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Using latent class analysis to identify money boys at highest risk of HIV infection

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ABSTRACT

Objectives: Limited research has been conducted to investigate the characteristics of money boys (MBs) in China. This study was aimed to identify the subgroups of MBs based on sexual behaviors, Net-based venue sex-seeking, and substance abuse.
Study design: Cross-sectional study.
Methods: Convenience sampling was used to recruit MBs from December 2014 to June 2015 in Tianjin, China. Face-to-face interviews were conducted for 330 MBs, and trained interviewers collected data.
Results: The laboratory-confirmed human immunodeficiency virus (HIV)–positive rate was 11.52% among 330 MBs. Four classes were identified through latent class analysis (LCA) method: 'relatively safe behavior' group, 'higher sexual risk' group, 'multiple sexual-partners' group, and 'unprotected sex and substance abuse' group, and there is a significant difference based on the HIV status. Significant differences were found in original residence, monthly income, duration in sex trade, employment, history of sexually transmitted infection (STI), HIV testing, knowledge of free antiviral treatment policy, and awareness of free AIDS testing between the four latent classes ($P < 0.05$). MBs who used Net-based venues to seek sexual partners; who have inconsistent condom use, substance abuse, a longer duration in sex trade, multiple sexual clients, and multiple anal sex; and who were full-time employed had the highest risk of HIV infection.

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Conclusions: The utility of LCA to identify subgroups based on risky behaviors attributes to formulating targeted intervention strategy.

Introduction

Prevalence estimates of human immunodeficiency virus (HIV) among men who have sex with men (MSM) in China are relatively high. According to the sentinel surveillance data, the HIV-positive rate among MSM was up to 7.3% nationwide.[1] In 2016, Zheng et al.[2] reported a pooled HIV prevalence of 11.1% among MSM in six Chinese cities. In 2018, Lei et al.[3] reported the overall HIV prevalence of MSM in Changsha to be 13.3%. The rapidly increasing HIV infection rate among MSM is an urgent public health problem that requires Chinese government to take actions.

Money boys (MBs) are male sex workers engaging in sexual activities for economic benefits and are known as a high-risk subgroup of men who have sex with men (MSM), are more likely to engage in high-risk sexual behaviors, and are likely to be infected with HIV.[4] Many research studies have been conducted to characterize MBs.[5–7] One study reported that Chinese MBs were generally young, currently employed, at low literacy levels, and highly mobile.[7] Another study found that the HIV prevalence among MBs was estimated to be 14.6%.[8] A great number of studies have focused on high-risk sexual behaviors, such as multiple sexual partners[8] and consistent condom use,[9] which were the main routine of HIV transmission.

Recently, illicit substance use has emerged as a significant public health problem among MSM.[10] A high prevalence of amphetamine-type stimulants that include ecstasy and methamphetamine but exclude cocaine has also been reported among MSM in China.[11] Drug use is the key way of transmitting HIV, directly through sharing needles and indirectly by increasingly risky sexual behaviors.[12] The emergence of drug use among MBs increases the difficulty of intervention strategy.

Owing to the illegal nature of sex trading in China, MBs may endure stigma and discrimination by both the public and MSM community. MBs have less access to contact and receive HIV interventions, which makes it more difficult and intractable to carry out targeted prevention paradigm among this population. Because of the popularity of smartphones, many MSM have embarked on Internet and gay applications (apps) to seek sexual partners because of its easy accessibility, easy facilitation of sexual hookups, anonymity of the encounter, and the ease of interaction between potential partners.[13]

The latent class analysis (LCA) model can be used to categorize people into classes using the observed items and identify items that best distinguish between classes.[14] It has been used to categorize subgroups in substance use[15–17] and other HIV behaviors.[18,19] The co-varying patterns of sexual behavior, substance abuse, and sex-trading venue have been rarely investigated. And such studies have not been conducted among MBs from China where sexual behavior patterns may be different and distinct groups of substance-using and venue sex-trading men exist among Chinese MB populations. Such information could be particularly useful for identifying high-risk subgroups of MBs that should be prioritized for more intensive and combined behavioral and biomedical HIV prevention efforts. To address this gap in knowledge, the LCA method is used to identify MB subgroups with sexual behaviors, substance abuse, and sex-trading venue.

