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Research paper

# HIV non-occupational post-exposure prophylaxis (nPEP) awareness and promotion among five key populations in China: A cross-sectional study <sup>☆</sup>

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## ABSTRACT

**Background:** This study investigated HIV non-occupational post-exposure prophylaxis (nPEP) awareness and promotion, and related sociodemographic and behavioural factors among five key populations in China.

**Methods:** From November 2018 to September 2019, we adopted convenience sampling to recruit participants who were age  $\geq 18$ , self-reported HIV status as either negative or unknown and provided informed consent from five key populations cross-sectionally in 10 Chinese cities. Univariable and multivariable logistic regressions were adopted.

**Findings:** Our analysis included data from 2022 participants with a mean age of 35 years (SD = 11.62). Approximately 60% of participants reported non-consistent condom use in the past month, and 37% had not been tested for HIV in the past 12 months. There were 857 (42%) participants hearing about nPEP before the study, and 1728 (86%) endorsing nPEP promotion after learning about nPEP. Sociodemographic and behavioural factors related to both nPEP awareness and endorsement of nPEP promotion included the key population indicator, age, HIV knowledge score, and HIV testing over life course.

**Interpretation:** The key populations in China generally had low nPEP awareness, particularly people who use drugs and female sex workers, while seronegative partners had the lowest endorsement of nPEP promotion. nPEP education and promotion campaigns should be integrated into conventional HIV services, and tailored to sexually active young individuals, people with poor HIV knowledge, and people never tested for HIV.

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### Research in context

#### Evidence before this study

Biomedical interventions such as antiretroviral therapy (ART) by people living with HIV and the use of HIV pre- and post-exposure prophylaxis are effective in preventing the spread of HIV. To date, non-occupational HIV post-exposure

prophylaxis (nPEP) has been proven to be efficacious in preventing HIV, yet it remains an underutilized prevention strategy in China. We searched PubMed, Global Health, and IBSS for English articles and CNKI and WANFANG DATA for Chinese articles (Jan 1990 to Jan 2020) using the following keyword searches in any fields: “HIV nonoccupational post-exposure prophylaxis” or “post-exposure prophylaxis” or “awareness, nonoccupational post-exposure prophylaxis, China” or “China HIV prevention strategies” or “China HIV.” We identified only two key systematic reviews about nPEP. One reported that the pooled rate of awareness of nPEP among MSM was 51.6% (95% CI: 40.6%–62.5%) and nPEP awareness tended to be more prevalent in upper-middle-income countries/regions and HIV-positive MSM. The second systematic review examined completion rates for HIV post-exposure prophylaxis (PEP) according to exposure type (i.e., occupational, nonoccupational, and sexual assault), patient, and program characteristics, finding adherence and completion rates to be very poor.

#### *Added value of this study*

This study is the first to provide data regarding nPEP awareness and endorsement of promotion in China as a prevention strategy for five key populations. Specifically, we interviewed (1) men who have sex with men (MSM); (2) female sex workers (FSW); (3) people who use drugs (PWUD); (4) men who have commercial or non-commercial casual sex with women (MCSW); and (5) seronegative partners among serodiscordant couples (SNP). Until such alternatives as pre-exposure prophylaxis (PrEP) become available, the need for nPEP as part of a comprehensive HIV prevention strategy is expected to remain high in China. The study identifies socio-demographic and behavioural characteristics related to nPEP awareness and endorsement of nPEP promotion, which we argue emphasizes the need for strategic informational targeting of vulnerable populations throughout China.

#### *Implications of all the available evidence*

The findings of this study suggest that nPEP services are urgently needed as part of a comprehensive HIV prevention strategy in China. Health education campaigns related to nPEP must be tailored to individuals with specific characteristics necessitating substantial changes to current HIV prevention strategies throughout China. HIV education campaigns have shown a positive impact on nPEP awareness and promotion when utilized and should be upgraded to cover knowledge and health care information related to nPEP. Qualitative studies are needed to develop an in-depth understanding of the barriers and challenges for high-risk groups in China.

## Introduction

Despite significant progress in scaling up HIV testing and treatment worldwide, 1.7 million people became newly infected with HIV in 2018, resulting in 37.9 million people living with HIV (PLWH), globally [1]. In China, the expanding HIV burden includes 860,000 people living with HIV, 720,000 PLWH on antiretroviral therapies (ART), and 680,000 PLWH having suppressed viral loads as of the end of 2018 [2]. As a result, China has placed greater emphasis on HIV prevention strategies via sexual transmissions, such as promoting condom use and HIV testing, with a particular focus on female sex workers (FSW) and men who have sex with men (MSM). However, these strategies fail to remedy occasions where individuals are newly exposed to HIV, particularly in a non-occupational context. In order to address this gap, it is necessary to adopt a strategy of using antiretroviral drugs (ARVs) for prevention, such as HIV pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) like those piloted in some provinces in China [3]. PrEP, which reduces the risk of HIV acquisition when taken before and after a potential exposure, remains largely un-

available throughout China. PEP, however, is available on a case-by-case basis and includes the use of short-term (28-day course) antiretroviral therapy (ART) taken within 72 h of exposure to prevent HIV seroconversion. Non-occupational exposure is defined as direct contact with potentially infectious body fluids containing HIV, which occurs outside perinatal or occupational situations [4,5]. Despite these pilot studies and its availability, HIV non-occupational post-exposure prophylaxis (nPEP) remains an unconventional and underutilized HIV prevention measure in China. Even though nPEP has been proven to be highly effective in HIV prevention and has been increasingly adopted in developed countries [6,7,8,9], China remains an important site for nPEP use expansion, yet in China, nPEP remains costly and inaccessible to many, as opposed to other low- and middle-income countries where nPEP services are more accessible and free [10].

