Rectal douching before sexual intercourse and inappropriate douching tool use associated with increased HIV infection among men who have sex with men: a cross-sectional study from Shenyang, China

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Abstract

Background: Rectal douching (RD) is widely practiced by men who have sex with men (MSM), and is correlated with increased risk of HIV infection. However, the mechanism of how RD increases the risk of HIV infection is not well understood, and there is limited data on RD behavior in MSM practicing anal sex in China. We examine the purpose of RD, its timing in relation to anal sex, the types of RD products used, and risky sexual behaviors among MSM reporting anal sex.

Methods: Between August 2017 and December 2018, a cross-sectional study was conducted among adult MSM in Shenyang, China. Data were collected on demographics, sexual behaviors, and RD for the most recent sexual intercourse by means of interviewer-administered face-to-face questionnaires. Blood samples were collected to test for antibodies to HIV and syphilis. Multivariable logistic regression models were used to assess the risk factors associated with HIV infection.

Results: A total of 515 eligible MSM participated in this survey (median age: 31 years). During the most recent anal intercourse, 28.3% (146/515) had condomless receptive anal intercourse (CRAI), 21.4% (110/515) practiced serosorting, and more than half (61.6%, 317/515) reported RD before or after anal sex. Of those practicing RD, 96.8% (307/317) conducted RD before sex, while 62.5% (198/317) conducted RD after sex. The douching devices used were primarily shower hoses (85.3%, 262/307), and relatively few MSM used commercial RD products (8.1%). The prevalence of HIV-1 and syphilis was 11.7% and 13.2%, respectively. HIV infection was positively associated with RD (adjusted odds ratio (AOR), 2.8; 95% confidence interval (CI), 1.4-5.5), practicing RD before sex (AOR, 2.3; 95% CI, 1.2-4.3), practicing RD after sex (AOR, 1.8; 95% CI, 1.0-3.1), using a shower hose for RD (AOR, 3.5; 95% CI, 1.1-13.0), condomless receptive anal intercourse (CRAI) (AOR, 2.9; 95% CI, 1.6-5.5), and using nitrite inhalants (AOR, 2.8; 95 % CI, 1.6-5.1) in the most recent anal intercourse.

Conclusions: RD is popular among Chinese MSM. Improper noncommercial RD tools increase the rates of HIV infection. Public health workers and the MSM community should publicize scientific knowledge and prevention approaches relating to RD and HIV transmission to MSM, and we recommend that better tools be offered to assist in RD in order to decrease the risk of acquiring HIV.

Background
Men who have sex with men (MSM) are disproportionately affected by HIV in China and many other countries [1–3]. Understanding the sexual behaviors and preferences of this key population group is essential for developing effective prevention strategies [4]. In recent years, the rectal douching (RD) behavior of MSM has received widespread attention. RD involves injecting various kinds of liquid into the rectum using tools to facilitate defecation and cleansing of the rectum. This behavior is common among MSM globally, both before and after anal sex. Thus, RD is commonly and routinely used globally by MSM in preparation for anal sex. In two studies, around 66% and 63% of MSM in the USA and Kenya, respectively, were found to have conducted RD [5, 6]. The percentages of MSM employing RD hover around 53.4–54.0% in the UK, Brazil, and France [4, 7, 8]. In Peru, the Netherlands, and China (Beijing City), the prevalence of RD among MSM is 18.2–27.0%, 13.6–46.0%, and 59.0%, respectively. These reports indicate that RD is a widespread practice among the key populations vulnerable to HIV infection. If ignored, this behavior may result in increased transmission of HIV.

Despite the reported association between RD and increased HIV infection, the mechanism by which RD contributes to HIV infection remains unclear.[9] RD timing and the types of RD tools used are two factors that may affect the HIV infection risk of MSM employing this practice. Percentages of MSM using RD is most frequently practiced before anal sex 87–97%, with only 13–48% conducting RD post-anal intercourse [10]. Considering this disparity between pre- and post-sex RD practice, it is essential to distinguish between the timings of RD in order to evaluate their impact on HIV infection. Currently, it is still unknown whether the timing of RD correlates with the rates of HIV infection among MSM. In addition, RD is a complex behavior that may involve various douching tools, including a shower hose, a plastic pump, and plastic bottles [7], which can be either commercial products or noncommercial/homemade products[11]. Until now, only scant attention has been paid to the association between the use of different kinds of douching tools and HIV infection, and there is a general lack of data on RD in China.

