A cross-sectional study of the relationship between sexual compulsivity and unprotected anal intercourse among men who have sex with men in Shanghai, China

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Abstract

Background: HIV prevalence among men who have sex with men (MSM) in China is rising rapidly, and unprotected anal intercourse (UAI) is associated with HIV transmission. Recent research has shown that associations between UAI and other factors can differ according to the type of sex partners, including regular partners and casual partners. This study aimed to explore the relationship between sexual compulsivity and UAI according to partner type among MSM in Shanghai, China.

Methods: A cross-sectional study was conducted among 547 MSM from four districts in Shanghai, China. All participants were recruited using snowball sampling. The Sexual Compulsivity Scale was used to evaluate participants’ sexual compulsivity. Multivariable logistic regression was used to identify factors associated with sexual compulsivity and UAI. The mediation effects of substance use before sex on the relationship between sexual compulsivity and UAI were tested through mediation analyses.

Results: After adjusting for sociodemographic variables, sexual compulsivity was associated with overall UAI (adjusted odds ratios [AOR] = 1.039, 95% confidence intervals [CI] = 1.004–1.075), UAI with non-regular sex partners (AOR = 1.089, 95% CI = 1.033–1.148) and UAI with commercial sex partners (AOR = 1.185, 95% CI = 1.042–1.349). No significant association was found between sexual compulsivity and UAI with regular sex partners (AOR = 1.029, 95% CI = 0.984–1.077). Mediation analyses indicated that the relationship between sexual compulsivity and UAI was not mediated by either alcohol use before sex or drug use before sex.

Conclusions: The association between sexual compulsivity and UAI varies depending on the type of UAI partner. Therefore, individuals may engage in different types of UAI for different reasons, and tailored HIV cognitive–behavioral intervention programs are needed.

Keywords: Men who have sex with men, Sexual compulsivity, Unprotected anal intercourse, Sex partners

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Background

HIV transmission in China occurs in various ways, including intravenous drug use, blood or plasma transfusion, and high-risk sexual behaviors, particularly among men who have sex with men (MSM) [1]. Among people living with HIV (PLWH) in China, the approximate percentage of infections from unprotected male-to-male sexual contact was 7.3, 11.0, 14.7, and 17.4% in 2005, 2007, 2009, and 2011, respectively [2–5]. Related data suggest that the fastest increase in HIV transmission in China is found in MSM [6, 7]. MSM have a disproportionately high HIV prevalence, which can be ascribed to the high prevalence of unprotected anal intercourse (UAI) [8, 9], one of the riskiest sexual behaviors for HIV transmission [10–13] in this subpopulation. Therefore, an in-depth understanding of UAI is urgently needed to prevent the rapid spread of HIV among MSM. There are many factors related to UAI, such as drug use [14, 15], depressive symptoms [16], lower risk of perception of UAI [16, 17], non-disclosure of sexual orientation to parents [18], self-efficacy in condom use [19], sexual sensation seeking [15, 20], and sexual compulsivity [19, 21–25].

Sexual compulsivity is “an insistent, repetitive, intrusive, and unwanted urge to perform specific acts often in ritualized or routinized fashions” [24], which is characterized by sexual fantasies and can interfere with personal, interpersonal, and vocational activities [26–28]. Individuals who are incapable of controlling sexual impulses sufficiently and are preoccupied with sexual activities may tend to engage in high-risk sexual behaviors disregarding the probability of contracting HIV and other potential adverse consequences [29–31]. To assess the degree of sexual compulsivity, Kalichman and colleagues developed the 10-item Sexual Compulsivity Scale (SCS), which was based on a self-assisted guide for self-reported sexual addiction [24, 32–34]. This scale has been widely used and shown to be reliable among sexually active individuals, including MSM and heterosexual men and women [15, 24, 34–37]. High sexual compulsivity, in many studies, has been certified that corresponded to high-risk sexual behaviors in MSM [38, 39]. For MSM with different ethnic and racial backgrounds, sexual compulsivity has been recognized as a stable personality trait [40]. The SCS has been translated into Chinese and back-translated into English by Chinese researchers to verify its reliability and validity [36]. The validated Chinese version of sexual compulsivity scale used in the present study can also be applied in many other populations in China as long as they can read and write the same Chinese language [20].