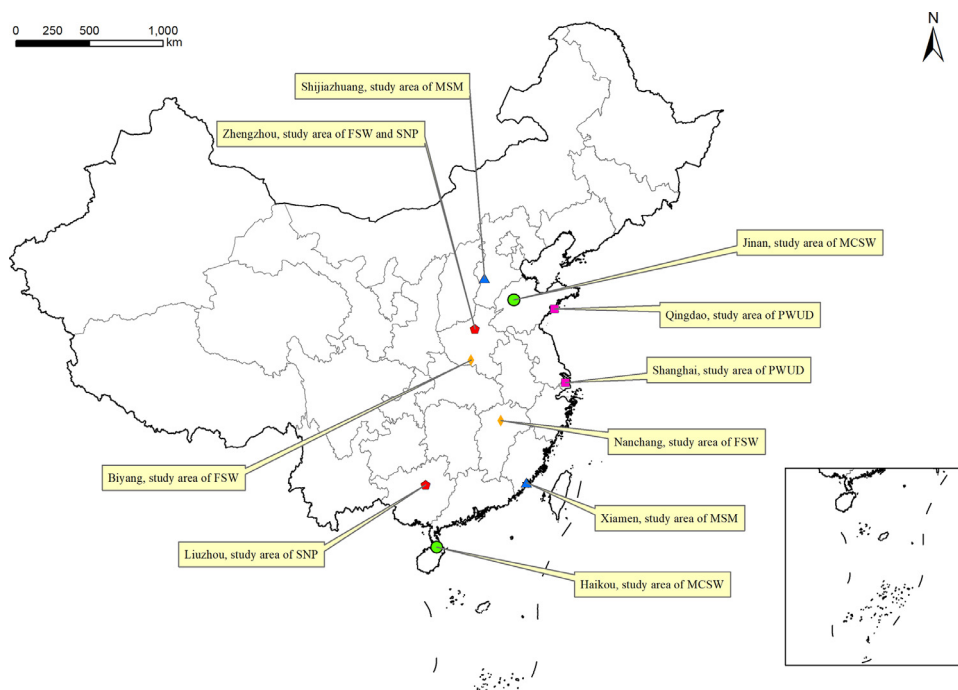
To date, few studies have focused on nPEP awareness and endorsement of nPEP promotion from the perspective of key populations at high risk of HIV acquisition. MSM and victims of sexual assault remain disproportionately represented in the nPEP literature [11,12], highlighting the need for more research from the perspective of previously unexplored vulnerable populations. A systematic review published in 2013 has reported that HIV epidemics in China remain concentrated in people who use drugs (PWUD), female sex workers (FSW), and MSM [13]. The Joint United Nations Programme on HIV/AIDS (UNAIDS) also reported in 2019 that only 52.3% sex workers, 56.4% MSM, and 55.2% PWUD in China were aware of their HIV status [2]. Except these three populations, there are another two emerging key populations for HIV transmission. A systematic review and meta-analysis published in 2013 urged greater attention to sexual risk and sexually transmitted disease prevalence among male clients of female sex workers in China [14]. Seronegative partners among serodiscordant couples is another emerging key population, even though a meta-analysis published in Chinese reported that HIV negative partners' or lovers' seroconversion rates among HIV serodiscordant couples in China are not high (1.0/100 person-year) [15].

In response, China is examining the possibility of utilizing nPEP as a national strategy in HIV prevention. However, little is known about the perceptions of nPEP among key populations. A meta-analysis published in 2019 has reported a wide range of nPEP awareness rates between 1.1% and 88.3% (median, 53.4%) [16]. Recent studies in Spain and Canada suggest that the geographic location of testing sites creates critical barriers for many potential nPEP users; Similarly, educational attainment and sexual history of sexually transmitted infections (STIs) have been found to have a direct impact on nPEP awareness [17,18]. A Chinese study reported that 67% of participants were aware of nPEP, and 64% expressed a need for access to nPEP [19]. The study further suggested that demand for nPEP services was related to their categorization within vulnerable groups who are at higher risk of HIV (e.g., MSM, PWUD) and initial nPEP awareness. Similarly, another Chinese study has found that 31% of MSM were aware of nPEP, with 62% highlighting the need for improved nPEP access and continued outreach [20]. In order to serve the planning and implementation of nPEP services, the current study aims to investigate the relationship between nPEP awareness and promotion and related socio-demographic and behavioural factors among five key populations at higher risk of HIV in China.

## Methods

### *Study area*

Our study targeted five key populations that are recognized by the Chinese Center for Disease Control and Prevention (China CDC)



as at higher risk of HIV acquisition in ten cities in China, including MSM in Shijiazhuang and Xiamen, FSW in Zhengzhou, Nanchang and Zhumadian, PWUD in Qingdao and Shanghai, men who have commercial or non-commercial casual sex with women (MCSW) in Jinan and Haikou, seronegative partners among serodiscordant couples (SNP) in Zhengzhou and Liuzhou respectively (Fig. 1).

### Study design

A cross-sectional design was adopted to examine the proportions of nPEP awareness and endorsement of nPEP promotion among five key populations from ten Chinese cities at the time when the study was conducted.

### Study population and sampling

The inclusion criteria were that MSM were males who reported having sex with another male in the past 6 months; FSW were females who provided commercial/transactional sex to males for money or goods in the past 12 months; PWUD were people who took illicit drugs in the past 12 months; MCSW were males who had casual sex with women through commercial/transactional or non-commercial ways in the past 12 months, and SNP were people who currently have spouses who have ever been diagnosed as HIV seropositive. All participants were (1) age  $\geq 18$  years; and (2) self-reported HIV negative or unknown. Participants were excluded if they were not currently living in these ten local cities, or could not complete the survey due to their personal reasons, such as getting drunk. These key populations are hard to reach because their behaviours are not well recognized in China, and there is no sampling frame for them. Given the funding, networks, and human resources we can use, convenience sampling was adopted. There is a dearth of literature about nPEP awareness among key populations, except MSM. We therefore first estimated the sample size of MSM using the formula:  $n = \frac{Z_{\alpha}^2}{d^2} p(1-p)$ , with  $p = 35\%$ ,  $d = 0.15p$ ,  $\alpha = 0.05$ ,  $Z_{\alpha} = 1.96$ , and taking into account a possible missing rate of 20%. We found it reasonable to refer to MSM and recruit 400 participants for each key population, and therefore around 2000 participants in total for the five key populations.