Methods

Procedures

Tianjin is an economic center of North China and an international port city with a population of over 14 million. On account of its convenient traffic and role of transit station, male-on-male sexual activities are quite frequent here. This project was funded by US Centers for Disease Control and Prevention (CDC)/Division of Global HIV/TB, China, hosted by Tianjin CDC, cooperation with district level CDCs. This study was conducted from December 2014 to June 2015 in Tianjin. Participants were recruited by the integrated AIDS intervention service station built by the Tianjin Hebei district Center for Disease Control and Prevention in the male service area, which has the advantage of being close to the target population. Participants were recruited via various methods, including face-to-face communication (in public toilets, parks, and other places where male sex workers are concentrated), QQ, WeChat, gay chat room (by posting notices on gay men's websites and communities, looking for principals of relevant platforms to assist and recruit), peer referral, bar, and clubhouse scene mobilization (mobilization of male sex workers who have gathered at the gay bar and club house to engage in the survey and inform them the related free HIV testing, counseling, etc., which may be received during this survey). After a rapid HIV testing, an anonymous face-to-face questionnaire was administered by trained staff from the integrated AIDS intervention service station.

Eligible participants must meet the following criteria: 1) 18 years or older, 2) biologically male, 3) have ever had at least once oral or anal sex with another man in the past one month, 4) currently in sex trade for money, 5) currently live in Tianjin, 6) willing to complete the study, 7) should be able to or willing to provide informed consent, and 8) fully understand the privacy issues and testing services that may be involved in the research process.

Specimen test

Qualified participants were invited to the integrated AIDS intervention service station. HIV antibody rapid detection of

oral mucosal exudate was used for primary screening (Mano Bio Pharmaceutical Co, Ltd. Beijing, China). Blood rapid detection reagent (Wan Fu Biotechnology Co, Ltd, Guangzhou, China) was used to reinspect the primary screening–positive participants. Five milliliters of venous blood was collected from participants with double positive or one positive and one negative and was sent to district-level CDCs for further reinspection using enzyme-linked immunosorbent assay (Wantai Biological Pharmaceutical Co., Ltd, Beijing, China). Finally, Western blot assay (MP Biomedical Asia Pacific Pte Ltd, Singapore) was used for HIV confirmation. The participants who tested positive were immediately registered in the Sexually Transmitted Disease and AIDS Prevention department of CDC and then medicines and psychological interventions were available.

Survey content

This is an entirely community-based and community-driven study. There is a good "cooperation" between the Shenlan Organization and CDC. The Shenlan Organization is a formally registered non-governmental organization that has good reputation among MSM, which also provides perceived safe environment, confidential and anonymous MSM testing, high-quality counseling, and psychosocial support. The staff members from the MSM group are more likely to trust. All the staff members from this organization have the same psychological and physical experience as the participants. It is an effective strategy for high-risk MSM. Moreover, CDC professionals and nurses are assigned to the integrated AIDS intervention service station to provide professional services to participants, especially for testing positive participants. The participants received HIV counseling and testing at the integrated AIDS intervention service station and provided informed consent for the HIV testing; anyone who was not willing to sign the informed consent was excluded from this study. Before the survey, all interviewers received intensive training in interviewing techniques, developing rapport, and ensuring confidentiality before conducting the interviews. The fingerprint identification system is used to identify and record the MBs participating in the survey, which avoids repeat testing in 3 months. Each candidate participating in the project had an in-depth interview with the interviewer. The respondents should systematically understand the privacy, sensitive issues, corresponding sample collection, and testing services that may be involved in the survey, and the questionnaire was completed on the basis of complete trust. In addition, the respondents were trained to correctly and accurately answer the questions involved in the questionnaire. To ensure the quality, a pilot test of the interviewers' skills, questionnaires, and convenience sampling procedures was performed with 5 MBs. All eligible respondents participated in a face-to-face anonymous interview in a private room located in the integrated AIDS intervention service station, and the questionnaires were completed in 30–40 min, which consist of sociodemographics, sexual behaviors, and sexually transmitted infection (STI)/HIV relevance. Then, blood samples were collected for laboratory testing. Sociodemographics include the use of Net-based venue, age, marital status, migration status, ethnicity/race, education, month income, sexual orientation, age of sexual debut, duration in sex trade, employment type, and so on. Sexual behaviors include the number of sex partners, times of anal intercourse, consistent condom usage, use of condom during the last sex, sexual orientation (homosexual, bisexual, or heterosexual), and substance abuse. STI (over the past one year) and HIV information include STI history, ever tested HIV, HIV-related knowledge, and so on. This procedure was conducted while the participants waited for the result of tests. All the participants who completed questionnaires received some health tools to encourage them to have safe sex (condoms, lubricant, and an MSM health booklet).