Many previous studies have found a significant association between UAI and sexual compulsivity [19, 21–25]. Some research has examined this high-risk sexual behavior in relation to the type of sexual partner with whom participants practice UAI [20, 36, 41–46]. These studies have found variation in the relationships between independent variables and different types of UAI (including UAI with regular sex partners, UAI with casual sex partners, and UAI with commercial sex partners). In the meantime, some survey studies found the prevalence rates of different types of UAI vary [42, 45–49]. Wang et al. (2017) suggested that cognitive variables, psychological factors, emotion-related variables, and social-structural factors are strongly associated with UAI with regular and/or non-regular sexual partners [41]. Therefore, research on the relationship between sexual compulsivity and UAI according to partner type may help to inform partner type-specific HIV prevention strategies that target MSM. In addition, substance use has been recognized as a robust predictor of UAI [14, 15] and a mediator of the association between sexual compulsivity and UAI [21]. Therefore, testing for mediation by substance use before sex was conducted to understand whether the relationship between sexual compulsivity and UAI is mediated by substance use.

We conducted this cross-sectional study in Shanghai, China, and evaluated relationships between sexual compulsivity and different types of UAI. The main hypotheses were 1) sexual compulsivity is associated with UAI, and 2) the relationship between sexual compulsivity and UAI varies according to partner type.

Methods

Setting, sample and recruitment

Shanghai, a large cosmopolitan city with relatively more tolerance to people with diversified sexuality, MSM in particular, making it an appropriate social setting for studies targeting MSM. This cross-sectional study used a snowball sampling method to recruit eligible participants from the Changning, Jingan, Zhabei, and Pudong districts from March 2014 to August 2014. This method initially identifies subgroup members from whom the targeted data can be collected; then these initial members serve as “seeds” to recruit new eligible participants. These participants, in turn, are encouraged to recruit other new participants until the sample size reaches the goal. Eligibility criteria in this research included male gender, age above 16 years, and having had UAI with another man in the past 6 months. With the help of the local Center for Disease Control and Prevention and some non-government organizations, 5 to 10 eligible persons from each district were enrolled as “seeds”. A total of 547 eligible participants were enrolled. Each participant signed an informed consent form before completing a questionnaire. Participants received 100 CNY (about 15.5 USD) as compensation. Trained workers introduced the survey to participants and answered any questions they had. Subsequently, anonymous face-to-face interviews were carried out to help...
participants to complete a series of questionnaires collecting sociodemographic data, data on behavioral variables, and SCS scores. At the end of this process, one participant’s data were excluded because he had not specified the partner type in his response.

Ethics, consent, and permissions
Each participant provided written, informed consent before participation. This study strictly complied with American Psychological Association standards and was approved by the institutional review board of the Shanghai Jiao Tong University School of Public Health.

Measures
Questionnaire data on sociodemographics, behavioral variables, and total SCS scores comprised the independent variables.

Sociodemographics
Respondents were asked about their age, highest educational level, current marital status (with women), monthly salary, residential status, and self-reported sexual orientation.

Behavioral variables
Behavioral variables measured were overall UAI and different forms of UAI according to partner type in the past 6 months, as well as substance use before sex. Individuals who reported inconsistent condom use (any at all, over the last 6 months) during sex with men were coded as having had UAI with male sex partners; this operational recording has been commonly used in published studies [50, 51]. Information about the type of sexual partner was also obtained. Regular sex partners were defined as boyfriends; namely, those individuals in stable relationships with participants. Non-regular sex partners were defined as sexual partners who were neither regular nor commercial. Commercial sex partners were defined as partners receiving money from participants for transactional sex. Some published studies on sexual activities have used similar definitions for sex partner types [52–54].

