased risk behaviors. Similar concerns have been raised regarding various HIV prevention efforts, including vaccines (Chesney, Chambers, & Kahn, 1997), male circumcision (Lagarde, Dirk, Puren, Reathe, & Bertran, 2003), and vaginal microbicides (Foss, Vickerman, Heise, & Watts, 2003). Since PrEP does not totally eliminate the risk of HIV (or other sexually transmitted infections) and requires daily use which makes adherence difficult for many people, US guidelines on PrEP currently recommend that other HIV risk-reduction approaches, particularly condoms, should be used alongside PrEP.

Women with substance use disorders (SUDs) experience high HIV risk due to substance use behaviors (including injecting) and overlapping sex and drug use networks. Compared with women without SUD, they disproportionately interact with the criminal justice system (CJS) (Drugs & Crime, 2018), engage in transactional sex (Azim, Bontell, & Strathdee, 2015; Iversen, Page, Madden, & Maher, 2015), and experience physical and sexual violence (Gilbert et al., 2015)— each of which independently increases HIV risk (Sarah Larney, Bradley M Mathers, Tonia Poteat, Adeeba Kamarulzaman, & Louisa Degenhardt, 2015; Willie, Stockman, Perler, & Kershaw, 2018). Despite potentially being able to benefit from PrEP for HIV prevention, PrEP uptake among women with SUDs is low, in part because women often underestimate their own HIV risk and are not aware of Pre-exposure prophylaxis (PrEP) as a personally relevant option (Qin et al., 2020).

Behavior changes and adopting risk-reduction practices highly depend on people's awareness and

perception of their degrees of HIV infection risk (Darbes, Crepaz, Lyles, Kennedy, & Rutherford, 2008; Jorjoran Shushtari et al., 2019; Shiferaw et al., 2014). However, as a multifaceted concept, risk perception could be directly or indirectly influenced by socioeconomic status, political and cultural factors (Auli et al., 2013; Taylor-Gooby & Zinn, 2006), and may be biased in different degrees and directions. For instance, though many people engaging in sex work know that they can acquire HIV through sexual contact, they focus on risk of infection from commercial, and not other partners (Bruce et al., 2011). Psychosocial/cognitive models of HIV prevention claim that 'incorrect' risk perceptions, which sometimes may even go as far as a sense of invulnerability, impede the development of protective and preventive behaviors, such as condom use and HIV testing (Tenkorang & Maticka-Tyndale, 2013). Past studies have identified associations between risk perception and HIV prevention behaviors, including delaying sexual debut, (Tenkorang, 2014) practicing abstinence (Gelibo, Belachew, & Tilahun, 2013; Iriyama, Nakahara, Jimba, Ichikawa, & Wakai, 2007), using condoms (Cederbaum, Gilreath, & Barman-Adhikari, 2014; Maharaj & Cleland, 2005), and adhering to daily oral pre-exposure prophylaxis (PrEP) (Corneli et al., 2014; Haberer et al., 2017; van der Straten et al., 2014). However, solid evidence on causal relationships between risk perception and behavior is limited due to lack of longitudinal studies (Gerrard, Gibbons, & Bushman, 1996; Protogerou, Johnson, & Hagger, 2018).

While several previous double-blind randomized placebo-controlled PrEP trials showed no evidence of sexual risk disinhibition and risk compensation (Baeten et al., 2012; Guest et al., 2008; Liu et al., 2013) these RCTs are not ideal to evaluate sexual risk behaviors change as participants did not know whether they were actually receiving PrEP or placebo. Therefore, studies simulating a real-world

scenario where participants are aware that they are taking PrEP are needed. Findings from a cross-sectional study suggest that people with highest risk perception at baseline most likely to anticipate increased HIV risk behaviors after starting PrEP (Shrestha et al., 2017). Studies involving women or women with SUDs for PrEP are limited even though in many areas of the world women remain at high-risk for HIV acquisition. As a result, this study maps the changes in risk behaviors among women with SUDs in addiction treatment and enrolled in a preference controlled un-blinded clinical trial of an HIV prevention decision aid. The objective is to evaluate whether these women experience changes in HIV risk behaviors over time, including sexual and injecting risk behaviors, after assessing their perceived HIV risk level. The primary hypothesis is that women who underestimated their personal HIV risk at baseline will have greater risk behaviors reduction than women who accurately or over-estimated their HIV risk.