We therefore conducted a cross-sectional study to investigate the relationship between the timing of RD and HIV infection in Shenyang, China in order to promote better safer-sex education and design effective guidelines for HIV prevention in the MSM community.
Methods
Study population
Between September 2017 and December 2018 we conducted a cross-sectional study in Shenyang, a politico-economic-cultural center in northeastern China and the provincial capital of Liaoning Province. Shenyang’s gross domestic product (GDP) ranked 34th of the 100 largest cities in China in 2018. The predominant HIV transmission route of annual newly reported HIV/AIDS cases in Shenyang was via the male-to-male sexual route, which accounted for 80.3% (712/887) of cases in 2017, and the reported HIV incidence was 6.9 (95% confidence interval (CI): 4.9–9.3)/100 person-years among MSM in Shenyang in 2013 [12, 13]. The MSM respondents were recruited via a mixed method, including outreach recruitment by community volunteers in places such as bars, parks, and baths, peer referral, and by recruitment on gay websites and gay chat rooms. Respondents were deemed eligible to participate in the study if they were: (i) over 18 years old; (ii) MSM who reported having had anal or oral sex within the previous six months; (iii) MSM who agreed to be tested for HIV and disclose information about their most recent experience of sexual intercourse; and (iv) were willing and able to sign a written informed consent document. Subjects who had previously tested HIV-positive were excluded from the study.

Research Procedures
This study was conducted at the First Affiliated Hospital of the China Medical University. The questionnaire was administered by professionally trained staff in one-to-one face-to-face interviews. After obtaining written informed consent from each research participant, we collected their sociodemographic information, sexual behaviors, and RD behaviors. The sociodemographic information included age, place of residence, educational level, highest educational degree obtained, marital status, and ethnicity. Sexual behaviors included the main channel for finding sexual partners, sexual roles, and usage of condoms and nitrite inhalants during their most recent sexual intercourse. For RD behaviors in the most recent experience of receptive anal intercourse (RAI), we asked MSM participants if they had cleansed their rectum before and/or after RAI, the type of liquid used for douching, the type of douching product, the reasons for RD, and their serosorting behavior, defined as the practice of agreeing to have unprotected anal intercourse only with partners of the same HIV
status, which is becoming increasingly popular among MSM in general [14].

The relevant research plan and the procedure for obtaining informed consent were approved by the Institutional Review Board (IRB) of the China Medical University ([2017]2015-140-4). All MSM who participated in this study received a HIV consultation before and after HIV testing, as well as condoms, lubricant, and educational materials on HIV.

**Laboratory Tests**

Following completion of the questionnaire, 10 ml of venous blood was collected from each research participant for HIV-1 antibody screening, HIV-1 Pooled-RT-PCR, Western blot (WB), and Treponema pallidum (TP) testing.

HIV antibodies were screened using Biomérieux’s Human Immunodeficiency Virus (HIV 1/2) antibody diagnostic kit (ELISA method). Secondary screening was performed using Abbott Laboratories’ Human Immunodeficiency Virus Antibody Rapid Detection Kit (colloidal gold method). Once HIV-positive status was confirmed by the screening, the HIV confirmation test was performed using Gene Lab’s serum HIV Western blot (WB) method. Antibody-negative specimens were tested with the 24 mini-pool nucleic acid amplification test (NAAT). Blood samples giving a positive ELISA result but a negative or indeterminate WB result were tested with NAAT individually without mixing, using COBAS AMPLICOR HIV-1 MONITOR™ Test, v1.5 diagnostic kit (Roche, 21118390123), according to the COBAS AmpliPrep/COBAS TaqMan HIV-1 Test method [15].

For the detection of plasma TP, a rapid serotonin ring card test (RPR) was used for screening (Shanghai Kehua Bio-Engineering Co., Ltd.), and those who tested positive were further confirmed with Treponema pallidum particle agglutination (TPPA) (Fuji Corporation, Japan). Those who were screened and confirmed as positive were deemed to be TP-positive.