### Data collection tools

The survey instrument was developed iteratively. We firstly used China's HIV/AIDS sentinel surveillance questionnaire [21] as a starting point. We then adapted it based on the literature and qualitative works. We validated it by consulting with frontline health-care staff experienced with HIV and nPEP research and clinical care and piloting among volunteers. The scope of the questionnaire included socio-demographic variables (i.e., age, local household, ethnicity, duration of living in the local city, education, monthly income, and marital status), HIV knowledge (a scale with eight categorical items and a Cronbach's Alpha of 0.765) [21], nPEP knowledge (a scale with 11 categorical items and a Cronbach's Alpha of 0.997) [22], HIV-related behaviours (i.e., utilization of HIV prevention services in the past 12 months, consistent condom use in the last month, ever use of illicit drugs, alcohol use in the past 3 months, and HIV testing over life-course), and perception (i.e., perceived HIV severity in your population), and two binary outcomes, including hearing of nPEP before joining the study (Yes or No) and endorsement of nPEP promotion after being introduced nPEP in the study (Yes or No) (see supplement for the details). Local collaborators, such as the Center for Disease Control and Prevention (CDC), hospitals, community-based organizations (CBOs), approached potential participants in health care settings or some specific venues (e.g., saunas, and nightclubs for MSM, entertainment venues for FSW). A self-administered and exclusive questionnaire link with personalized credentials was provided to eligible participants via the Wenjuanxing web portal. A paper-based questionnaire was an alternative if desired. Participants completed the survey on site and were compensated CNY 50 (about USD 7.50).

### Data management and analysis

Our two outcomes are the proportions of individuals who were aware of nPEP and endorsed its promotion, respectively. Descriptive analyses were first conducted using chi-square tests and T-tests. We then conducted univariable logistic regression to examine the associations between socio-demographic and behavioural variables and these two outcomes, respectively. Variables with  $p \leq 0.10$  in the univariable analyses were considered as poten-

tial confounding factors and were included in the multivariable logistic regression models without any further elimination [23]. Odds ratios (ORs) and adjusted odds ratios (aOR) and respective 95% confidence intervals (CI) were calculated. Multicollinearity (using tolerance and variance inflation factors), Hosmer-Lemeshow's goodness-of-fit statistic, outliers, and influential observations (using estimated values and Pearson and Deviance residuals) were also assessed. All statistical analyses were performed using Statistical Analysis System® software (SAS 9.4 for Windows; SAS Institute Inc., NC, USA) treating  $p < 0.05$  as statistically significant.

### Ethics issues

All research procedures complied with the Declaration of Helsinki and were approved by the Ethics Review Committee of Public Health at Shandong University (IRB No:20180904). We explained the study in detail to participants; assured them of anonymity, voluntary, and privacy protection; and guaranteed no reprisal for refusing to participate or withdrawing at any time. Informed consent was obtained from all participants before the study commencement.

### Role of the funding source

The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all of the data in the study and had final responsibility for paper submission for publication.

## Results

### Sample characteristics

We received a total of 2029 questionnaires, seven incomplete questionnaires were excluded, and 2022 participants remained in the study, including 419 MSM, 400 FSW, 401 PWUD, 400 MCSW, and 402 SNP. Less than half (857, 42.47%) of the participants had any previous awareness of nPEP before joining this study, including 303 (72.32%) MSM, 208 (52.00%) MCSW, 166 (41.29%) SNP, 120 (29.93%) PWUD, and 60 (15.00%) FSW. Most (1728, 85.80%) participants endorsed nPEP promotion after knowledge acquisition, including 384 (91.65%) MSM, 345 (86.25%) MCSW, 345 (86.25%) FSW, 338 (84.29%) PWUD, and 316 (78.61%) SNP (Fig. 2). SNP had a higher percentage of nPEP awareness than FSW and PWUD but had the lowest percentage of endorsement of nPEP promotion.

Descriptive analyses were presented in Table 1. Participants had a mean age of 35 years (SD = 11.62). Participants who heard of nPEP and endorsed nPEP promotion both had younger mean ages than participants who did not hear of nPEP or endorse its promotion (31.45 vs 37.95, 34.91 vs 36.60, respectively). About 64% of participants had an education level of high school or above, 52% of them earned a monthly income at or below CNY 3000 (USD 419), and 44% of them were married. The total population had an HIV knowledge mean score of 6.65 (SD = 1.76). Participants who heard of nPEP and endorsed nPEP promotion both had higher HIV knowledge mean scores than participants who did not hear of nPEP or endorse its promotion (7.10 vs 6.32, 6.78 vs 5.84, respectively). The total populations had an nPEP knowledge mean score of 3.37 (SD = 4.23). Participants who heard of nPEP and endorsed nPEP promotion both had higher nPEP knowledge mean scores than participants who did not hear of nPEP or endorse its promotion (7.96 vs 0.00, 3.62 vs 1.94, respectively). Although participants living in a local city for a longer duration seemed to have a higher awareness of nPEP, participants living in a local city for

6–12 months and 1–2 years had the lowest percentages of endorsing nPEP promotion. Participants who never took a test for HIV reported the lowest percentage (31.02%) of nPEP awareness, while participants who tested for HIV more than 12 months ago reported the lowest percentage (82.50%) of endorsing nPEP promotion.