Latent class indicators

The latent class indicators include seven items that represent multiple dimensions of MBs' characteristics: sex-trading venue (Net-based venue sex-seeking), high-risk sexual behaviors (early sexual debut, multiple anal sex, multiple sexual partners, condom use during the last sex, and consistent condom use), and substance abuse. Binary latent class indicators were created to best reflect existing behaviors and lifestyle.

Sex-trading venue

Sex-trading venue was classified into two categorical variables according to their use of Net-based venue. MBs who reported always using the QQ, WeChat, gay dating applications, gay chat rooms to seek sexual partners for sex trading were classified into Net-based venue, whereas those who always use traditional venues to seek sexual partners (through fixed venues such as bars, parks, public toilets, club manager, and friend recommendation) were classified into non-Net-based venue sex-trading.

Substance abuse

MBs who ever used one or more types of substance (including rush [a variety of volatile gas nitrite], capsule No 0 [dimethylamine 5meo-dipt], assistive agent, cocaine, ketamine, opium, cannabis, heroin, dolantin, morphine) to seek excitement and happiness in the past 3 months were classified under substance abuse.

High-risk sexual behaviors

In our analysis, high-risk sexual behaviors include age of sexual debut (those who have sexual debut at less than 18 years were coded as early sexual debut and the others were coded as non-early sexual debut), consistent condom use (those who use condoms during every sexual intercourse were coded as consistent condom use and the others were coded as non-consistent condom use), condom use during the last sex (yes/no), multiple sexual partners (MBs who had 13 [median] or more sexual partners in the past one month were categorized into multiple sexual partners and the others were categorized into non-multiple sexual partners), multiple anal sex (MBs who had 15 [median] or more anal sex in the past one month were categorized into multiple anal sex and others were categorized into non-multiple anal sex).

Statistical methods

All data were analyzed using SAS, version 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive statistics were used to examine characteristics of the sample, including sociodemographics, sexual behaviors, substance abuse, and status of HIV infection. For continuous variables, medians and interquartile ranges were given and proportions are presented. The Kruskal–Wallis test was used for continuous variables of non-normal distribution. Categorical variables were compared using the chi-squared test or the Kruskal–Wallis test for ordinal variables.

LCA was performed using PROC LCA.[20] LCA is a maximum likelihood approach that uses a postulated multilevel latent variable to identify different patterns of responses to a set of indicator variables; based on reported responses, individuals receive a probability of membership in each class of the latent variable, every individual's highest posterior probability of membership was used for assignment to a most likely class of sex-seeking venue, sexual behaviors, and substance abuse. The number of latent classes was selected based on information criteria as well as interpretation following Akaike information criteria (AIC) and Bayesian information criteria (BIC); for the two information criteria, a lower value indicates an improved model fit and a more optimal balance between the model fit and parsimony. And each class will be assigned a meaningful label to make the model interpretable. Following model selection, each latent class of MBs was described by including sociodemographics and HIV-related characteristic as a grouping variable in the latent class model, and the association was estimated between each characteristic and latent class membership by including each characteristic as a covariate in the model.

Results

Participant characteristics

Among 330 MBs, 38 (11.52%) were laboratory-confirmed HIV positive and 64 (19.09%) had been diagnosed with STI over the past one year. The characteristics of all participants are shown in Table 1.

Number of latent classes

Models were compared with two to five latent classes to identify the optimal model based on fit criteria. According to information criteria, the four-class model was optimal, with indicators (G^2, *AIC*, *BIC*, and *CAIC*) decreasing continuously from 2 to 4 classes. Considering that BIC is recommended to be the best indicator to decide the number of latent classes[14] and the interpretability and high class separation is clear, the final model yielded a four-class solution (Table 2).