Methods

Study design and setting

This is a secondary analysis of data derived from *Project Options: Developing and Testing the Effect of a Patient-Centered HIV Prevention Decision Aid on PrEP uptake for Women with Substance Use in Treatment Settings,* which has been described elsewhere (Qin et al., 2020).The original study is a preference controlled un-blinded study, designed to inform, develop and test a patient-centered decision aid about PrEP for women with SUDs.

Study sample and data collection

The sample was recruited using provider-, self-, and peer-referrals and followed at the APT

Foundation or research offices in New Haven, Connecticut for 1 year. Referred clients were then screened for inclusion and exclusion criteria by a trained research assistant in a private room onsite. This study enrolled 165 cis- or trans-female volunteers ⩾18 years old who were self-reported HIV-uninfected, had diagnosed SUDs, and were presenting for or currently enrolled in drug treatment. Women were excluded if they were currently taking PrEP or were experiencing active withdrawal that would interfere with consent processes.

The baseline study visit included an assessment of baseline sex- and drug-related HIV risk behavior (modified from NIDA's Risk Behavior Assessment), baseline preferences for PrEP as HIV prevention, and preferences for receiving more information on PrEP. Those who opted to receive further information were assigned to the "treatment arm", and received the decision aid in English or Spanish, facilitated by the trained research assistant using a standardized script and pre-printed handout or pamphlet. Treatment arm participants also received a local resource guide for PrEP. Participants in both arms received standard harm reduction counseling through the treatment center as standard of care and were followed quarterly for 12 months with study visits to evaluate for HIV risk behaviors and PrEP uptake. At each study visit, participants completed a brief structured interview with a trained research assistant, and reviewed pill counts (only if on PrEP), and received an appointment card for the subsequent visit.

Study measures

The main outcome of interest was HIV risk behavior score, which evaluated sex- and drug-related HIV risk behaviors for participants. Participants were asked about different HIV risk behaviors,

including condomless sex with a man who injects drugs, condomless sex with a man who has sex with men, condomless sex with a man who has HIV but is not virally suppressed, condomless sex with a man with HIV status unknown, injection drug use and sharing equipment, exchanged sex. The risk scale was modified from Denver HIV risk scale to conduct the assessment. Participants who scored 0-1 in the baseline risk assessment were classified as low risk for HIV. Others were classified as in medium or high risk for HIV (medium:2-3 points, high:≥4 points). Participants were informed about their true risk for HIV after baseline HIV risk assessment. Risk behavior assessments were also conducted at quarterly follow-up visits.

The main exposure of interest was the accuracy of baseline HIV risk perception, which was calculated based on HIV risk assessment and self-reported HIV risk perception. Participants were asked "How likely are you to become infected by HIV right now?" and responded on a 5-point Likert scale from 1 (not at all likely) to 5 (extremely likely). For participants who were classified in high risk for HIV from the HIV risk behavior score, if they selected 1-3 points in the Likert scale, they were then categorized as underestimating their HIV risk, otherwise they were categorized as accurately or over- estimating their HIV risk. For participants classified as medium risk for HIV, if they selected 1-2 points in the Likert scale, they were then categorized as underestimating, otherwise they were categorized as accurately or over- estimating their HIV risk. Participants in low HIV risk were all categorized as accurately or over- estimating their risk. (Fig 1)

Figure 1. Categories of accuracy of HIV risk assessment

		Actual behavioral HIV risk		
		Low	Medium	High
Perceived HIV risk on 5-point Likert scale	1-2	accurate	underestimated	underestimated
	3	overestimated	accurate	underestimated
	4-5	overestimated	overestimated	accurate

Other covariates included age, race, marital status, education level, usual employment pattern, total monthly income, which was analyzed continuously and dichotomized at the federal poverty level, HIV concern, last time health check-up, would take PrEP if available, and receiving decision aid. For individuals, the annual Income less than $12,800 was considered as below the federal poverty level according to criteria from the Department of Health and Human Services (HHS)("Annual Update of the HHS Poverty Guidelines," 2021). Chronic medical problems were defined as any serious physical conditions that require regular care, (i.e.,medication, dietary restriction) preventing full advantage of their abilities. Substance use disorders were evaluated at baseline using Addiction Severity Index (ASI)(McLellan et al., 1992). Severe lifetime alcohol use was defined as having alcohol composite score ⩾0.17. And severe lifetime drug use was defined as having drug composite score⩾0.12. Severe lifetime psychiatric disorder was defined as having ASI-P⩾0.22. Hazardous drinking was evaluated using the AUDIT (⩾4 scores) at baseline (Conigrave, Hall, & Saunders, 2006).