### Correlates of hearing of nPEP and endorsing nPEP promotion

Univariable and multivariable analyses were presented in Table 2. In univariable analyses, a list of variables were significantly associated with the outcome of hearing of nPEP, including key populations, age, local household, duration of living in local city, education, monthly income, being married, HIV knowledge score, utilization of HIV prevention services in the past 12 months, consistent condom use in the past month, ever use of illicit drugs, alcohol use in the past 3 months, HIV testing over life-course, and perceived HIV severity in your populations. However, the multivariable analyses showed that, compared to MSM, FSW (aOR = 0.154; 95% CI 0.098–0.242) and PWUD (aOR = 0.060; 95% CI 0.022–0.163) were less likely to hear of nPEP. Compared to SNP, FSW (aOR = 0.263; 95% CI 0.163–0.424) and PWUD (aOR = 0.103; 95% CI 0.037–0.290) were less likely to hear of nPEP. Compared to MCSW, FSW (aOR = 0.202; 95% CI 0.127–0.322) and PWUD (aOR = 0.079; 95% CI 0.028–0.223) were less likely to hear of nPEP. Participants were more likely to hear of nPEP when they had higher HIV knowledge scores (aOR = 1.277; 95% CI 1.177–1.384), utilized HIV prevention services in the past 12 months (aOR = 1.567; 95% CI 1.156–2.126), tested for HIV over life-course (aOR = 2.286; 95% CI 1.533–3.408, aOR = 1.969; 95% CI 1.411–2.749, aOR = 2.179; 95% CI 1.530–3.104, respectively), and perceived HIV severity in their populations (aOR = 1.839; 95% CI 1.313–2.576). Participants were less likely to hear of nPEP when they were older in age (aOR = 0.962; 95% CI 0.949–0.975), had primary school as their highest education (aOR = 0.288; 95% CI 0.126–0.656), never used illicit drugs (aOR = 0.192; 95% CI 0.073–0.509), used alcohol 1–4 times per week or more in the past 3 months (aOR = 0.595; 95% CI 0.416–0.852), and had no idea of HIV severity in their populations (aOR = 0.644; 95% CI 0.457–0.910).

In univariable analyses, a list of variables were significantly associated with the outcome of endorsing nPEP promotion, including key populations, age, ethnicity, duration of living in local city, education, being married, HIV knowledge score, nPEP knowledge score, utilization of HIV prevention services in the past 12 months, HIV testing over life-course, perceived HIV severity in your population, and hearing of nPEP. However, multivariable analyses also showed that, compared to MSM, SNP (aOR = 0.309; 95% CI 0.168–0.567) were less likely to endorse nPEP promotion. Compared to SNP, FSW (aOR = 2.361; 95% CI 1.378–4.044), PWUD (aOR = 2.957; 95% CI 1.655–5.281) and MCSW (aOR = 2.348; 95% CI 1.330–4.146) were more likely to endorse nPEP promotion. Participants were more likely to endorse nPEP promotion when they had higher HIV knowledge scores (aOR = 1.262; 95% CI 1.170–1.362) or nPEP knowledge scores (aOR = 1.119; 95% CI 1.017–1.231), and tested HIV once vs more than once in the past 12 months (aOR = 1.847; 95% CI 1.264–2.699). Participants were less likely to endorse nPEP promotion when they were living in the local city for 6–12 months (aOR = 0.368; 95% CI 0.162–0.835) or 1–2 years (aOR = 0.360; 95% CI 0.170–0.764), tested HIV more than 12 months ago vs tested HIV once in the past 12 months (aOR = 0.596; 95% CI 0.378–0.941).

## Discussion

This study has identified some factors (i.e., key populations, HIV knowledge score, and HIV testing) related to both nPEP awareness and promotion. We found that only 15% of FSW and 30% of PWUD had heard about nPEP, rates substantively lower than MSM,