Characteristics of each latent class

Each latent class corresponds to an underlying subgroup of participants characterized by a special behavioral pattern. The probability of reporting each of the seven behaviors within the

Table 1 – Characteristics of sociodemographics, sexual behaviors, HIV, STI, and AIDS-related knowledge of the MBs.

Study characteristics	N	%
I. Sociodemographics		
Net-based venue		
No	183	55.5
Yes	147	44.5
Age (years)		
Median (IQR)	23.00 (5.00)	
Marital status		
Unmarried	299	90.6
others	31	9.4
Original residence		
Non-local	299	90.6
Local	31	9.4
Education		
Middle school and below	131	39.7
High school	158	47.9
College	41	12.4
Monthly income (RMB)		
≤5000	103	31.2
5001-8000	154	46.7
>8000	73	22.1
Sexual orientation		
Homosexual	205	62.1
Heterosexual	65	19.7
Bisexual	60	18.2
Duration in sex trade (month)		
Median (IQR)	13.0 (23.0)	
Employment		
Part-time	61	18.5
Full-time	269	81.5
Greater mobile		
No	73	22.1
Yes	257	77.9
II. Sexual behaviors		
With regular sexual partners (in the past 30 days)		
Age of sexual debut		
<18 years	148	44.9
≥18 years	182	55.2
Number of sexual partners		
Median (IQR)	14.0 (11.0)	
Times of anal sex		
Median (IQR)	15.0 (10.0)	
Consistent condom usage (N = 327)		
No	137	41.9
Yes	190	58.1
Condom usage in last sex (N = 327)		
No	43	13.2
Yes	284	86.8
Role in anal intercourse (N = 327)		
Insertive	99	30.3
Receptive	83	25.4
Both	145	44.3
Ever in group sex (N = 327)		
No	277	84.7
Yes	50	15.3
With commercial clients (in the past 30 days)		
Age of first sex trade		
<18 years	12	3.6
≥18 years	318	96.4
Consistent condom usage (N = 327)		
No	106	32.4
Yes	221	67.6

Table 1 – (*continued*)

Study characteristics	N	%
Multiple sexual clients		
Median (IQR)	13.0 (12.0)	
Multiple anal sex		
Median (IQR)	15.0 (11.0)	
Sexual intercourse type		
Anal sex	329	99.4
Oral sex	273	83.2
Licking anus	20	6.1
Fisting	12	3.7
Finger intercourse	41	12.5
Masturbate	285	86.9
Condom usage in last sex (N = 327)		
No	31	9.5
Yes	296	90.5
Using substance during sex in the past 3 months		
No	106	32.1
Yes	224	67.9
III. HIV, STI, and AIDS-related knowledge		
HIV status		
Negative	292	88.5
Positive	38	11.5
STI history		
No	267	80.9
Yes	63	19.1
Ever tested for HIV		
No	115	34.9
Yes	215	65.1
Knowledge of free antiviral treatment policy		
No	153	46.4
Yes	177	53.6
Awareness of free AIDS testing		
Don't know	75	22.7
Vague	98	29.7
Clear	157	47.6

N: Number of participants.
HIV, human immunodeficiency virus; STI, sexually transmitted infection; MBs, money boys; IQR, interquartile range.

generated classes was used to characterize the different profiles of MBs (Fig. 1). The latent class probabilities of the four classes were 48.48%, 8.79%, 29.39%, and 13.33%. MBs in class 1 have a pattern of consistent condom usage (0.79), non-Net-based venue sex-trading (0.68), fewer sexual partners (0.81), fewer anal sex (0.97) and were labeled the "relatively safe behavior" group (n = 160, 48.48%). MBs in class 2 differed from class 1 by their higher probability of inconsistent condom usage (0.97), Net-based venue sex-trading (0.82), substance abuse (0.87), multiple sexual partners (0.99), and multiple anal sex (0.98) and were termed the "higher sexual risk" group (n = 29, 8.79%). The class 3 denoted the "multiple sexual partners" group (n = 97, 29.39%) and was characterized by a relatively high probability of multiple sexual partners (0.98) and multiple anal sex (0.98). Class 4 was distinguished from other classes by inconsistent condom usage (0.99) and substance abuse (0.73) and was labeled the "unprotected sex and substance abuse" group (n = 44, 13.33%).

Table 2 – Goodness-of-fit indices comparing class membership models of sex-trading venue, sexual behavior, and substance abuse patterns (N = 330).