**Data analysis**

Questionnaire and laboratory test results were recorded by two research assistants twice using EpiData 3.02 software until the data from both questionnaires were fully consistent. Descriptive statistical analysis was performed using mean ± standard deviation or the median and interquartile range (IQR) as a measure of statistical dispersion. Categorical variables were analyzed using rate and
percentage. Chi-square tests were used to compare differences in the categorical variables (e.g., marital status, education, and information related to the most recent anal sex).

HIV infection-related factors were analyzed using multivariable logistic regression model analysis. On the basis of univariate analysis, variables with \( p < 0.2 \) were screened out and entered into a multivariable logistic regression model analysis. In Model 1, covariates including age, education, and household registration were adjusted; in Model 2, covariates including age, education, household registration, and sexual roles were adjusted, and unprotected sexual roles and RD information were included in the multivariable logistic regression model for analysis. The inspection level \( \alpha \) was set at 0.05. Statistical analysis was performed using SPSS 17.0 statistical software (IBM).

Results
Demographic characteristics of the study participants
In this study, 95.4\% (515/540) of the MSM approached were eligible to participate in the cross-sectional study. The main reasons for exclusion were: (i) being underage (3.7\%, 20/540) and (ii) 0.9\% (5/540) refusing to participate in the research (Fig. 1). The median age among the research participants was 31 (IQR 25–37) years. Other demographic characteristics are given in Table 1.

| Characteristic                          | Total (n, %) | Reported RD (n, %) | No reported RD (n, %) | \( \chi^2 \) | P-value |
|----------------------------------------|--------------|--------------------|-----------------------|--------------|---------|
| Total                                   | 515          | 100.0              | 317                   | 198          | 38.4    |
| Age (years)                             |              |                    |                       |              |         |
| 18–29                                   | 238          | 46.2               | 149                   | 89           | 44.9    |
| \( \geq 30 \)                           | 277          | 53.8               | 168                   | 109          | 55.1    |
| Registered Liaoning Province residency  |              |                    |                       |              |         |
| No                                      | 88           | 17.1               | 47                    | 41           | 20.7    |
| Yes                                     | 427          | 82.9               | 270                   | 157          | 79.3    |
| Education                               |              |                    |                       |              |         |
| Junior high school and below            | 137          | 26.6               | 70                    | 67           | 33.8    |
| Senior high school                      | 114          | 22.1               | 69                    | 45           | 22.7    |
| College and above                       | 264          | 51.3               | 178                   | 86           | 43.4    |
| Marital status                          |              |                    |                       |              |         |
| Single                                  | 307          | 59.6               | 184                   | 123          | 62.1    |
| Married/divorced/cohabiting with female | 101          | 19.6               | 63                    | 38           | 19.2    |
| Cohabiting                              | 107          | 20.8               | 70                    | 37           | 18.7    |

Table 1
Characteristics of Shenyang MSM who either used or did not use rectal douching (RD)
| Cohabiting with male partner |  |
|------------------------------|---|
| Venue where sex is found     |   |
| Offline                      | 197 | 38.3 | 111 | 35.0 | 86 | 43.4 |
| Online                       | 318 | 61.7 | 206 | 65.0 | 112 | 56.6 | 3.657 | 0.056 |

| Information related to most recent anal sex |   |
|---------------------------------------------|---|
| CRAI                                        | Yes | 146 | 28.3 | 111 | 34.1 | 35 | 17.7 |
|                                            | No  | 369 | 71.7 | 206 | 65.9 | 163 | 82.3 | 18.039 | < 0.001 |

| Main anal sexual role with males            |   |
| Versatile roles                            | 174 | 33.8 | 119 | 37.5 | 55 | 27.8 |
| Bottom                                     | 165 | 32.0 | 110 | 34.7 | 55 | 27.8 |
| Top                                        | 176 | 34.2 | 88 | 27.8 | 88 | 44.4 | 15.187 | 0.001 |
| CRAI                                       | Yes | 146 | 28.3 | 111 | 34.1 | 35 | 17.7 |
|                                            | No  | 369 | 71.7 | 206 | 65.9 | 163 | 82.3 | 18.039 | < 0.001 |

| Anal bleeding after anal sex               |   |
| No                                         | 491 | 95.3 | 296 | 93.4 | 195 | 98.5 | 1 |
| Yes                                        | 24  | 4.7  | 21  | 6.6  | 3   | 1.5  | 7.161 | 0.007 |