**Table 1**  
Social demographic characteristics of five key populations at higher risk of HIV in China (N = 2022).

	Total sample (N = 2022)	Had heard about nPEP or not (N = 2018)		Endorsing nPEP promotion or not (N = 2014)	
		Had heard about nPEP N = 857 (42.47%)	Had not heard about nPEP N = 1161 (57.53%)	Endorsing nPEP promotion N = 1728 (85.80%)	No endorsing nPEP promotion N = 286 (14.20%)
Key populations		***		***	
Men who have sex with men (MSM)	419 (20.72)	303 (72.32)	116 (27.68)	384 (91.65)	35 (8.35)
Female sex workers (FSW)	400 (19.78)	60 (15.00)	340 (85.00)	345 (86.25)	55 (13.75)
People who use drugs (PWUD)	401 (19.83)	120 (30.23)	277 (69.77)	338 (84.92)	60 (15.08)
Men who have commercial or non-commercial casual sex with women (MCSW)	400 (19.78)	208 (52.00)	192 (48.00)	345 (86.47)	54 (13.53)
Sero-negative partners among sero-discordant couples (SNP)	402 (19.88)	166 (41.29)	236 (58.71)	316 (79.40)	82 (20.60)
Missing		4		8	
Age (years)	Mean = 35.20, SD = 11.62	*** Mean = 31.45, SD = 10.09	Mean = 37.95, SD = 11.90	* Mean = 34.91, SD = 11.22	Mean = 36.60, SD = 13.51
Missing	4	1	3	3	1
Local household		***			
Yes	1114 (55.48)	432 (38.92)	678 (61.08)	935 (84.54)	171 (15.46)
No	894 (44.52)	423 (47.32)	471 (52.68)	783 (87.58)	111 (12.42)
Missing	1	2	12	10	4
Ethnicity				*	
Han	1891(93.75)	812 (43.03)	1075 (56.97)	1626 (86.26)	259 (13.74)
Non-Han	126 (6.25)	45 (35.71)	81 (64.29)	97 (78.23)	27 (21.77)
Missing	5		5	5	
Duration of living in local city		**		*	
<3 months	146 (7.24)	47 (32.19)	99 (67.81)	134 (97.78)	12 (8.22)
3–6 months	104 (5.16)	34 (32.69)	70 (67.31)	92 (89.32)	11 (10.68)
6–12 months	109 (5.41)	36 (33.03)	73 (66.97)	89 (81.65)	20 (18.35)
1–2 years	204 (10.12)	86 (42.16)	118 (57.84)	166 (81.37)	38 (18.63)
>2 years	1453 (72.07)	654 (45.13)	795 (54.87)	1242 (85.89)	204 (14.11)
Missing	6	0	6	5	1
Education		***		**	
Illiterate	48 (2.39)	17 (35.42)	31 (64.58)	43 (89.58)	5 (10.42)
Primary school	240 (11.96)	28 (11.67)	212 (88.33)	194 (80.83)	46 (19.17)
Secondary school	440 (21.93)	117 (26.59)	323 (73.41)	358 (81.92)	79 (18.08)
High/ Polytechnic school	489 (24.38)	190 (39.18)	295 (60.82)	424 (86.89)	64 (13.11)
College or above	789 (39.33)	504 (63.88)	285 (36.12)	696 (88.55)	90 (11.45)
Missing	16	1	15	13	2
Monthly income (CNY)		***			
< 1500	481 (23.86)	153 (31.94)	326 (68.06)	409 (85.74)	68 (14.26)
1500–3000	577 (28.62)	221 (38.37)	355 (61.63)	493 (85.74)	82 (14.26)
3001–5000	522 (25.89)	260 (49.81)	262 (50.19)	451 (86.40)	71 (13.60)
5001–8000	290 (14.38)	144 (49.83)	145 (50.17)	245 (84.48)	45 (15.52)
> 8000	146 (7.24)	75 (51.37)	71 (48.63)	126 (86.90)	19 (13.10)
Missing	6	4	2	4	1
Being married		***		***	
Yes	894 (44.41)	328 (36.73)	565 (63.27)	736 (82.70)	154 (17.30)
No	1119 (55.59)	526 (47.13)	590 (52.87)	985 (88.34)	130 (11.66)
Missing	9	3	6	7	2
HIV knowledge score	Mean = 6.65, SD = 1.76	*** Mean = 7.10, SD = 1.23	Mean = 6.32, SD = 2.01	*** Mean = 6.78, SD = 1.65	Mean = 5.84, SD = 2.13
Missing	6	2	4	5	1
nPEP knowledge score	Mean = 3.37, SD = 4.23	*** Mean = 7.96, SD = 2.38	Mean = 0.00, SD = 0.00	*** Mean = 3.62, SD = 4.30	Mean = 1.94, SD = 3.48
Missing	9	5		8	1
Utilization of HIV prevention services in the past 12 months		***		***	
Yes	1609 (79.81)	721 (44.89)	885 (55.11)	1397 (87.20)	205 (12.80)
No	407 (20.19)	132 (32.51)	274 (67.49)	326 (80.30)	80 (19.70)
Missing	6	4	2	5	1
Consistent condom use in the past month		*			
Yes	814 (40.34)	318 (39.11)	495 (60.89)	685 (84.26)	128 (15.74)
No	1204 (59.66)	537 (44.68)	665 (55.32)	1039 (86.80)	158 (13.20)
Missing	4	2	1	4	
Ever use of illicit drugs		***			
Yes	445 (22.02)	156 (35.37)	285 (64.63)	375 (84.84)	67 (15.16)
No	1576 (77.98)	701 (44.48)	875 (55.52)	1352 (86.06)	219 (13.94)
Missing	1	0	1	1	0

(continued on next page)

Table 1 (continued)

	Total sample (N = 2022)	Had heard about nPEP or not (N = 2018)		Endorsing nPEP promotion or not (N = 2014)	
		Had heard about nPEP	Had not heard about nPEP	Endorsing nPEP promotion	No endorsing nPEP promotion
		N = 857 (42.47%)	N = 1161 (57.53%)	N = 1728 (85.80%)	N = 286 (14.20%)
Alcohol use in the past 3 months		***			
No use	782 (38.75)	322 (41.34)	457 (58.66)	677 (86.91)	102 (13.09)
1 or 2 times	488 (24.18)	232 (47.54)	256 (52.46)	422 (87.01)	63 (12.99)
1–3 times per months	406 (20.12)	191 (47.04)	215 (52.96)	348 (86.14)	56 (13.86)
1–4 times per week or more	342 (16.95)	111 (32.46)	231 (67.54)	279 (81.58)	63 (18.42)
Missing	4	1	2	2	2
HIV testing over life-course		***			
Never	494 (24.50)	152 (31.02)	338 (68.98)	412 (83.57)	81 (16.43)
Tested more than 12 months ago	243 (12.05)	115 (47.33)	128 (52.67)	198 (82.50)	42 (17.50)
Tested once in the last 12 months	746 (37.00)	279 (37.40)	467 (62.60)	665 (89.62)	77 (10.38)
Tested more than once in the last 12 months	533 (26.44)	310 (58.16)	223 (41.84)	447 (83.86)	86 (16.14)
Missing	6	1	5	6	0
Perceived HIV severity in your population		***			
Not serious	324 (16.03)	103 (31.79)	221 (68.21)	271 (84.16)	51 (15.84)
Serious	865 (42.80)	509 (59.05)	353 (40.95)	782 (90.40)	83 (9.60)
Have no idea	832 (41.17)	245 (29.48)	586 (70.52)	674 (81.60)	152 (18.40)
Missing	1		1	1	0

Note. nPEP = non-occupational post-exposure prophylaxis, HIV = human immunodeficiency virus. CNY = Chinese Yuan (1 CNY = 0.1398 USD). p-values: \* <0.05 \*\*<0.01 \*\*\*<0.001. Missing values were not taken into account in the percentage calculation.