Number of classes	G^2	*df*	AIC	BIC	CAIC
2	226.49	112	256.49	313.48	328.48
3	176.36	104	222.36	309.73	332.73
4	**119.56**	**96**	**181.56**	**299.33**	**330.33**
5	90.20	88	168.20	316.37	355.37

AIC, Akaike information criteria; BIC, Bayesian information criteria; cAIC, consistent Akaike information criterion.

Characteristics of latent class membership

The "higher sexual risk" had the highest proportion of HIV positive (27.59% vs 8.25%), ever tested for HIV (86.21% vs 34.09%), knowledge of free antiviral treatment policy (75.86% vs 31.82%), and a longer duration in sex trade (20.00 months vs 9.00 months), whereas the "unprotected sex and substance abuse" (class 4) had the lowest percentage. Class membership varied across several characteristics. HIV status was significantly related to class membership ($P < 0.05$) among the HIV positive participants. When compared with class 3, the odds ratio of the other 3 classes are as follows: class 2 (odds ratio [OR] = 4.24, 95% confidence interval [CI]: 1.43–12.60), class 1 (OR = 1.41, 95% CI: 0.59–3.38), and class 4 (OR = 1.11, 95% CI: 0.32–1.91). Ever tested for HIV was associated with class membership ($P < 0.01$); MBs who had ever tested for HIV were very likely to be in class 2 (86.21%). Employment status was significantly associated with class membership ($P < 0.01$); regarding part-time employment, 52.27% of participants were in class 4. However, most sociodemographics were not significantly associated with class membership. Details are presented in Table 3.

Multivariable multinomial logistic model

Table 4 summarizes the results of multinomial logistic regression. Multivariate analysis demonstrated that MBs who were HIV positive, had lower monthly income, were part-time employed, had STI history and had significantly higher odds of being in classes 1, 2, and 4 versus class 3.

Discussion

Our results showed that the HIV infection rate was 11.52%, which was higher than that of the sentinel surveillance data (7.3%),[1] but lower than that of the study conducted among MSM in Changsha (13.3%).[3] The recruited sample represented a group of young, unmarried, non-local, low literacy, greater mobile, full-time employed MBs. This work provides valuable contribution to literature about sexual health among MBs, as patterns of behavior likely represent a more realistic and comprehensive assessment than in-depth assessments of any single behavior. LCA identified four distinct classes of MBs demonstrating different characteristics and HIV infection risk and there is a significant difference among different classes based on HIV status. These findings may be potentially helpful in targeting high-risk subgroups and developing specific intervention strategies.

Class 1, the relatively safe behavior group, was the most prevalent category (59.2%) in our sample. Although MBs in this group have a high HIV infection rate, MBs in class 1 have engaged in safe sexual behavior and less substance abuse. The

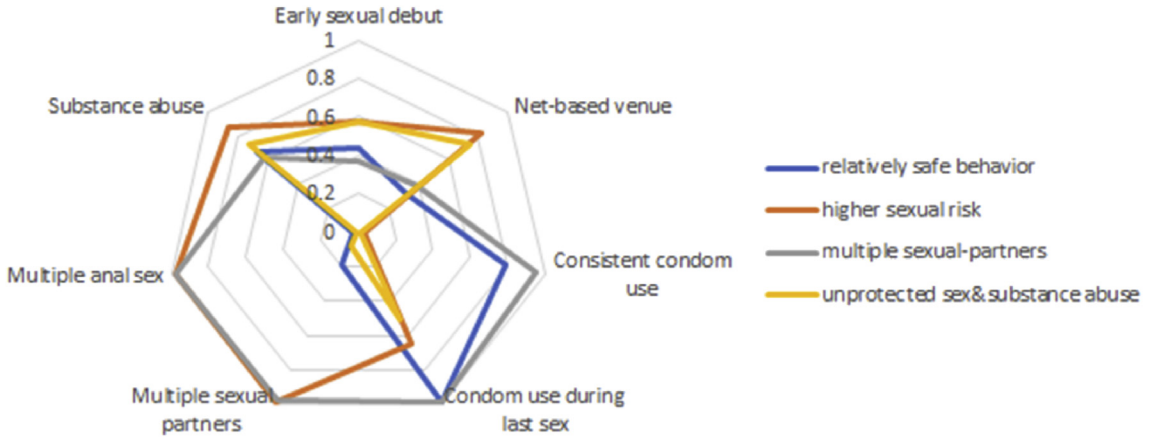

Fig. 1 – Item-response probabilities of high-risk sexual behaviors, substance abuse, and Net-based venue sex-trading for the four-class model: probability of endorsing an item given a latent class. Item-response probabilities are the probabilities of MBs responding to different items depending on latent class membership. For example, among those in the dangerous behavioral group, the probability of endorsing multiple sexual partners was 0.99.