| Used nitrite inhalants                    |   |
| No                                         | 366 | 71.1 | 193 | 60.9 | 173 | 87.4 |
| Yes                                        | 149 | 28.9 | 124 | 39.1 | 25  | 12.6 | 41.595 | < 0.001 |

| Serosorting                               |   |
| No                                         | 405 | 78.6 | 240 | 75.7 | 165 | 83.3 | 4.217 | 0.040 |
| Yes                                        | 110 | 21.4 | 77  | 24.3 | 33  | 16.7 |

| Syphilis infection                        |   |
| No                                         | 447 | 86.8 | 268 | 84.5 | 189 | 90.4 |
| Yes                                        | 68  | 13.2 | 49  | 15.5 | 19  | 9.6  | 3.654 | 0.056 |

| HIV infection                             |   |
| No                                         | 455 | 88.3 | 269 | 84.9 | 186 | 93.9 |
| Yes                                        | 60  | 11.7 | 48  | 15.1 | 12  | 6.1  | 9.765 | 0.002 |

## Rectal Douching And Sexual Behaviors Of The Study Participants

Among all of the research participants, 61.6% (317/515) reported douching their rectum at some time during their most recent anal intercourse, with 59.6% (307/515) conducting RD before sex and 38.4% (198/515) conducting RD after sex. Douching devices (Fig. 2) used before anal intercourse include a shower hose (85.3%, 262/307), commercial RD products (8.1%, 25/307), a bulb syringe (2.9%, 9/307), a syringe (1.6%, 5/317), a basin and water bottle (1.3%, 4/307), as well as other items (0.7%, 2/307). The types of douching liquids used included tap water (98.1%, 311/317), mixed solutions of water and soap (1.6%, 5/317), and commercial douching liquids (0.6%, 2/317). Almost all (97.4%, 299/307) of those who conducted RD reported doing so before anal sex for hygienic reasons, 23.1% (71/307) for...
feeling greater pleasure during sex, and 6.8% (21/307) for satisfying their sexual partner. The major reason for RD post-anal intercourse was similar: 95.5% (189/198) did so in the interests of personal hygiene. Others doused their rectum after sex because their sexual partners did not use a condom during sex (14.1%, 28/198), and they felt that RD would prevent HIV infection (4.0%, 8/198).

Compared with RD non-users, RD users had: (i) a higher level of education, (ii) their roles in their most recent anal sex were as a bottom and/or versatile, (iii) were more likely to have had condomless receptive anal intercourse (CRAI) and condomless insertive anal intercourse (CIAI) with male partners, (iv) were more likely to engage in serosorting, (v) were more likely to use nitrite inhalants, and (vi) were more likely to be living with HIV. Differences in the sociodemographic and behavioral characteristics among MSM who reported RD and those who did not are listed in Table 1.

**HIV, Syphilis Infection And Factors Associated With HIV Infection**

Of the 515 MSM recruited, 60 men (11.7%) (95% CI: 9.0–14.7) tested HIV-1-positive and 68 men (13.2%) (95% CI: 10.4–16.4) tested syphilis-positive. None were detected HIV-1 screening negative but pooled NAAT positive. Bivariate and multivariable logistic regressions were used to assess the factors associated with HIV infection (Table 2). The univariate logistic regression results indicated that HIV infection was statistically correlated with RD during the most recent anal intercourse, RD before and after anal intercourse, playing the receptive sexual role, having condomless sex when playing the receptive role, being infected by syphilis, and using nitrite inhalants before sex.