MCSW, and SNP; and SNP had the lowest proportion of endorsement of nPEP promotion. This indicates a heightened need to target these populations in future HIV prevention campaigns. This is consistent with previous studies, reporting that some vulnerable groups may underestimate or accept their level of HIV risk after many risk episodes and therefore did not seek nPEP [11,24]. After being informed about nPEP utility, FSW, and PWUD both reported high proportions of endorsing nPEP. These findings indicate

that different populations may have different perceptions of nPEP and if FSW and PWUD are effectively covered by HIV prevention campaigns, they may be more receptive to the nPEP services. Participants with higher HIV knowledge scores reported more awareness and endorsement of nPEP, which suggests that HIV education may play an important role in nPEP promotion [28]. Participants who have ever been tested for HIV were more likely to be aware of nPEP than participants who have never been tested for HIV, and

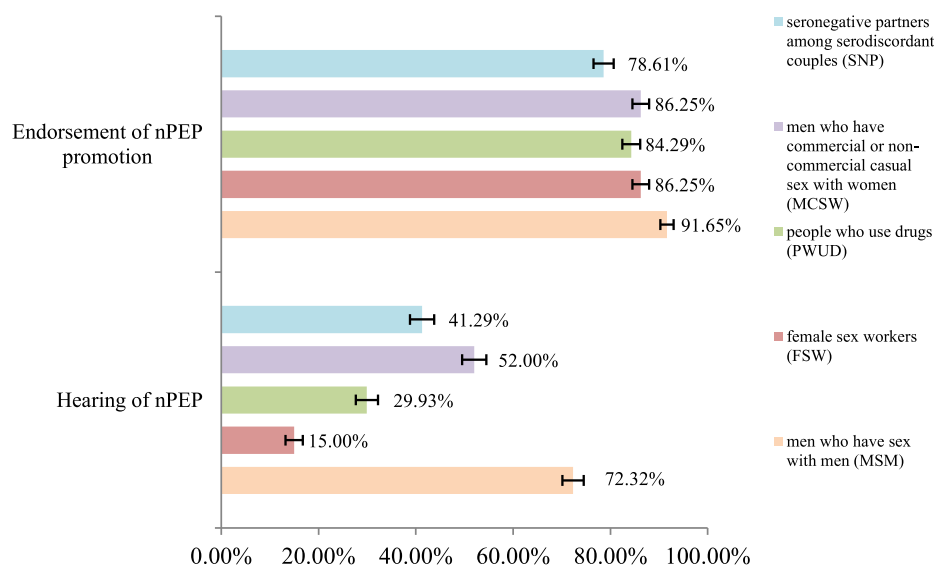


Fig. 2. Proportions of hearing of nPEP, endorsement of nPEP promotion among five key populations in China, 2018 (N = 2022) Note. Total n = 2022, 857 (42.38%) participants hearing of nPEP before joining the study, including 303 (72.32%) MSM, 60 (15.00%) FSW, 120 (29.93%) PWUD, 208 (52.00%) MCSW, and 166 (41.29%) SNP; 1728 (85.46%) participants endorsing nPEP promotion after acquiring knowledge, including 384 (91.65%) MSM, 345 (86.25%) FSW, 338 (84.29%) PWUD, 345 (86.25%) MCSW, and 316 (78.61%) SNP; The error bars represent the 95% confidence intervals. Among those participants who heard of nPEP, 44.48% hearing from CBOs, 39.84% from the Internet/social media/APP, 34.84% from CDCs, 25.44% from medical doctors, 18.70% from friends, 12.31% from mass media (e.g., broadcasting, TV), and 0.58% from other channels.

**Table 2**Correlates associated with hearing of nPEP and endorsing nPEP promotion in univariable and multivariable logistic regressions among five key populations at higher risk of HIV in China, 2018 ( $N = 2022$ ).

Variables	Univariable and multivariable logistic regression with the outcome of hearing of nPEP				Univariable and multivariable logistic regression with the outcome of endorsing nPEP promotion			
	CrudeOR (95% CI)	p value	Adjusted OR (95% CI)	p value	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Key populations		$P < 0.0001$	†	$P < 0.0001$		$P < 0.0001$	§	$P = 0.0012$
Men who have sex with men (MSM)	ref		ref		ref		ref	
Female sex workers (FSW)	0.068 (0.048, 0.096)***		0.154 (0.098, 0.242)***		0.572 (0.365, 0.895)*		0.729 (0.414, 1.285)	
People who use drugs (PWUD)	0.166 (0.123, 0.224)***		0.060 (0.022, 0.163)***		0.513 (0.330, 0.799)**		0.913 (0.542, 1.538)	
Men who have commercial or non-commercial casual sex with women (MCSW)	0.415 (0.310, 0.554)***		0.761 (0.521, 1.110)		0.582 (0.372, 0.913)*		0.725 (0.436, 1.205)	
Sero-negative partners among sero-discordant couples (SNP)	0.269 (0.201, 0.361)***		0.584 (0.370, 0.924)*		0.351 (0.230, 0.536)***		0.309 (0.168, 0.567)***	
Age (years)	0.947 (0.939, 0.956)***	$P < 0.0001$	0.962 (0.949, 0.975)***	$P < 0.0001$	0.988 (0.978, 0.998)*	$P = 0.0225$	1.013 (0.997, 1.029)	$P = 0.11$
Local household		$P = 0.0002$		$P = 0.83$		$P = 0.052$		$P = 0.50$
Yes	ref		ref		ref		ref	
No	1.410 (1.179, 1.685)**		1.027(0.801, 1.318)		1.290 (0.998, 1.668)		1.110 (0.819, 1.503)	
Ethnicity		$P = 0.11$				$P = 0.014$		$P = 0.93$
Han	ref		ref		ref		ref	
Non-Han	0.736 (0.505, 1.071)		0.572 (0.366, 0.894)*		0.977 (0.562, 1.696)		0.977 (0.562, 1.696)	
Duration of living in local city		$P < 0.01$		$P = 0.72$		$P = 0.042$		$P = 0.044$
<3 months	ref		ref		ref		ref	
3–6 months	1.023 (0.598, 1.750)		0.837 (0.415, 1.689)		0.749 (0.317, 1.770)		0.605 (0.242, 1.515)	
6–12 months	1.039 (0.612, 1.763)		0.694 (0.348, 1.383)		0.399 (0.186, 0.856)*		0.368 (0.162, 0.835)*	
1–2 years	1.535 (0.984, 2.395)		0.805 (0.441, 1.470)		0.391 (0.197, 0.778)**		0.360 (0.170, 0.764)**	
>2 years	1.733 (1.206, 2.489)**		0.956 (0.563, 1.624)		0.545 (0.297, 1.002)		0.550 (0.274, 1.105)	
Education		$P < 0.0001$		$P < 0.0001$		$P = 0.0031$		$P = 0.22$
Illiterate	ref		ref		ref		ref	
Primary school	0.241 (0.118, 0.490)***		0.288 (0.126, 0.656)**		0.490 (0.184, 1.307)		0.560 (0.192, 1.628)	
Secondary school	0.661 (0.352, 1.238)		0.510 (0.231, 1.128)		0.527 (0.202, 1.373)		0.836 (0.291, 2.398)	
High/Polytechnic school	1.174 (0.632, 2.181)		0.704 (0.316, 1.569)		0.770 (0.294, 2.017)		1.020 (0.352, 2.958)	
College or above	3.225 (1.754, 5.930)***		1.118 (0.498, 2.513)		0.899 (0.347, 2.329)		0.961 (0.328, 2.814)	
Monthly income (CNY)		$P < 0.0001$		$P = 0.73$		$P = 0.95$		
< 1500	ref		ref		ref		ref	
1500–3000	1.326 (1.028, 1.712)*		1.197 (0.851, 1.686)		1.000 (0.706, 1.414)		1.000 (0.706, 1.414)	
3001–5000	2.114 (1.634, 2.735)***		1.251 (0.875, 1.790)		1.056 (0.738, 1.511)		1.056 (0.738, 1.511)	
5001–8000	2.116 (1.567, 2.856)***		1.244 (0.817, 1.896)		0.905 (0.602, 1.362)		0.905 (0.602, 1.362)	
> 8000	2.251 (1.544, 3.281)***		1.366 (0.819, 2.280)		1.103 (0.638, 1.904)		1.103 (0.638, 1.904)	
Being married		$P < 0.0001$		$P = 0.11$		$P = 0.0003$		$P = 0.55$
Yes	ref		ref		ref		ref	
No	1.536 (1.283, 1.838)***		0.775 (0.567, 1.059)		1.585 (1.232, 2.040)***		1.120 (0.775, 1.618)	
HIV knowledge score	1.351 (1.268, 1.438)***	$P < 0.0001$	1.277 (1.177, 1.384)***	$P < 0.0001$	1.277 (1.203, 1.356)***	$P < 0.0001$	1.262 (1.170, 1.362)***	$P < 0.0001$
NPEP knowledge score	NA		NA		1.114 (1.076, 1.153)***	$P < 0.0001$	1.119 (1.017, 1.231)*	$P = 0.02$
Utilization of HIV prevention services in the past 12 months		$P < 0.0001$		$P = 0.0038$		$P = 0.0004$		$P = 0.13$
Yes	1.691 (1.344, 2.128)***		1.567 (1.156, 2.126)**		1.672 (1.257, 2.224)***		1.314 (0.927, 1.864)	