Sexual compulsivity
The degree of sexual compulsivity was assessed using the SCS, a 10-item, four-point Likert-type scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total score ranges from 10 to 40. Sample items included “My sexual appetite has gotten in the way of my relationships,” “My sexual thoughts and behaviors are causing problems in my life” and “I sometimes fail to meet my commitments and responsibilities because of my sexual behaviors.” A higher total score indicates a greater degree of sexual compulsivity. Cronbach’s α for this scale is 0.86, as reported by Kalichman & Rompa [24], and was 0.853 for the current sample.

Statistical analysis
Internal reliability was assessed by using the Cronbach’s α. Descriptive analysis was performed, then the associations between background variables and sexual compulsivity were examined using t-tests and ANOVA. In addition, multivariable logistic regression was conducted to determine the association between independent variables and different types of UAI, obtained their adjusted odds ratios (AOR) and 95% confidence intervals (CI). The criterion of statistical significance was \( p < .05 \). At the final stage, meditational analyses were conducted by computing the separate \( Z_{\text{Mediation}} \), which was recommended by a published study for categorical mediators and dependent variables [55]. All data analyses were performed using SPSS version 22.0 for Windows (SPSS, Inc., Chicago, IL, USA).

Mediation analyses
The aims of this research included investigating whether substance use before sex as a robust predictor of UAI mediate the relationship between sexual compulsivity and UAI. According to a published study recommending the solution for meditational analyses using categorical mediators and dependent variables, the \( Z_{\text{Mediation}} \) was computed [55]. The mediation effect is significant at the level of \( \alpha = 0.05 \) if the \( Z_{\text{Mediation}} \) exceeds \( |1.96| \) (for a 2-tailed test with \( \alpha = 0.05 \)).

Results
Sample description
Table 1 shows the frequency distribution of participant sociodemographic characteristics and Table 2 shows descriptive statistics for sexual compulsivity. Most respondents were single non-local people aged 25–40 years, with a college-level education or above and self-reported as gay/homosexual. The distribution of income was even. Regarding the substance use, 49.3% of participants reported alcohol use before sex, and 96.9% of participants reported no drug use before sex during the 6 months prior to the study. Of the participants, 54.4% were coded as having had UAI with male sex partners in the past 6 months. Regarding sex partners, 61.5% of respondents reported having regular sex partners and 50.9% of these had had UAI with regular sex partners in the past 6 months; 51.8% of respondents reported having non-regular sex partners and 42.8% of these had had UAI with non-regular sex partners in the past 6 months; 14.3% of respondents reported having commercial sex partners and 55.1% of these had had UAI with commercial sex partners in the past 6 months. The range, mean
SCS scores were 30, 22.41 and 23.00 respectively.

Table 2 shows total SCS scores by sociodemographic and behavioral variables. There were significant between-group differences in SCS scores for highest educational level, current marital status, residential status, UAI with non-regular sex partners, and UAI with commercial sex partners. Individuals having had UAI with non-regular sex partners and with commercial sex partners have a higher SCS mean scores than individuals having had UAI with regular sex partners.

Analyses showed that highest educational level and monthly salary were significantly related to UAI. Age was significantly related to UAI with regular sex partners. Age, highest educational level, and self-reported sexual orientation were significantly related to UAI with non-regular sex partners. Self-reported sexual orientation was significantly related to UAI with commercial sex partners. Table 3 presents the main outcome of the analysis.

The relationships between sexual compulsivity and UAI, UAI with non-regular sex partners, and UAI with commercial sex partners were significant. AORs for the associations between sexual compulsivity and different types of UAI were calculated after adjusting for background variables. Sexual compulsivity was found to be associated with overall UAI (AOR = 1.039, 95% CI = 1.004–1.075), UAI with non-regular sex partners (AOR = 1.089, 95% CI = 1.033–1.148) and UAI with commercial sex partners (AOR = 1.185, 95% CI = 1.042–1.349). No significant association was found between sexual compulsivity and UAI with regular sex partners (AOR = 1.029, 95% CI = 0.984–1.077).