**Table 2**

| Characteristic related to most recent anal sex | N = 515 | HIV infection (%) | Crude OR (95% CI) | Model 1† AOR (95% CI) | P-value | Model 2† AOR (95% CI) | P-value |
|-----------------------------------------------|--------|-------------------|--------------------|-----------------------|---------|-----------------------|---------|
| Information related to most recent anal sex   |        |                   |                    |                       |         |                      |         |
| Main sexual role with males                   |        |                   |                    |                       |         |                      |         |
| Top                                           | 176    | 14 (8.0)          | Reference          |                       |         |                      |         |
| Bottom                                        | 165    | 31 (18.8)         | 2.7 (1.4–5.2)      |                       |         |                      |         |
| Versatile                                     | 174    | 15 (8.6)          | 0.9 (0.5–2.3)      |                       |         |                      |         |
| CRAI                                          |        |                   |                    |                       |         |                      |         |
| No                                            | 369    | 30 (8.1)          | 1.0                | Reference             | 1.0     | Reference             | 1.0     |
| Yes                                           | 146    | 30 (20.5)         | 2.9 (1.7–5.1)      | 2.7 (1.6–4.7)         | < 0.001 | 2.9 (1.6–5.5)         | 0.001   |
| CIAI                                          |        |                   |                    |                       |         |                      |         |
| No                                            | 394    | 41 (10.4)         | 1.0                | Reference             | 1.0     | Reference             | 1.0     |
| Yes                                           | 21     | 11 (52.4)         |                    |                       |         |                      |         |
In Model 1, an adjustment was made for variables such as age, educational level, and place of residence with p-values smaller than 0.2. Multivariable logistic regression analysis revealed that variables that were statistically correlated with HIV infection in the most recent anal intercourse included: (i) RD (vs. no RD; adjusted odds ratio (AOR), 2.8; 95% CI, 1.4–5.5), (ii) practicing RD before sex (vs. no RD; AOR, 2.3; 95% CI, 1.2–4.2), (iii) practicing RD after sex (vs. no RD; AOR, 1.9; 95% CI, 1.1–3.2), (iv) CRAI (vs. using a condom during sex; AOR, 2.7; 95% CI, 1.6–4.7), (v) using nitrite inhalants.
inhalants before anal sex in the most recent anal sex (vs. no nitrite inhalants; AOR, 2.6; 95% CI, 1.5–4.5), and (vi) syphilis infection (AOR, 2.1; 95% CI, 1.0–4.1) (Fig. 3).

In Model 2, an adjustment was made for variables such as age, educational level, place of residence, and sexual role with p-values smaller than 0.2. Multivariable logistic regression analysis also revealed that variables that were statistically correlated with HIV infection in the most recent anal intercourse included: (i) RD (vs. no RD; AOR, 2.8; 95% CI, 1.4–5.5), (ii) practicing RD before sex (vs. no RD; AOR, 2.3; 95% CI, 1.2–4.3), (iii) practicing RD after sex (vs. no RD; AOR, 1.8; 95% CI, 1.0–3.1), (iv) using a shower hose for RD (vs. commercial tools; AOR, 3.8; 95% CI, 1.1–13.0), (v) CRAI (vs. using a condom during sex; AOR, 2.9; 95% CI, 1.6–5.5), (vi) CIAI (vs. using a condom during sex; AOR, 4.1; 95% CI, 1.8–9.3), (vii) using nitrite inhalants before anal sex (vs. no nitrite inhalants; AOR, 2.8; 95% CI, 1.6–5.1), and (viii) no serosorting behavior in the most recent anal sex (vs. serosorting; AOR, 2.6; 95% CI, 1.2–5.9) (Fig. 3).

Discussion

This cross-sectional study of 515 MSM in Shenyang, China reports the proportion of and reasons for practicing RD among MSM in China. It investigated the impacts of RD products, douching liquid types, and the timing of RD on HIV infection. We found that using a shower hose to assist RD was positively associated with the odds of HIV-1 infection among MSM. This finding contributes to our understanding of RD behavior and the risks of HIV infection among MSM. It also helps to clarify the possible reasons for the high HIV disease burden of MSM in China, and our study provides first-hand evidence to include in future publicity materials and educational activities about the risks associated with RD and HIV infection among MSM.

This study found that the proportion of RD among MSM in Shenyang, a city with a lower level of GDP than other cities in China, was over 60%, similar to the percentage reported for Beijing (59.3%) [16]. These figures suggest that RD might be a common practice among MSM in urban China whatever their economic level. The prevalence of RD behavior among MSM in China is close to that of the USA (66%), Kenya (63%) [5, 6], the UK, Brazil, and France (53.4–54.3%)[4, 7, 8], but greater than that in Peru (18.2–27.0%) [17, 18] and the Netherlands (13.6–46%)[19, 20]. Despite this high prevalence
among MSM worldwide, scientific data for and knowledge of RD in the Chinese MSM population is still poor. Around a quarter of MSM in the USA did not know how to douche the rectum correctly [21], and more than 94% of MSM in Brazil had not received any kind of professional instruction [7]. Currently, there is no authoritative information on RD for MSM in China. The disparity between the prevalence of RD and the lack of instruction about it highlights the importance of delivering accurate and relevant information about RD to the MSM population via social media.