(continued on next page)

Table 2 (continued)

Variables	Univariable and multivariable logistic regression with the outcome of hearing of nPEP				Univariable and multivariable logistic regression with the outcome of endorsing nPEP promotion			
	CrudeOR (95% CI)	p value	Adjusted OR (95% CI)	p value	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
No Consistent condom use in the last month	ref	$P = 0.013$	ref	$P = 0.21$	ref	$P = 0.11$	ref	
Yes	0.796 (0.664, 0.953)*		0.843 (0.645, 1.102)		0.814 (0.632, 1.047)			
No Ever use of illicit drugs	ref	$P = 0.0007$	ref	$P = 0.0009$	ref	$P = 0.52$		
Yes	1.464 (1.176, 1.822)***		0.192 (0.073, 0.509)***		1.103 (0.820, 1.484)			
No Alcohol use in the past 3 months	ref	$P < 0.0001$	ref	$P = 0.0117$	ref	$P = 0.095$		$P = 0.14$
1 or 2 times	1.286 (1.024, 1.615)*		1.064 (0.797, 1.454)		1.009 (0.721, 1.413)		0.839 (0.568, 1.238)	
1–3 times per months	1.261 (0.990, 1.605)		0.914 (0.659, 1.269)		0.936 (0.659, 1.330)		0.746 (0.495, 1.125)	
1–4 times per week or more	0.682 (0.522, 0.891)**		0.595 (0.416, 0.852)**		0.667 (0.473, 0.941)*		0.625 (0.418, 0.936)*	
HIV testing over life-course		$P < 0.0001$		$P < 0.0001$		$P = 0.0024$	§	$P = 0.01$
Never	ref		ref		ref		ref	
Tested more than 12 months ago	1.998 (1.456, 2.741)***		2.286 (1.533, 3.408)***		0.927 (0.615, 1.396)		0.811 (0.510, 1.289)	
Tested once in the last 12 months	1.328 (1.043, 1.692)*		1.969 (1.411, 2.749)***		1.698 (1.214, 2.374)**		1.360 (0.894, 2.068)	
Tested more than once in the last 12 months	3.091 (2.389, 3.998)***		2.179 (1.530, 3.104)***		1.022 (0.733, 1.424)		0.736 (0.479, 1.131)	
Perceived HIV severity in your population ‡		$P < 0.0001$		$P < 0.0001$		$P < 0.0001$		$P = 0.35$
Not serious	ref		ref		ref		ref	
Serious	3.094 (2.361, 4.054)***		1.839 (1.313, 2.576)***		1.773 (1.219, 2.580)**		1.351 (0.896, 2.038)	
Have no idea	0.897 (0.680, 1.184)		0.644 (0.457, 0.910)*		0.834 (0.590, 1.181)		1.160 (0.789, 1.706)	
Heard of nPEP	NA		NA			$P < 0.0001$		$P = 0.39$
Yes	NA		NA		2.137 (1.621, 2.817)***		0.718 (0.337, 1.533)	
No	NA		NA		ref		ref	

**Note.** nPEP = non-occupational post-exposure prophylaxis, HIV = human immunodeficiency virus, SD = standard deviation, OR = odds ratio, CI = confidence interval.