Data Analysis

The baseline characteristics were described, including demographics, SUD severity, attitude toward PrEP, HIV risk and HIV risk perception of the total participants. We conducted a comparison of baseline characteristics between the low risk and medium/high risk groups. Continuous variables were summarized by means and standard deviation and compared using Student's t-test or Wilcoxon rank

sum test. Categorical variables were summarized by proportion and compared by chi-squared test or Fisher's exact test. Violin plots of distribution of HIV risk behavior score were performed using R studio. Two-sided tests were used and statistical significance level was set to 0.05. All statistical analyses were performed using SAS 9.4 statistical software.

Mixed effect models were applied to model the changes of HIV risk behaviors over time among women with different HIV risk perceptions. The dependent variable to evaluate HIV risk behavior change was HIV risk score reduction, which was coded as baseline HIV risk behavior assessment score minus HIV risk assessment score at the 3^{rd}, 6^{th}, 9^{th}, and 12^{th} month, respectively. Three linear mixed effects models were estimated with the REML method in a repeated measures design. Since the correlations were expected to decrease as the assessment times were further removed from each other, autoregressive(1) was used as covariance structure. These model takes subjects and time as random effect, and is to estimate the fixed effect of accuracy of HIV risk perception and other covariates on change of HIV risk behavior score, including age, race, education level, marital status, income (below federal poverty level or not), receiving decision aid and time (ordinal). Interaction between accuracy of HIV risk perception and time was taken into account.

Results

A total of 164 women with SUDs in treatment were enrolled in the study. Table 1-1 shows the sociodemographic characteristics by baseline HIV risk. Age ranged from 19 to 61 years with a mean age of 40.4±10.3 years. Over half of participants were single and about 22% were married. The majority of participants were identified as White (73.2%) and Black (14.6%). This was consistent with the

demographic profile of people in drug treatment programs from SAMHSA National Survey on Drug Use and Health (SAMHSA, 2018). Only 60 (36.6%) completed college or graduate education and others completed 12 years education or less. Though 67.7% of participants were employed fulltime or part-time, over 70% of them had a total monthly income that fell below the federal poverty level. Approximately half of participants had chronic medical problems which could potentially interfere with their life. About 43.8% of the 32 women who responded to questions about alcohol use met criteria for severe lifetime alcohol use. Among 89 women who responded to questions about drug use, only one did not have severe lifetime drug use. 31 (54.4%) of the 57 women responding to AUDIT met criteria for hazardous drinking. The mean age of women in the low-risk group (43.6±9.8) was higher than that of women in the medium/high-risk group (38.2±10.2, $p<0.001$). A greater proportion of women in the low-risk group had chronic medical problems compared to women in medium/high-risk group (60.3% vs. 44.2%, $p=0.043$). There was no significant difference observed between low and medium/high HIV risk group in terms of marital status, race, education, usual employment pattern, total monthly income.

HIV risk perception

Among the total participants, 29 (16.5%) reported that they were somewhat or extremely likely to be infected by HIV, while the other 135 (82.3%) women thought they were not at all likely to be infected. Compared to women at low HIV risk, women at medium/high HIV risk were more likely to self-report that they were somewhat or extremely likely to be infected with HIV (27.1% vs. 4.4%, $p<0.001$). In terms of the accuracy of HIV risk perception, 83 women underestimated their HIV risk at baseline, accounting for 50.6% of total participants.

When asked about "How concerned are you about your risk for HIV", the proportion of answering "Not at all", "Somewhat", and "Extremely" was 67.1%, 25.7% and 7.2% respectively. More women reported that they were not at all concerned about their HIV risk in low-risk group (p=0.001). Less than half of women had their last regular checkup or physical with a health care provider within 6 months. When asked about whether they would take PrEP if it were available, only 25% answered "Yes", and about 45% answered they didn't know what PrEP is. More people in the low-risk group did not know about PrEP than in the medium/high-risk group (58.8% vs. 34.4%, p=0.004).