reasons may be complex. First, with the improvement of health education and health intervention in China,[21] the MBs in class 1 are likely to have higher awareness of safe sexual behavior. Second, it is possible because men may practice safe sex with outside partners but not with primary partners,[22] thus limiting the additional risk that could be attributed to group and anonymous sex.

MBs in the "higher sexual risk" (class 2) were more likely to be not only HIV infected but also engaged in significantly higher HIV-risk behaviors by self-reporting multiple sex partners, multiple anal sex, inconsistent condom use, substance abuse, and Net-based venue sex-trading. Net-based venue remains predominant in sex-trading in class 2 membership. On the one hand, although online sex-trading can facilitate sexual hookups, saving travelling time, cost, and improving the likelihood of finding compatible sexual partners,[13] Internet-using MSM were also more likely to be HIV positive.[23] On the other hand, Net-based venue is also an ideal way to promote HIV prevention, early testing, and early treatment. In addition, MBs in this group were more likely to be full-time employed and have longer duration in sex trade, which suggest that MBs in this group were engaged in sex trade to earn money. Correct and consistent use of condoms can reduce HIV transmission by approximately 85–90%.[24] MBs in this group had low probability of consistent condom use, which indicates that MBs in this class were at high exposure of HIV infection. However, MBs in this group have a higher awareness of HIV-related prevention knowledge and skills; the separation feature between high-risk sexual behaviors and HIV-related prevention knowledge and skills may be a result of self-perception and taking preventive measures consciously which arise from treatment optimism and intervention fatigue to some extent. This evidence indicated that the higher HIV prevalence in this class was a result of compounded risk, which also suggests an urgent need for targeted HIV prevention strategies for the "higher sexual risk" MBs.

In addition, MBs with multiple sexual partners, multiple anal sex, consistent condom use, low HIV infection rate, and STI history were largely distributed in the "multiple sexual-partners" group. These findings were consistent with other studies conducted on MBs,[8,25] and these behaviors were also indicators of frequent sexual activities. However, MBs in this class have relatively a higher consistent condom use rate, which slows down the HIV transmission to a certain extent. The lowest rate of HIV infection and STI history revealed the co-varying effect of aforementioned behaviors.

Alternatively, substance abuse is an important characteristic in the "unprotected sex and substance abuse" group. Previous studies had investigated drug/substance abuse among MBs.[26,27] Drugs could drive sex with clients without love or an emotional connection while HIV can be transmitted by increasingly risky sexual behaviors,[12] which indicates MBs in this group were at high risk of HIV infection, so substance abuse should attract public attention. MBs in this group also have a shorter duration in sex trade, lower proportion of full-time employment, low HIV-related knowledge, which show that MBs in this group may be in pursuit of excitement rather than money, leading to the highest STI history compared with other classes. Renewed strategies should be implemented to this group of MBs, aiming at the change of high-risk sexual behaviors.

These findings might be used to formulate new prevention strategy and initiatives for the most at-risk MBs. Historically, HIV prevention programs have relied heavily on the promotion of "safe sex" (such as consistent condom usage), but evidence of "prevention fatigue" among MSM[28] reveals the limitations of this approach. New prevention strategy that targets previously underdocumented behaviors and behavior combinations may not face the same fatigue among MBs. By regular HIV testing and counseling on targeted subpopulation (highest HIV infection risk subgroup), high-risk MBs can be identified as early as possible, and early detection of HIV status enables patients to avoid risk behavior through care and support services. Early detection also helps patients in receiving timely antiretroviral treatment to reduce HIV viral load in the body, leading to an effective reduction in the spread of HIV.

This analysis provides further evidence of the utility of LCA to describe patterns of sexual behavior, substance abuse, and

Table 3 – Characteristics of MBs according to latent classes.