This study found that RD is positively correlated with the odds of HIV infection (AOR = 2.8) in MSM participants, consistent with previous findings from the USA and Europe and a recent meta-analysis [9, 20–23]. We also found that the use of a shower hose (vs. commercial douching products/bulb syringe) and before/after anal intercourse RD (vs. no RD before/after sex) correlated with increased odds of HIV infection. Shower hoses are not expressly designed for RD as they have irregular edges (Fig. 2). The process of using a shower hose to complete RD may cause damage to the perianal skin, and hence increase the risk of HIV infection. In this survey, more than 85% of MSM participants used the shower hose to flush their anus, which is significantly higher than in foreign MSM populations.

According to our study results, health workers and MSM community based organizations (CBOs) should widely publicize the potential for this type of RD to increase HIV infection in the MSM community. In addition, this study found that most MSM conducted pre-anal intercourse RD using tap water. Due to the difference in fluid osmotic pressure inside and outside the rectal epithelial cells, the latter are in a fully filled state following RD, and the risk of rupturing them is increased during anal sex. Water-based enema solutions are typically hypotonic and exert a lower osmotic pressure compared to the contents of the colon. As a result, excess water may be absorbed by epithelial cells, leading to water toxicity and cell lysis.[24] So enemas consisting of saline solution are recommended for MSM who practice RD frequently. For the benefit of MSM who engage in RD, it is recommended that they receive proper educational materials on how to select the most appropriate douching products and liquids so as to reduce the risk of HIV and sexually transmitted infections (STIs) resulting from rectal mucosal injuries.

This study found that, compared to MSM who do not perform RD, MSM who do use RD engaged in a
greater proportion of bottom and versatile roles during anal sex. To exclude its mediating effect on HIV infection, we used two multivariable logistic models in this study, and found that whether adjusted the variable of sexual role RD is positively associated with increased odds of HIV infection among MSM participants. The results of our analysis have given us more reliable evidence of the association between RD behavior and HIV infection in the MSM population.

Understanding the reasons why MSM practice RD is important for promoting HIV-related education and conducting further studies. Over 95% of MSM participants did so because they wanted to remain clean and hygienic before and/or after having anal intercourse and to increase pleasure during sex. A proportion (14.6%) were under the misconception that RD could wash semen away from the rectum and prevent HIV infection and STIs. This suggests that MSM participants were very concerned about their own health and about preventing HIV infection and other sexually transmitted diseases (STDs).

Given the positive correlation between RD behavior and a willingness to use rectal microbicides among Peruvian MSM [18], our study findings indicate that Chinese MSM are likely to be good candidates to be recruited to use rectal microbicide enemas for HIV prevention.

This study also found that factors contributing to HIV-1 infection include: (i) condomless anal intercourse; (ii) using nitrite inhalants before anal intercourse; and (iii) not serosorting in the most recent anal intercourse. These findings are consistent with those of international peer reports [9, 25].

It is worth noting that previously there was a lack of evidence to support the implementation of serosorting behavior to prevent HIV infection in MSM in China, although the Chinese Center for Disease Control and Prevention (China CDC) had issued related serosorting guidelines for MSM in 2016. Hence, in China, pertinent interventions, such as promoting serosorting among MSM who practice RD and the promotion of partner notification, are urgently needed. The results of this study will help China and other countries in a similar situation to promote serosorting measures among MSM to reduce HIV infection.

**Strengths Of The Study**

This study demonstrates an association between the types of RD products used and HIV infection among MSM, providing empirical evidence for informing future sexual health education efforts. In
addition, we found for the first time that serosorting and HIV are negatively correlated among MSM in China. Reluctance to discuss HIV infection status with sexual partners and CAI in turn contribute to the transmission of HIV.

**Limitations Of The Study**

In order to reduce the effects of recall bias, this study only collected information on RD behavior during the most recent sexual experience. It did not analyze the cumulative effect of RD frequency and timing on HIV infection. Additionally, research participants from the sample pool all came from Shenyang, and thus were not representative of other areas in China. Lastly, the cross-sectional study design used in this study cannot determine the cause–effect relationship between RD and the risk of HIV infection, for which further prospective cohort studies should be undertaken.