Table 1-1. Baseline characteristics among different HIV risk level groups

	Total		Low		Median/High		*P*
	N	%	N	%	N	%	
Total	164	100.00	68	41.46	96	58.54	
Age (Mean±SD)	40.40	10.33	43.58	9.78	38.15	10.15	<0.001
Marital status							0.469
Married	36	22.09	18	26.87	18	18.75	
Single	85	52.15	33	49.25	52	54.17	
Widowed/Separated/Divorced	42	25.77	16	23.88	26	27.08	
Race							0.846
White	120	73.17	48	70.59	72	75.00	
Black	24	14.63	12	17.65	12	12.50	
Hispanic/Latino	3	1.83	1	1.47	2	2.08	
Other	17	10.37	7	10.29	10	10.42	
Education							0.968
College/Graduate	60	36.59	25	36.76	35	36.46	
⩽High school	104	63.41	43	63.24	61	63.54	
Usual employment pattern							0.725
Fulltime/Part time	111	67.68	44	64.71	67	69.79	
Retired/Disability/controlled	17	10.37	7	10.29	10	10.42	
Unemployed	36	21.95	17	25.00	19	19.79	
Total Monthly Income (median, IQR)	793.50	836.00	815.00	857.00	768.50	836.00	0.521
Below federal poverty level	116	70.73	47	69.12	69	71.88	0.702
Chronic Medical Problems	83	50.92	41	60.29	42	44.21	0.043
Severe lifetime alcohol use	14	43.75	5	41.67	9	45.00	0.854
Severe lifetime drug use	88	98.88	28	100.00	60	98.36	1.000
Hazardous drinking	31	54.39	10	45.45	21	60.00	0.283
Severe lifetime psych disorder	110	91.67	41	85.42	69	95.83	0.087

Table 1-2. HIV related attitude and risk perception among different HIV risk groups

	Total		Low		Median/High		*P*
	N	%	N	%	N	%	
Self-reported HIV risk							<0.001
Not at all likely	135	82.32	65	95.59	70	72.92	
Somewhat/Extremely Likely	29	17.68	3	4.41	26	27.08	
HIV concern							0.001
Not at all concerned	102	67.11	52	83.87	50	55.56	
Somewhat concerned	39	25.66	8	12.90	31	34.44	
Extremely concerned	11	7.24	2	3.23	9	10.00	
Last health check-up							0.126
Less than 6 months	79	48.17	38	55.88	41	42.71	
6 months - 1 year	52	31.71	16	23.53	36	37.50	
1-2 years	23	14.02	8	11.76	15	15.63	
More than 2 years	10	6.10	6	8.82	4	4.17	
Would take PrEP if available							0.004
Yes	41	25.00	13	19.12	28	29.17	
Maybe	39	23.78	9	13.24	30	31.25	
No/Unsure	11	6.71	6	8.82	5	5.21	
Don't know what PrEP is	73	44.51	40	58.82	33	34.38	
Accuracy of HIV risk perception							<0.001
Underestimated	83	50.61	0	0.00	83	86.46	
Accurately/overestimated	81	49.39	68	100.00	13	13.54	

Table 2. Comparison of HIV risk or protective behaviors between the two accuracy of perception groups at each time point															
		BL			M3			M6			M9			M12		
		A/O[a]	U[b]		A/O	U		A/O	U		A/O	U		A/O	U	
		N / %	N / %	*P*	N / %	N / %	*P*	N / %	N / %	*P*	N / %	N / %	*P*	N / %	N / %	*P*
Total (N)		81	83		65	62	0.395	51	52	0.967	53	45	0.143	55	46	0.100
					80.25	74.50		62.96	62.65		65.43	54.22		67.90	55.42	
Risk behaviors	Have sex without condom	41	80	**<.001**	28	34	0.185	19	35	**0.002**	22	28	**0.041**	27	28	0.237
		50.62	96.39		43.08	54.84		37.25	67.31		41.51	62.22		49.09	60.87	
	Exchange sex	1	15	**<.001**	2	4	0.433	0	4	0.118	1	2	0.592	2	4	0.407
		1.23	18.07		3.08	6.45		0.00	7.69		1.89	4.44		3.64	8.70	
	Share injecting equipment	3	22	**<.001**	2	5	0.266	2	4	0.678	3	4	0.700	1	3	0.328
		3.70	26.51		3.08	8.06		3.92	7.69		5.66	8.89		1.82	6.52	
Protective methods	Abstinence				30	14	**0.005**	25	15	**0.036**	27	11	**0.007**	24	14	0.173
					46.15	22.58		49.02	28.85		50.94	24.44		43.64	30.43	
	Condom				8	14	0.126	6	6	0.972	4	6	0.505	3	5	0.463
					12.31	22.58		11.76	11.54		7.55	13.33		5.45	10.87	
	Practicing harm reduction with injecting practice				3	8	0.097	0	3	0.243	3	11	**0.008**	3	9	**0.029**
					4.62	12.90		0.00	5.77		5.66	24.44		5.45	19.57	
	Regular HIV testing				5	5	1.000	5	9	0.267	3	7	0.179	3	8	0.055
					7.69	8.06		9.80	17.31		5.66	15.56		5.45	17.39	
	Know your partners status				26	37	**0.027**	16	30	**0.007**	22	25	0.165	24	26	0.197
					40.00	59.68		31.37	57.69		41.51	55.56		43.64	56.52	
	Drug treatment				52	53	0.414	47	44	0.233	48	36	0.136	46	40	0.640
					80.00	85.48		92.16	84.62		90.57	80.00		83.64	86.96	
HIV risk assessment [c]		1.0	3.0	**<.001**	0.0	1.0	**0.001**	0.0	1.0	**<.001**	0.0	2.0	**0.003**	1.0	1.5	**0.005**
		1.0	3.0		1.0	2.0		1.0	2.0		1.0	3.0		1.0	2.0	