After adjusting for the effects of background variables, the results showed that for each unit increase in the total SCS score, the odds of having had UAI

| Variables                                      | N (%)         |
|------------------------------------------------|---------------|
| **Age group (years)**                          |               |
| < 25                                           | 148 (27.1)    |
| 25–40                                          | 336 (61.5)    |
| > 40                                           | 62 (11.4)     |
| **Highest educational level**                  |               |
| Senior high school or below                    | 157 (28.8)    |
| College degree or above                        | 389 (71.2)    |
| **Current marital status**                     |               |
| Married                                        | 82 (15.0)     |
| Single                                         | 433 (79.3)    |
| Divorced or widowed                            | 31 (5.7)      |
| **Income (monthly CNY)**                       |               |
| < 3000                                         | 133 (24.4)    |
| 3000–6000                                      | 211 (38.6)    |
| > 6000                                         | 202 (37.0)    |
| **Residential status**                         |               |
| Local                                          | 147 (26.9)    |
| Non-local                                      | 399 (73.1)    |
| **Self-reported sexual orientation**           |               |
| Non-homosexual                                 | 157 (28.8)    |
| Gay/homosexual                                 | 389 (71.2)    |
| **Alcohol use before sex**                     |               |
| Yes                                            | 277 (50.7)    |
| No                                             | 269 (49.3)    |
| **Drug use before sex**                        |               |
| Yes                                            | 529 (96.9)    |
| No                                             | 17 (3.1)      |
| **Have regular sex partners**                  |               |
| Yes                                            | 336 (61.5)    |
| No                                             | 210 (38.5)    |
| **UAI with regular sex partners**              |               |
| Yes                                            | 171 (50.9)    |
| No                                             | 165 (49.1)    |
| **Have non-regular sex partners**              |               |
| Yes                                            | 283 (51.8)    |
| No                                             | 263 (48.2)    |
| **UAI with non-regular sex partners**          |               |
| Yes                                            | 121 (42.8)    |
| No                                             | 162 (57.2)    |
| **Have commercial sex partners**               |               |
| Yes                                            | 78 (14.3)     |
| No                                             | 468 (85.7)    |

| Variables                                      | N (%)         |
|------------------------------------------------|---------------|
| **UAI with commercial sex partners**           |               |
| Yes                                            | 43 (55.1)     |
| No                                             | 35 (44.9)     |

and median of participants’ SCS scores were 30, 22.41 and 23.00 respectively.

Table 2 shows total SCS scores by sociodemographic and behavioral variables. There were significant between-group differences in SCS scores for highest educational level, current marital status, residential status, UAI with non-regular sex partners, and UAI with commercial sex partners. Individuals having had UAI with non-regular sex partners and with commercial sex partners have a higher SCS mean scores than individuals having had UAI with regular sex partners.

### Relationships between background variables and UAI, UAI with regular sex partners, UAI with non-regular sex partners, and UAI with commercial sex partners

Analyses showed that highest educational level and monthly salary were significantly related to UAI. Age was significantly related to UAI with regular sex partners. Age, highest educational level, and self-reported sexual orientation were significantly related to UAI with non-regular sex partners. Self-reported sexual orientation was significantly related to UAI with commercial sex partners. Table 3 presents the main outcome of the analysis.

### Relationships between sexual compulsivity and UAI, UAI with regular sex partners, UAI with non-regular sex partners, and UAI with commercial sex partners

The relationships between sexual compulsivity and UAI, UAI with non-regular sex partners, and UAI with commercial sex partners were significant. AORs for the associations between sexual compulsivity and different types of UAI were calculated after adjusting for background variables. Sexual compulsivity was found to be associated with overall UAI (AOR = 1.039, 95% CI = 1.004–1.075), UAI with non-regular sex partners (AOR = 1.089, 95% CI = 1.033–1.148) and UAI with commercial sex partners (AOR = 1.185, 95% CI = 1.042–1.349). No significant association was found between sexual compulsivity and UAI with regular sex partners (AOR = 1.029, 95% CI = 0.984–1.077).