Characteristics	Class 1	Class 2	Class 3	Class 4	P value
N (%)	160 (48.5)	29 (8. 8)	97 (29.4)	44 (13.3)	
Age (years)					0.36
Median (IQR)	23.0 (4.0)	22.0 (4.0)	24.0 (4.0)	22.00 (5.0)	
Marital status					0.68
Unmarried	147 (91.9)	27 (93.1)	85 (87.6)	40 (90.9)	
others	13 (8.1)	2 (6.9)	12 (12.4)	4 (9.1)	
Original residence					0.09
Non-local	149 (93.1)	23 (79.3)	89 (91.8)	38 (86.4)	
Local	11 (6.9)	6 (20.7)	8 (8.2)	6 (13.6)	
Education					0.35
Middle school and below	63 (39.4)	8 (27.6)	42 (43.3)	18 (40.9)	
High school	74 (46.3)	15 (51.7)	45 (46.4)	24 (54.6)	
College	23 (14.4)	6 (20.7)	10 (10.3)	2 (4.6)	
Monthly income (RMB)					<0.01
≤5000	69 (43.1)	5 (17.2)	9 (9.3)	20 (45.5)	
5001-8000	76 (47.5)	15 (51.7)	48 (49.5)	15 (34.1)	
>8000	**15 (9.4)**	9 (31.0)	**40 (41.2)**	9 (20. 5)	
Sexual orientation					0.14
Homosexual	87 (54.4)	23 (79.3)	60 (61.9)	35 (79.6)	
Heterosexual	45 (28.1)	2 (6.9)	17 (17.5)	1 (2.3)	
Bisexual	28 (17.5)	4 (13.8)	20 (20.6)	8 (18.2)	
Duration in sex trade (month)					<0.01
Median (IQR)	9.0 (25.5)	**20.0 (13.0)**	19.0 (24.00)	**5.0 (12.0)**	
Employment					<0.01
Full-time	131 (81.9)	**25 (86.2)**	92 (94.9)	21 (47.7)	
Part-time	29 (18.1)	4 (13.8)	5 (5.2)	**23 (52.3)**	
Greater mobile					0.62
No	32 (20.0)	9 (31.0)	22 (22.7)	10 (22.7)	
Yes	128 (80.0)	20 (68.9)	75 (77.3)	34 (77.3)	
HIV status					<0.05
Negative	142 (88.8)	21 (72.4)	89 (91.8)	40 (90.9)	
Positive	18 (11.3)	**8 (27.6)**	**8 (8.3)**	4 (9.1)	
STI history					<0.01
No	135 (84.4)	24 (82.8)	92 (94.9)	33 (75.0)	
Yes	25 (15.6)	5 (17.2)	**5 (5.2)**	**11 (25.0)**	
HIV testing					<0.01
No	56 (35.0)	4 (13.8)	26 (26.8)	29 (65.9)	
Yes	104 (65.0)	**25 (86.2)**	71 (73.2)	**15 (34.1)**	
Knowledge of free antiviral treatment policy					<0.01
No	84 (52.5)	7 (24.1)	32 (32.9)	30 (68.2)	
Yes	76 (47.5)	**22 (75.9)**	65 (67.1)	**14 (31.8)**	
Awareness of free AIDS testing					<0.01
Don't know	47 (29.4)	3 (10.3)	17 (17.5)	8 (18.2)	
Vague	44 (27.5)	4 (13.8)	28 (28.9)	22 (50.0)	
Clear	69 (43.1)	**22 (75.9)**	52 (53.6)	**14 (31.8)**	

MBs, money boys; IQR, interquartile range; HIV, human immunodeficiency virus; STI, sexually transmitted infection.

sex-trading venues. The final model was identified, in part, because of excellent class separation and was effective at identifying patterns of behaviors associated with HIV. This analysis should be replicated in other samples to look for similar patterns, which makes additional factors in future analyses informative.