a-b. A/O: accurately/overestimated; U: underestimated

c. HIV risk assessment: HIV risk scores were summarized using median and IQR; p-values for it were generated from Wilcoxon rank sum test

HIV risk behaviors and protective behaviors

Among the 164 women, the proportion who attended the 3rd, 6th ,9th and 12th month visit was 77.4%, 62.8%, 59.8%, 61.6% respectively. And only 62 (37.8%) attended all quarterly visits. There was no significant difference in attrition in terms of accuracy of risk perception at each visit.

According to Table 2, for HIV risk behaviors, a significantly greater number of women who underestimated their HIV risk had had sex without a condom in the past 6 months than women who accurately or overestimated their HIV risk at baseline (96.4% vs. 50.6%, $p<0.001$), the 6th month (67.3% vs. 37.3%, $p=0.002$) and the 9th month (62.2% vs. 51.5%, $p=0.041$) of follow-up. However, the difference in HIV risk behaviors between the two groups disappeared in the 3rd month and 12th month. The proportion who had sex without a condom in the past 6 months among the underestimate group dropped from 96.4% at baseline to 54.8% at the 3rd month, varied in the following visits but still kept below 70% (Fig 2). Among the accurately/overestimated group, the proportion of women who had sex without a condom in the past 6 months also had a slight decrease from around 50% to around 40%, but then went back to 49.1% in the 12th month (Fig 2). These findings indicate a decrease in condomless sex over time among women who underestimated their HIV risk at baseline. At baseline, the proportion of women who had exchanged sex (18.1% vs. 1.2%, $p<0.001$) and who shared drug injecting equipment (26.5% vs. 3.70%, $p<0.001$) in the past 6 months were both greater in the underestimated group than in the accurately/over-estimated group. Nevertheless, no significant differences of exchanging sex and sharing injecting equipment between the underestimated group and the accurately/overestimated group were observed at the subsequent visit. Among the underestimated group, the proportions of women who exchanged sex and who shared injecting equipment declined after the 3rd month (Fig 3 and Fig 4).

In terms of use of protective methods, very few women reported using condoms, practicing harm reduction injecting behaviors (e.g., accessing syringe service programs, bleaching needles, syringes or other injecting equipment), or having regular HIV tests. Compared to women in the underestimated group, more women who accurately or over-estimated their risk were abstinent from sex in the 3rd, 6th and 9thmonth. Interestingly, many women chose to know their partners' HIV status and asked for proof of test results, including over 50% of the underestimated group and 30%-40% in the accurately/over-estimated group at each visit. Besides, the proportion who chose to know their partners' HIV status was greater among women who underestimated their HIV risk in the 3rdand the 6th month. In both risk perception groups, there were over 80% women reported they had drug treatment with a medication, which is expected given our study setting. (Table 2)

For HIV risk assessment, the median of women who underestimated their HIV risk was significantly higher than that of women who accurately or overestimated their risk at each time point (Table 2). Moreover, the IQR of HIV risk score was larger among the underestimated group, indicating a more disperse distribution. We also visualized the distribution of risk assessment scores using violin plots and boxplots, and found a shift from baseline at each visit for women who underestimated their risk. The most obvious downward shift was from baseline to the 3rd month. For the accurately/overestimate group, the distributions were relatively stable at each time point. (Fig 5)