After adjusting for the effects of background variables, the results showed that for each unit increase in the total SCS score, the odds of having had UAI
increased by 3.9%, the odds of having had UAI with non-regular sex partners increased by 8.9% and the odds of having had UAI with commercial sex partners increased by 18.5%. Given the range of the total SCS score, these increases in odds are considerable. Table 3 presents the main outcome of this analysis.

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**Mediation analyses**

The meditational analyses indicated that the relationships between sexual compulsivity and UAI, UAINP, UAICP were not mediated by either alcohol use before sex or drug use before sex. Table 4 presents the main outcomes of the analyses.

**Discussion**

This survey explored the relationships between sexual compulsivity and different types of UAI among MSM in Shanghai, China. The prevalence rates for different types of UAI among participants were 50.9% (UAI with regular sex partners), 42.8% (UAI with non-regular sex partners), and 55.1% (UAI with commercial sex partners). These statistics are in line with previous study [42, 45–49], indicating that the prevalence rate of UAI with regular sex partners is higher than the prevalence rate of UAI with non-regular sex partners. The findings also showed that the association between sexual compulsivity and UAI varied according to partner type. In other words, sexual compulsivity was significantly associated with UAI in general, UAI with non-regular sex partners, and UAI with commercial sex partners. No significant association was observed between sexual compulsivity and UAI with regular sex partners. This result is consistent with findings from several previous studies, suggesting that individuals who exhibit a greater degree of sexual compulsivity are more likely to engage in UAI with casual sex partners than those who exhibit less sexual compulsivity [17, 23, 32–34, 56]. In addition, we investigated potential mediators of the relationships between sexual compulsivity and UAI, UAINP, UAICP, and failed to find any significant mediation effect. More research is warranted to understand whether substance use before sex mediates the association between sexual compulsivity and UAI in Chinese MSM.

The choice of variable type (categorical variable versus continuous variable) is a critical issue that could potentially influence the result of statistical analyses. Before presenting results produced by using the continuous SC variable in Table 3, multivariable analyses were carried out respectively to compare the results obtained by using the continuous SCS variable and by using the categorical SCS variable. In spite of a lack of established, defined cut-point to designate sexual compulsivity, the developers of this scale used the 80th percentile as their cut-point to ensure that compulsive individuals defined by them were at least one SD (standard deviation) above the mean on this scale [21]. The 85% percentile was defined as the cut-point in our study according to this method. The result obtained by using the categorical variable still failed to find a significant association between SC and UAI with regular sex partners while still finding evidence of association for the other partner.
types (general UAI and UAI with commercial sex partners). Given that the result may vary according to different cut-points and the cut-point may vary according to different samples, using the continuous variable may produce a more stable result.

Analyses indicated that highest educational level and monthly salary were significantly related to UAI; age was significantly related to UAI with regular sex partners; age, highest educational level, and self-reported sexual orientation were significantly related to UAI with non-regular sex partners; self-reported sexual orientation was significantly related to UAI with commercial sex partners. Participants with a higher educational level were less likely to perform UAI. This difference may result from the situation that participants with a lower educational level are less informed about HIV prevention knowledge in China [57]. Therefore, sex and HIV/AIDS-related education and research are urgently needed.