NA = not applicable, CNY = Chinese Yuan (1 CNY = 0.1398 USD).

p-values: \* <0.05 \*\*<0.01 \*\*\*<0.001.

† Compared to SNP, FSW and PWUD were less likely to hear of nPEP with aOR = 0.263; 95% CI 0.163–0.424 and aOR = 0.103; 95% CI 0.037–0.290 respectively; Compared to MCSW, FSW and PWUD were less likely to hear of nPEP with aOR = 0.202; 95% CI 0.127–0.322 and aOR = 0.079; 95% CI 0.028–0.223, respectively.

‡ Chi-square test found that 266 (30.75%) MSM, 144 (16.65%) FSW, 186 (21.50%) PWUD, 172 (19.88%) MCSW, and 97 (11.21%) NSP endorsed perceived HIV severity among their populations, with Chi sq = 216.76, DF = 8,  $p < 0.0001$ .

§ Compared to SNP, FSW, PWUD, and MCSW were more likely to endorse nPEP promotion with aOR = 2.361; 95% CI 1.378–4.044, aOR = 2.957; 95% CI 1.655–5.281, and aOR = 2.348; 95% CI 1.330–4.146, respectively.

¶ Compared to participants who tested HIV once in the past 12 months, participants who tested HIV more than 12 months ago were less likely to endorse nPEP promotion (aOR = 0.596; 95% CI 0.378–0.941). Compared to participants who tested HIV more than once in the past 12 months, participants who tested HIV once in the past 12 months was more likely to endorse nPEP promotion (aOR = 1.847; 95% CI 1.264–2.699).



participants who had an HIV test in the past 12 months were more likely to endorse nPEP than participants who had an HIV test more than 12 months ago. These findings indicate that people with access to HIV testing and care services may be more likely to know about nPEP and endorse its promotion [15,26].

This study also identified some other factors related to nPEP awareness or promotion respectively. Participants who had never heard of nPEP were more likely to be older, have primary school as the highest education, receive no conventional HIV prevention services, use no illicit drugs, but use alcohol most frequently, and perceive no HIV severity or have no idea about HIV severity in their populations. Our study supports the argument that younger individuals were more likely to know about new strategies for HIV prevention (e.g., nPEP) [25,16], which may be because the young people are easier to get to know new things [26]. This is different from some other studies reporting older age associated with nPEP awareness [19,21]. Individuals who did not receive conventional HIV services were less likely to be aware of nPEP, which is consistent with previous studies [27,28]. When participants cared less about HIV severity in their populations, they would pay less attention to HIV prevention measures. These findings suggest a need to increase the coverage of current HIV prevention and intervention campaigns and to introduce and promote various risk-reduction strategies. Participants who used illicit drugs were more likely to hear of nPEP, while participants who used alcohol most frequently were less likely to hear of it. Similarly, mixed findings regarding the associations between substance use and nPEP awareness have been reported in other studies [16,21,29,30]. These indicate that individuals who used illicit drugs may be different from individuals who used alcohol in some ways [31]. In China, PWUD who are recognized by CDC as a key population at higher risk of HIV acquisition may be more likely to be covered by the current HIV prevention and intervention campaigns and therefore more likely to get to know various HIV prevention measures than alcohol users. Although these factors can help identify individuals with less likeliness of nPEP awareness, they cannot be used to identify individuals with less likeliness of endorsing nPEP promotion right after nPEP being introduced. Instead, living in local cities for 6 months to 2 years and having lower nPEP knowledge scores should be taken into account, so as to better target specific individuals for improving their likeliness of endorsing nPEP promotion.

The study has important public health implications. First, nPEP-related campaigns need to be tailored to individuals with specific characteristics, particularly FSW, PWUD, SNP, and people with less HIV and nPEP knowledge or never being tested for HIV. A package of HIV prevention information and options, including HIV and nPEP counseling, HIV testing, linkage to nPEP, and transition from nPEP to PrEP, should be provided to these key populations through upgrading the current conventional HIV services. Studies have reported that nPEP promotional campaigns increased nPEP awareness and could significantly increase the intention to use nPEP [16,32]. Second, specific characteristics related to nPEP awareness and promotion endorsement among different populations should be examined respectively in future studies. Third, additional qualitative studies are needed to develop an in-depth understanding of developing associations with nPEP awareness and promotion, including education levels, duration of living in a local city, and HIV testing behaviours.

Our study has limitations. First, our use of convenience sampling may exclude important demographics who did not access care within the selected study populations, limiting the generalizability of the findings. But the findings can help plan and implement nPEP services and related promotion campaigns in China. The recruitment of five key populations and using a large sample size of 2022 participants might help mitigate potential bias in some

sense. Future studies designed for specific populations can help address this issue. Second, social desirability bias may be a concern, since HIV is still a sensitive issue in China.

In summary, this study not only adds to the literature by examining nPEP awareness among key populations but also contributes to public health practices of nPEP promotion. Participants from the five key populations generally had low nPEP awareness, particularly FSW and PWUD. After the introduction of nPEP, most populations had high percentages of endorsing nPEP promotion, except SNP. nPEP education and promotional campaigns should be tailored to specific vulnerable groups and individuals with specific characteristics, particularly sexually active young individuals, people with poor HIV and nPEP knowledge, and people who have never been tested for HIV. Population-specific studies and qualitative methods are recommended for future research.

## Contributors

HL and WM contributed to the conception and design of the study. HL and EP drafted the report. WM provided oversight for data collection. HL and KJ assisted in data collection and management. EP, HL, and KJ searched the literature. HL, EPFC, and TL analyzed the data. HL and KJ made the figure and tables. EPFC, TL, and WM provided substantial comments. HL, EP, EPFC, and TL provided careful edit on the drafts. All authors participated in critically appraising the content and approving the final version.

## Declaration of Competing Interests

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## Data sharing statement

The study protocol and deidentified participant data can be accessed on demand to the corresponding author after signing a data signature agreement and upon submission of a protocol summary.

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.lanwpc.2020.100086](https://doi.org/10.1016/j.lanwpc.2020.100086).

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