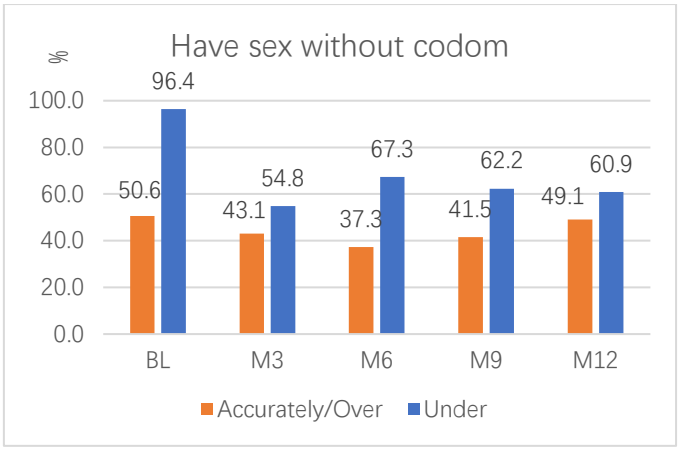

Figure 2. Proportion of women having sex without condom by accuracy of risk perception groups at each visit.

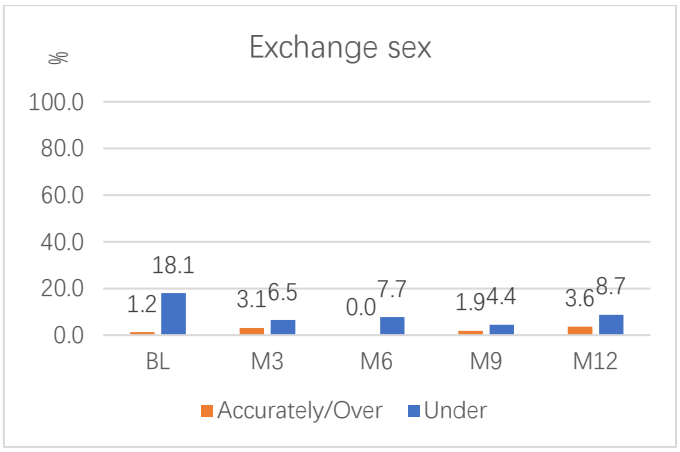

Figure 3. Proportion of women exchanging sex by accuracy of risk perception groups at each visit.

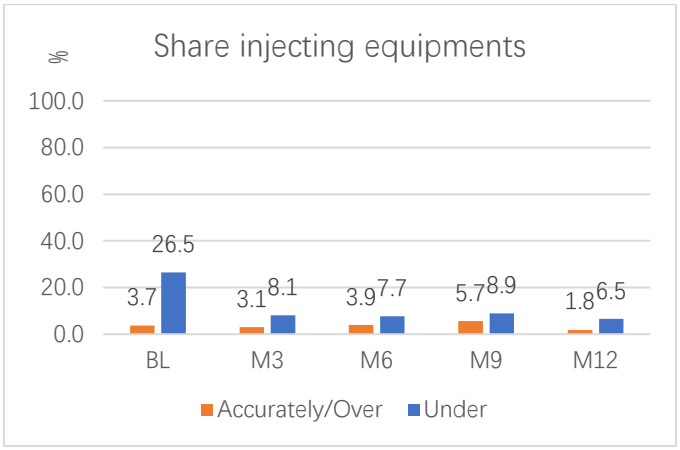

Figure 4. Proportion of women sharing injecting equipment by accuracy of risk perception groups at each visit.