Limitations

This study is subjective to several limitations. First, the cross-sectional nature of this study design did not allow us to elucidate the temporal sequence of substance abuse, high-risk sexual behaviors, or HIV status. Consequently, a causal relationship between these variables cannot be established. Second, as a hidden and marginalized group, it is difficult to reach them. Consequently, convenience sampling was chosen to recruit participants, which may lead to selection bias. All the same, the study was collaborated with non-government organization of MSM in Tianjin, which raises the representativeness of the sample and a preferable generalizability of results could be obtained. Third, the sensitive nature of questions related to sexual behaviors and substance abuse might lead to information bias due to social desirability. Nevertheless, each candidate participating in the project had an in-depth interview with the interviewer. The respondents should have systematically understood the privacy, sensitive issues, corresponding sample collection, and testing services that may be involved in the survey, while the questionnaires

Table 4 – Results of the logistic regression model investigating factors associated with class membership.

Characteristics	Class 1 vs class 3		Class 2 vs class 3		Class 4 vs class 3	
	OR	95% CI	OR	95% CI	OR	95% CI
Duration in sex trade (month)						
Median (IQR)	0.99	0.97–1.01	0.99	0.97–1.02	0.99	0.97–1.02
Monthly income (RMB)						
≤5000	Reference					
5001-8000	0.19*	0.08–0.43	0.44	0.12–1.57	0.08*	0.03–0.23
>8000	0.05*	0.02–0.12	0.29	0.047–1.18	0.06*	0.02–0.22
Employment						
Full-time	Reference					
Part-time	4.11*	1.37–12.38	2.79	0.62–12.56	16.11*	4.67–55.61
HIV status						
Negative	Reference					
Positive	1.28	0.49–3.38	4.06*	1.31–12.59	0.95	0.22–4.11
STI history						
No	Reference					
Yes	3.61*	1.15–11.31	3.41	0.81–14.43	2.62	0.64–10.78
Ever tested for HIV						
No	Reference					
Yes	1.26	0.54–2.95	1.68	0.37–7.58	0.39	0.11–1.40
Knowledge of free antiviral treatment policy						
No	Reference					
Yes	0.88	0.38–2.05	1.29	0.34–4.96	0.91	0.25–3.39
Awareness of free AIDS testing						
Don't know	Reference					
Vague	0.65	0.26–3.39	1.68	0.33–8.53	1.15	0.26–5.14
Clear	0.68	0.27–1.67	0.71	0.12–4.16	1.57	0.44–5.53

OR, odds ratio; CI, confidence interval; HIV, human immunodeficiency virus; STI, sexually transmitted infection.
*$P < 0.05$.

were completed on the basis of full trust anonymously. Fourth, there is evidence showing that unhealthy alcohol use was independently associated with any drug use.[29] Meanwhile, self-reported alcohol use at the last sex was also associated with drug use.[30] Therefore, in our study, the use of alcohol could be partly replaced by substance abuse. Future research could involve this variable, which may provide more information that differentiates MBs across classes. However, four typical behavior patterns were identified in our analysis, which provides information for targeted intervention and further research.

Conclusion

Our study inductively identified four distinct latent classes of substance use among MBs in China. Findings here suggest that not all types of MBs contribute to high-risk sex, suggesting that interventions should identify and target the highest risk groups. MBs who used Net-based venue to seek sexual partners; who have inconsistent condom use, substance abuse, a longer duration in sex trade, multiple sexual clients, and multiple anal sex; and who were full-time employed had the highest risk of HIV infection. HIV-negative individuals in those high-risk groups may benefit most from corresponding interventions. Intervention strategy targeting the highest risk group may be important for expanding HIV-related knowledge, policy, free testing service, and free antiviral treatment among those populations. Future study should also consider whether identification of the highest risk group via methods such as LCA leads to better change in behaviors compared to identification of higher risk groups via traditional routes and whether this method may ultimately lead to a reduced incidence of HIV infection.

Author statements

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Ethical approval

The study protocol has been reviewed and approved by the Institution Review Board of Tianjin Medical University (IRB approval number: TMuhMEC2011051). A written informed consent was obtained from all study participants.

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Conflicts of interest

None declared.

Contributors

Z.C. designed the survey. C.-m.G., M.-h.Y., H.G., and Y.L. were responsible for data collection; J.X., Z.L., Y.-j.G., J.Y., and C.-p.L. did the epidemiological analysis; F.S. and M.G. performed quality assurance; C.-m.G. and F.S. contributed to analysis and interpretation of the data and writing of the first draft of the report. All authors critically reviewed and approved the final version of the report.

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