### Table 3: Relationships between sociodemographics, sexual compulsivity, and UAI/UAIRP/UAINP/UAICP

| Sociodemographics                  | UAI (N = 546)       | UAIRP (N = 336)     | UAINP (N = 283)     | UAICP (N = 78)      |
|------------------------------------|---------------------|---------------------|---------------------|---------------------|
|                                    | N (%) | AOR (95% CI) | N (%) | AOR (95% CI) | N (%) | AOR (95% CI) | N (%) | AOR (95% CI) |
| **Age group (years)**              |       |             |       |             |       |             |       |             |
| < 25                               | 76 (51.4%) | 1 | 53 (58.9%) | 1 | 19 (29.2%) | 1 | 10 (62.5%) | 1 |
| 25–40                              | 186 (55.4%) | 1.011 (0.654–1.563) | 96 (47.3%) | 0.517 (0.295–0.906)* | 84 (45.4%) | 2.176 (1.097–4.316)* | 24 (53.3%) | 0.517 (0.125–2.139) |
| > 40                               | 35 (56.5%) | 1.076 (0.530–2.181) | 22 (51.2%) | 0.595 (0.245–1.444) | 18 (54.5%) | 3.011 (1.049–8.639)* | 9 (52.9%) | 0.621 (0.099–3.877) |
| **Highest educational level**      |       |             |       |             |       |             |       |             |
| Senior high school or below        | 99 (63.1%) | 1 | 47 (50.0%) | 1 | 53 (59.6%) | 1 | 27 (57.4%) | 1 |
| College degree or above            | 198 (50.9%) | 0.614 (0.387–0.974)* | 124 (51.2%) | 0.957 (0.529–1.732) | 68 (35.1%) | 0.418 (0.218–0.799)** | 16 (51.6%) | 1.335 (0.367–4.862) |
| **Current marital status**          |       |             |       |             |       |             |       |             |
| Single                             | 232 (53.6%) | 1 | 139 (51.1%) | 1 | 83 (39.9%) | 1 | 25 (56.8%) | 1 |
| Married                            | 48 (58.5%) | 0.803 (0.458–1.409) | 22 (45.8%) | 0.841 (0.410–1.725) | 26 (47.3%) | 0.460 (0.211–1.002) | 13 (52.0%) | 0.328 (0.079–1.356) |
| Divorced or widowed                | 17 (54.8%) | 0.795 (0.354–1.788) | 10 (62.5%) | 1.712 (0.561–5.224) | 12 (66.7%) | 1.700 (0.538–5.368) | 5 (55.6%) | 0.782 (0.132–4.643) |
| **Income (monthly CNY)**           |       |             |       |             |       |             |       |             |
| < 3000                             | 64 (48.1%) | 1 | 37 (45.7%) | 1 | 28 (48.3%) | 1 | 19 (61.3%) | 1 |
| 3000–6000                          | 132 (62.6%) | 1.969 (1.235–3.139)** | 70 (54.7%) | 1.691 (0.933–3.064) | 57 (47.5%) | 1.151 (0.568–2.331) | 16 (55.2%) | 0.736 (0.213–2.538) |
| > 6000                             | 101 (50.0%) | 1.341 (0.803–2.240) | 64 (50.4%) | 1.567 (0.807–3.043) | 36 (34.3%) | 0.769 (0.347–1.708) | 8 (44.4%) | 0.260 (0.054–1.257) |
| **Residential status**             |       |             |       |             |       |             |       |             |
| Local                              | 80 (54.4%) | 1 | 52 (52.5%) | 1 | 27 (42.2%) | 1 | 7 (43.8%) | 1 |
| Non-local                          | 217 (54.4%) | 0.854 (0.565–1.291) | 119 (50.2%) | 0.791 (0.472–1.326) | 94 (42.9%) | 0.982 (0.516–1.866) | 36 (58.1%) | 2.173 (0.556–8.503) |
| **Self-reported sexual orientation**|       |             |       |             |       |             |       |             |
| Non-homosexual                     | 91 (58.0%) | 1 | 46 (50.0%) | 1 | 46 (50.5%) | 1 | 26 (65.0%) | 1 |
| Gay/homosexual                     | 206 (53.0%) | 0.837 (0.564–1.242) | 125 (51.2%) | 0.967 (0.580–1.615) | 75 (39.1%) | 0.571 (0.327–0.996)* | 17 (44.7%) | 0.222 (0.069–0.709)* |
| Sexual Compulsivity Scale score     | 1.039 (1.004–1.077) | 1.029 (0.984–1.077) | 1.089 (1.033–1.148)** | 1.185 (1.042–1.349)** |