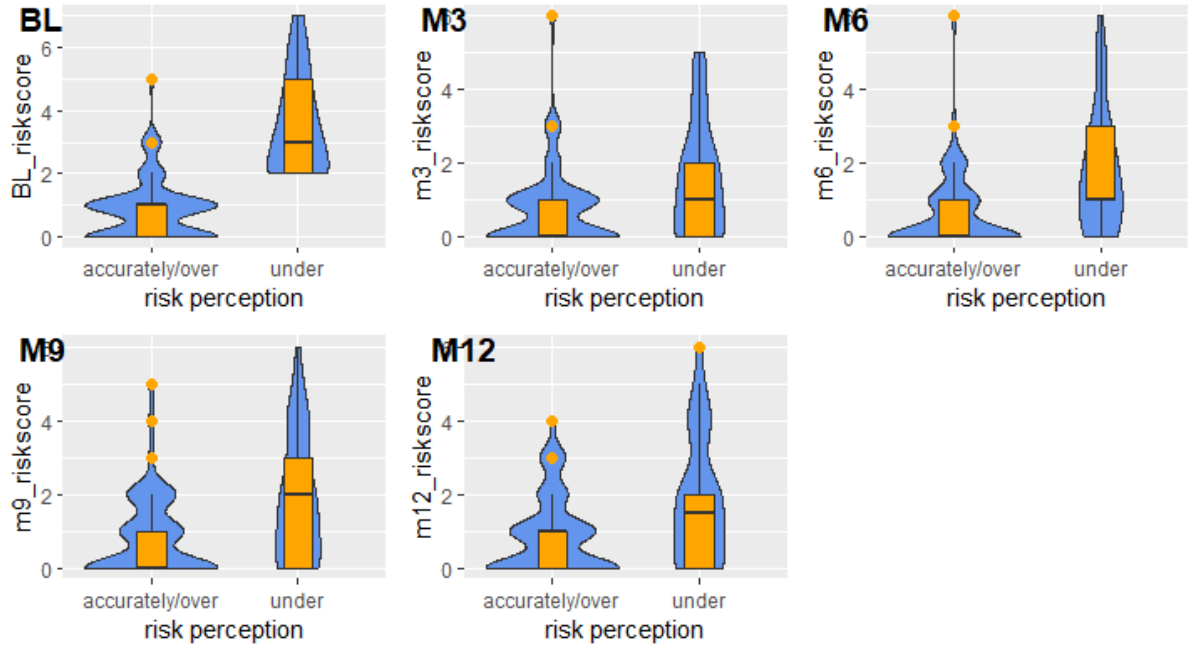

Figure 5. Violin plots of HIV risk behavior assessment scores at each time point, by accuracy of risk perception

Mixed effect model

Model 1 was to target the effect of accuracy of HIV risk perception on HIV risk behavior change, including time as a covariate to see if there was a trend of the change over time. Model 2 further included baseline HIV risk level as another covariate. In Model 2, the significant effect of baseline HIV risk on risk behavior change was detected while the significant effect of accuracy of risk perception disappeared. This could because of the correlation between these two variables, given that the classification of HIV risk perception accuracy was based on baseline HIV risk and self-reported likelihood to get infected. As the aim is to target the effect of underestimating HIV risk, we finally built Model 3 which dropped baseline HIV risk and included accuracy of HIV risk perception. Other covariates in Model 3 including age, race, education level, marital status, income, receiving decision aid and time. The interaction between accuracy of HIV risk perception and time was also incorporated.

The result of Model 3 was shown in Table 3, compared to women who accurately or over-estimated their HIV risk, the reduction of HIV risk behavior scores among women who underestimated HIV risk at baseline was 1.98 (95%CI:1.43-2.52, p<0.001) points greater, after adjusting for other covariates. But this difference of HIV risk behavior scores reduction was 0.34 points smaller at the 6th month (p=0.039). Women who were widowed, separated or divorced has 0.71 (95%CI:0.01-1.40, p=0.046) greater decrease than women who were married.

Table 3. Results of the Mixed Effect Model

Effect	Estimate	SE	P	95%CI
Underestimate HIV risk	1.98	0.28	**<.001**	**(1.43,2.52)**
Underestimate* Month 3	reference			
Underestimate* Month 6	-0.34	0.16	**0.039**	**(-0.66,-0.02)**
Underestimate* Month 9	-0.13	0.17	0.433	(-0.47,0.20)
Underestimate* Month 3	-0.29	0.19	0.122	(-0.65,0.08)
Accurately/overestimate*Month 3	reference			
Accurately/overestimate*Month 6	0.06	0.16	0.718	(-0.26,0.38)
Accurately/overestimate*Month 9	-0.07	0.16	0.647	(-0.39,0.24)

Accurately/overestimate*Month 12		-0.19	0.17	0.285	(-0.53,0.16)
Month	3	reference	.	.	
	6	0	-	-	-
	9	0	-	-	-
	12	0	-	-	-
Decision aid		0.14	0.23	0.561	(-0.32,0.60)
Age		0.02	0.01	0.259	(-0.01,0.04)
Marital status	Married	reference	.	.	
	Single	0.30	0.30	0.313	(-0.29,0.89)
	Widowed/Separated/Divorced	0.71	0.35	**0.046**	**(0.01,1.40)**
Race	White	reference	.	.	
	Black	-0.27	0.35	0.429	(-0.96,0.41)
	Hispanic/Latino	0.50	0.83	0.544	(-1.13,2.13)
	Other	0.13	0.41	0.752	(-0.68,0.94)
Education level	College and graduate	reference	.	.	
	High school	-0.24	0.25	0.332	(-0.72,0.24)
Below federal poverty level		0.19	0.26	0.465	(-0.33,0.71)

Discussion

In this study of accuracy of HIV risk perception among 164 women with substance use disorders in treatment, we tested the hypothesis that women who underestimated their HIV risk at baseline would reduce their risk behavior over time. We observed a positive association between underestimating HIV risk at baseline and reduction of HIV risk behaviors over time. Because participants in the underestimate group would aware that their personal HIV risk was actually higher than they had perceived after baseline assessment, which promoted them to reduce risk behaviors. While participants in the accurately/overestimate group had already know their risk level well and thus were less likely to change their behaviors. Though women who underestimated their HIV risk did reduce their HIV risk behaviors to some extent over time, their HIV risk was still higher than women who accurately or overestimated HIV risk at each subsequent visit. Some high-risk behaviors persisted.