**Conclusions**

RD behavior is prevalent among MSM in Shenyang in northeastern China. Because RD may increase the odds of HIV infection, it is suggested that relevant health information targeting MSM who have used shower hoses for RD before/after sex should be promoted. This can help MSM to understand the association between RD and HIV infection so as to reduce the spread of HIV among the MSM population. Moreover, safer types of douching products and liquids should be formulated in order to contain a potential new channel of HIV dissemination.

**Declarations**

**Abbreviations**

CAI: Condomless anal intercourse; CDC: (China) Center for Disease Control and Prevention; CIAI: Condomless insertive anal intercourse; CRAI: Condomless receptive anal intercourse; ELISA: Enzyme-linked immunosorbent assay; GDP: Gross domestic product; HIV: Human immunodeficiency virus; IQR: Interquartile range; IRB: Institutional review board; MSM: Men who have sex with men; NAAT: Nucleic acid amplification testing; RAI: Receptive anal intercourse; RD: Rectal douching; RPR: Rapid serotonin ring card test; TP: Treponema pallidum; TPPA: Treponema pallidum particle agglutination; WB: Western blot;

**Ethics approval and consent to participate**

The relevant research plan and the procedure for obtaining informed consent were approved by the
Institutional Review Board (IRB) of the China Medical University ([2017]2015-140-4). All participants must complete informed consent procedures to participate.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The data bank analyzed during this study are available from the corresponding authors on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors’ contributions**

ZXC, HS, and JJX conceived and designed the experiments. ZXC, QHH, HYW, JZ, WQG, and YJJ carried out the study and experiments. ZXC, GQS, and WD analyzed and interpreted the results of study. ZXC, GQS, WD, and JJX, wrote and revised the manuscript. All authors reviewed the manuscript. ZXC and GQS contributed equally to this work.

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Figures
Figure 1

Flowchart of MSM study population, focusing on proportion of MSM using RD and HIV prevalence according to sexual role and use non-use of RD
Figure 2

Shower hose devices used by MSM for RD before/after anal intercourse
### Figure 3

#### A. Lower risk vs. Higher risk

| Behavior                        | AOR (95% CI) | P-value |
|---------------------------------|--------------|---------|
| Shower hose used for RD         | 3.3(1.0-11.3) | 0.053   |
| RD                              | 2.8(1.4-5.4)  | 0.003   |
| RD before sex                   | 2.2(1.2-4.2)  | 0.012   |
| RD after sex                    | 1.9(1.1-3.2)  | 0.026   |
| CRAI                            | 2.7(1.6-4.7)  | <0.001  |
| CIAI                            | 1.6(0.9-2.9)  | 0.13    |
| No Serosorting                  | 1.9(0.9-4.2)  | 0.103   |
| Used nitrite inhalants          | 2.6(1.5-4.5)  | 0.001   |
| Syphilis infection              | 2.1(1.1-4.2)  | 0.033   |

#### B. Lower risk vs. Higher risk

| Behavior                        | AOR (95% CI) | P-value |
|---------------------------------|--------------|---------|
| Shower hose used for RD         | 3.8(1.1-13.0) | 0.033   |
| RD                              | 2.8(1.4-5.5)  | 0.003   |
| RD before sex                   | 2.3(1.2-4.3)  | 0.012   |
| RD after sex                    | 1.8(1.0-3.1)  | 0.044   |
| CRAI                            | 2.9(1.6-5.5)  | 0.001   |
| CIAI                            | 4.1(1.8-9.3)  | 0.001   |
| No Serosorting                  | 2.6(1.2-5.9)  | 0.021   |
| Used nitrite inhalants          | 2.8(1.6-5.1)  | <0.001  |
| Syphilis infection              | 1.7(0.9-3.5)  | 0.128   |
Adjusted odds ratios and their 95% confidence intervals (CI) between high-risk behavior and HIV infection among MSM participants. HIV infection-related factors were analyzed using multivariable logistic regression model analysis. Multivariable logistic Model 1 controlled for fixed covariates (age, education, and household registration), and Model 2 controlled for fixed covariates (age, education, household registration, and sexual roles). Abbreviations RD, rectal douching; CRAI, condomless receptive anal intercourse; CIAI, condomless insertive anal intercourse.