AOR: adjusted odds ratio, UAI: unprotected anal intercourse, UAIRP: unprotected anal intercourse with regular sex partners, UAINP: unprotected anal intercourse with non-regular sex partners, UAICP: unprotected anal intercourse with commercial sex partners, 95% CI: 95% confidence interval

*p < 0.05, **p < 0.01
needed, not only to fill the knowledge gap in Chinese 
sex education but also to help mitigate social discrimina-
tion and stigma toward MSM [58].

The differences in the associations between sexual 
compulsivity and UAI with regular sex partners, UAI 
with non-regular sex partners, and UAI with commercial 
sex partners provide new insights into the reasons for 
different UAI and indicate the importance of differenti-
ating between these practices in future research [41]. 
Continued research on the nature of sexual compulsivity 
may help to clarify the mechanism underlying UAI with 
non-regular and commercial sex partners. Sexual com-
pulsivity represents sexual preoccupation and lack of 
sexual control, which is more likely to be associated with 
casual sexual interactions [32, 34]. This may be a result 
of a diminished ability to avoid sexual risk, as rational 
decision-making may be impaired under sexual arousal, 
making sexual risks less salient [59]. In other words, 
individuals who are sexually aroused may have a compro-
mised capacity in perceiving specific risky sexual 
behaviors and avoid them. Therefore, individuals with a 
high level of sexual compulsivity may show a diminished 
long-term ability to avoid risky sexual behaviors, as such 
individuals experience prolonged states of sexual arousal 
[59]. However, although there is a relatively high 
prevalence rate of UAI with regular sex partners, it 
seems not to be a result of an impaired ability to 
avoid sexual risks. Crawford et al. (2006) reported 
that with regular partners who are HIV-seropositive, 
insertive UAI without ejaculation is much more fre-
quent than receptive UAI with ejaculation, whereas 
with casual partners who are HIV-seropositive, inser-
tive and receptive UAI practices occur almost as fre-
cently [46]. Therefore, it is possible that individuals 
who practice UAI with regular sex partners are not 
unaware of the HIV risk. Previous studies on regular 
sex partners have suggested several important factors 
related to UAI with regular sex partners, including 
greater sexual impulsivity and concern about perceptions 
of mistrust between partners, intimacy interference, and syndemic stress [47, 60–62].

Thus, factors related to UAI should be considered in 
light of participants’ partner types, and HIV prevention 
strategies should be tailored to specific types of UAI, 
which is in line with previous research recommendations 
[41, 63]. For UAI with non-regular and commercial sex 
partners, therapy for sexual compulsivity may be effective 
to promote sexual health. Furthermore, providing con-
doms, communication, and behavior change can help to 
decrease UAI exposure [45]. Regarding UAI with regular 
sex partners, pre-exposure prophylaxis is a promising way 
to prevent HIV transmission among MSM individuals 
who are willing to practice condomless sex with partners 
to maintain intimacy [64]. However, a baseline survey for 
a clinical trial of PrEP in Shanghai indicated that the ac-
tual willingness of MSM to participate in the PrEP pro-
gram is low [65]. At current circumstance in China, the 
implementation of PrEP is still challenging, and effective 
education to promote acceptance of PrEP is needed.

Several limitations of this study should be pointed out. 
First, caution is needed in drawing a causal conclusion, as 
this was a cross-sectional study. Second, the snowball 
sampling method may have caused selection bias, which 
might have affected the accuracy of the study conclusions; 
however, this sampling method is frequently used in studies 
targeting hard-to-reach populations. Additionally, social 
desirability may have affected the responses, as the 
questionnaire surveys were completed with the help of 
face-to-face interviews; participants thus may have been 
reluctant to provide honest answers. Finally, the HIV 
serostatus of participants and the type of sexual behavior 
(e.g., insertive or receptive) were not measured in this study.