Moreover, women in the underestimate group had the most remarkable change of risk behavior at

the first visit (3rd month), and this impact seems wore out slightly as time passed by. Thus, the greatest impact of realizing exact HIV risk on the self-reported HIV risk behaviors was initially after baseline with reduced behavioral change over time, indicating this impact on the change of HIV risk behaviors may be short-term and fade if no other intervention is delivered. This could be well explained by the law of diminishing returns, which was an economic law stating that if one input was increased while all other inputs were fixed, a point will eventually be reached at which additions of the input yield progressively smaller, or diminishing, increases in output. Therefore, acknowledge of personal HIV risk level could be an initial motivation for behaviors change among high-risk population, but to maintain this change more other efforts are desired, such as periodical counselling, motivational interviewing and booster sessions for more regular contact. However, behavior change and behavior change maintenance per se were difficult and affected by multifaceted factors, such as changing roles of motives, elf-regulation, habits, resources (Kwasnicka, Dombrowski, White, & Sniehotta, 2016). Initial behavior change was usually motivated by expectations of uncertain long-term outcomes, in this case, changing behaviors to reduce HIV infection risk.

Condomless sex was a very common HIV risk behavior among participants, regardless of baseline HIV risk perception. Though we observed a sharp decrease in condomless sex over time among the "underestimate" group, the proportion was above 50% throughout the period of observation. This could possibly be attributed to other determinants that affect women's decisions of whether to use condom, including violence, substance abuse, inability to negotiate with sexual partners. The hardest thing about condoms was that they were partner dependent. Many women are unable to negotiate condoms with their partners, limiting the potential for male condoms as a comprehensive HIV prevention strategy. Previous studies have reported higher mortality due to violence among women with SUDs compared to age-matched peers (Sarah Larney, Bradley M. Mathers, Tonia Poteat, Adeeba Kamarulzaman, & Louisa Degenhardt, 2015). Many women with SUDs experience intimate partner

violence (IPV) when negotiating condom use (Qin et al., 2020). Limited social capital and economic dependence on partners can also lead to unprotected sex (Muchomba, Chan, & El-Bassel, 2015). This may also explain the greater reduction of HIV risk behaviors among widowed, separated or divorced women than among married women.

The proportions of exchanging sex and sharing injecting equipment both declined among participants at follow-up visits to the extent no different from women accurately or over- estimating their HIV risk in this study. Potentially, individuals tend to attach more importance to exchanging sex and sharing injecting equipment, relating higher HIV transmission risk to them, and feel easier to quit from them. Interestingly, abstinent and knowing partners' HIV status were the most frequently used protective methods among participants, while taking regular HIV test was only adopted by few people.

Limitations

This study had a few limitations. Firstly, HIV risk behaviors were self-reported, which may be subject to social desirability effect. In addition, it was a secondary analysis, as a result, data collected was not tailor-made for the purposes of this analysis. If more detailed information related to multiple types of HIV risk behaviors, such as the number of sex partners, partners' HIV status, frequency of unprotected sex, frequency of sharing drug injecting equipment, etc., could be collected and analyzed, we would be powered to detect differences in these outcomes. Besides, only 37.8% of participants had attended all follow-up visits. The result can be biased if loss-to-follow-up was related to HIV risk or accuracy of risk perception. But the analysis showed that there was no association between missingness and the accuracy of risk perception at each time point. Lastly, behavior change was associated with multiple factors. Though some demographic characteristics was adjusted in the mixed effect model

when assess the impact of accuracy of HIV risk perception on behavior change, many other possible confounders still can hardly be taken into account in the study, such as IPV.

Conclusion

In this study of HIV prevention decision-making among women with substance use disorders in treatment, underestimating personal HIV risk was positively associated with reduction of HIV risk behaviors. However, this effect was short-lived. Studies considering more information about other confounders are needed to research the intensity and duration of this effect.

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