**Conclusions**

Our study showed that the association between sexual 
compulsivity and UAI varies according to the type of 
UAI. Sexual compulsivity is not significantly associated 
with UAI with regular sex partners but is significantly 
associated with UAI with non-regular and commercial 
sex partners. Tailored cognitive–behavioral therapies tar-
geting various types of UAI are urgently needed to 
optimize current HIV intervention programs.

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**Table 4** Summary of analyses testing mediation

| Independent variable | Dependent variable | Mediator | Z\text{Mediation} | Significance |
|----------------------|--------------------|----------|------------------|-------------|
| Sexual compulsivity  | UAI                | Alcohol use before sex | −1.055452192 | ns          |
| Sexual compulsivity  | UAI                | Drug use before sex | −1.3142261 | ns          |
| Sexual compulsivity  | UAINP              | Alcohol use before sex | −1.034265068 | ns          |
| Sexual compulsivity  | UAINP              | Drug use before sex | 1.026276748 | ns          |
| Sexual compulsivity  | UAICP              | Alcohol use before sex | 0.62461196 | ns          |
| Sexual compulsivity  | UAICP              | Drug use before sex | 0.436276904 | ns          |

Z\text{Mediation} < −1.96 or Z\text{Mediation} > 1.96

UAI unprotected anal intercourse, UAINP unprotected anal intercourse with non-regular sex partners, UAICP unprotected anal intercourse with commercial sex partners

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Abbreviations
AOR: Adjusted odds ratio; CI: Confidence interval; HIV: Human immunodeficiency virus; MSM: Men who have sex with men; ORu: Univariate odds ratio; SCS: Sexual Compulsivity Scale; UAI: Unprotected anal intercourse

Acknowledgments
We are grateful to the study participants for their contribution. We thank the Shanghai Center for Disease Control and Prevention, the Shanghai Dermatology Hospital, and the Shanghai Youth AIDS Health Promotion Centre for helping us to organize the survey. We thank Diane Williams, PhD, from Lwien Bians, Edanz Group China (www.liwenbianji.cn/ac), for editing the English text of a draft of this manuscript.

Funding
This study was sponsored by the Shanghai Municipal Education Commission (14YS022), the Shanghai Jiao Tong University School of Medicine (14XJ10007), the Cross-study Research Foundation about Medicine and Engineering of Shanghai Jiao Tong University (YG2014QN023), the National Natural Science Foundation of China (71603166, 71673187), the Shanghai Pujiang Program (14PJ1076), the 2016 Shanghai Jiao Tong University School of Public Health-SCDC Research Cooperation Fund, the Social Cognitive and Behavioral Sciences program of Shanghai Jiao Tong University (14JCR03), the National Science Foundation of China Young Scientist Fund (81703278), the Australian National Health and Medical Research Council Early Career Fellowship (APP1092621), and the Sanming Project of Medicine in Shenzhen (SZSM201811071). The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Availability of data and materials
The datasets generated and analyzed during the current study are not publicly available, and data will not be shared because of some sensitive information contained in it and of the agreement with the participants but are available from the corresponding author on reasonable request.

Authors’ contributions
YC, YW, KW, and other authors discussed, conceived, and designed the study. ZZW and XQJ performed the data collection and were involved in data analysis. KW, GY, and YC analyzed the data with suggestions from other authors. HZ and KL contributed to the critical revision. KW, ZZW, and XQJ wrote the paper. GX, KW, HZ, and YC contributed substantially to the revision of the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Ethical approval was provided by the School of Public Health, Shanghai Jiao Tong University. Written consent was obtained from the participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 24 January 2018 Accepted: 23 August 2018
Published online: 15 September 2018

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