Preplanned Studies

# Increasing Uptake of Pre-Exposure Prophylaxis and Associated Behavioral Changes Among Men Who Have Sex with Men — Qingdao City, Shandong Province, China, 2024–2025

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**Summary**

**What is already known on this topic?**

Pre-exposure prophylaxis (PrEP) effectively prevents human immunodeficiency virus (HIV) infection among men who have sex with men (MSM); however, its uptake in China remains low.

**What is added by this report?**

In a prospective cohort of MSM in Qingdao, recent PrEP use doubled from 4.6% in June 2024 to 10.4% in June 2025, which was accompanied by decreased condomless anal intercourse and increased HIV testing. MSM who seek sexual partners online are less likely to use PrEP.

**What are the implications for public health practice?**

Public health strategies should prioritize targeted digital interventions for MSM who primarily seek sexual partners online, reinforce health education on the benefits of PrEP, and institutionalize PrEP referral pathways to accelerate PrEP scale-up.

## ABSTRACT

**Introduction:** Pre-exposure prophylaxis (PrEP) coverage among men who have sex with men (MSM) in China is suboptimal, and longitudinal data on uptake dynamics are scarce. This study describes temporal trends in PrEP use and identifies correlates of recent uptake among MSM in Qingdao, China.

**Methods:** Prospective cohort study conducted on MSM in Qingdao. Participants were enrolled between January 2024 and June 2024, with follow-up surveys conducted every six months until June 2025. The primary outcome was PrEP use in the past six months. Cochran–Armitage tests and generalized estimating equations were used for analysis.

**Results:** Among 580 MSM enrolled at baseline, 518 (89.3%) completed all follow-up visits. In this sample, recent PrEP use doubled from 4.6% in June 2024 to 10.4% in June 2025, which was accompanied by decrease in condomless anal intercourse and an increase in human immunodeficiency virus testing. The multivariate analysis revealed that MSM who primarily sought sexual partners online were less likely to use PrEP [adjusted odds ratio (*aOR*)=0.32, 95% confidence interval (*CI*): 0.15, 0.67], whereas perceived PrEP effectiveness (*aOR*=7.43, 95% *CI*: 3.29, 16.81) and prior post-exposure prophylaxis (PEP) use (*aOR*=2.20, 95% *CI*: 1.28, 3.71) were strong predictors of uptake.

**Conclusion:** PrEP uptake is increasing among MSM in Qingdao, complemented by positive shifts in sexual health behaviors. Public health strategies must prioritize innovative digital interventions to reach MSM who are active online, reinforce the benefits of PrEP, and institutionalize the PEP-to-PrEP pathways.

Pre-exposure prophylaxis (PrEP) is the use of antiretroviral medication against the human immunodeficiency virus (HIV), and it has been proven to be highly effective in diverse populations. As a critical component of combination HIV prevention, PrEP is instrumental in achieving the Joint United Nations Program on HIV/AIDS (UNAIDS)'s "95-95-95" targets to end the HIV epidemic. However, PrEP coverage among men who have sex with men (MSM) remains suboptimal in China, despite increasing policy attention and pilot implementation (*1*). Previous studies have relied mainly on cross-sectional designs and "ever used" metrics that obscure temporal patterns of engagement. To address this gap, we used longitudinal data to characterize the dynamic changes in PrEP use and identify its correlates among MSM in Qingdao, Shandong Province, China.

We conducted a prospective cohort study among MSM in Qingdao to analyze the temporal trends in PrEP use and identify the key factors influencing

recent uptake. Participants were recruited using snowball sampling through community-based organizations (CBOs) between January and June 2024. Eligible participants were HIV-negative, aged ≥18 years, and reported having sex with a man in the past six months. Following a baseline survey, participants were followed up every six months, and the final visit was completed in June 2025. Data on sociodemographics, risk behaviors, and healthcare utilization were collected via face-to-face interviews using structured questionnaires. Data entry was performed using the EpiData software (version 3.1, EpiData Assoc., Odense, Denmark). The primary outcome of interest was "recent PrEP use", which is defined as self-reported use in the six months preceding the survey. In addition, "ever used" was defined as any use of PrEP at any point up to the survey date. Reporting was consistent with the STROBE checklist. This study was approved by the Ethics Committee of the National Center for AIDS/STD Control and Prevention and the Chinese Center for Disease Control and Prevention (Approval No. X151113388, dated June 18, 2024), and conformed to the ethical principles of the Declaration of Helsinki (2024). Written informed consent was obtained from all participants before enrollment.

Temporal trends in PrEP use and related behaviors were analyzed using the Cochran-Armitage test, and correlates of recent PrEP use were identified using generalized estimating equations (GEE). The model included a study visit to explicitly model the time trend. Other covariates selected based on univariate analyses ($P \leq 0.2$) were also included to identify independent predictors of recent PrEP use. A sensitivity analysis was performed to assess the potential impact of attrition bias, which included all baseline participants and all available follow-up data. All analyses were performed in SAS (version 9.4, SAS Institute Inc., Cary, NC, USA), and a $P$-value of ≤0.05 (two-tailed) was considered statistically significant.

A total of 580 MSM were enrolled at baseline, of which 518 (89.3%) completed all follow-up visits and were included in the primary analysis. Participants were predominantly aged ≥30 years (71.0%), highly educated (79.0% college graduates or above), and sexually active, with 87.1% reporting three or more casual partners in the past six months at baseline. More than two-thirds (66.7%) perceived PrEP to be effective, and 20.9% had previously used PEP (Table 1).

The percentage of the study group reported to have ever used PrEP increased from 8.7% at baseline to 19.3% by June 2025, whereas the group who reported recent PrEP use doubled from 4.6% to 10.4%. In the same period, the prevalence of condomless anal intercourse (CAI) decreased (from 97.1% to 90.0%), while the proportion reporting frequent HIV testing (≥ 3 times in the past six months) increased significantly (from 85.7% to 93.1%) (Table 2).

The multivariate GEE model revealed that after accounting for covariates, recent PrEP use was significantly higher at the 12-month follow-up compared to baseline [adjusted odds ratio (*aOR*)=1.76, 95% confidence interval (*CI*): 1.15, 2.69], while no significant change was observed at six months. Several factors were independently associated with PrEP uptake. Participants who perceived PrEP to be effective (*aOR*=7.43, 95% *CI*: 3.29, 16.81) and those with a history of PEP use (*aOR*=2.20, 95% *CI*: 1.28, 3.71) were significantly more likely to report recent PrEP use. In contrast, MSM who primarily sought sexual partners online had significantly lower odds of using PrEP recently compared to those who sought partners offline (*aOR*=0.32, 95% *CI*: 0.15, 0.67) (Table 3).

A sensitivity analysis that included all 580 baseline participants yielded findings consistent with the primary analysis. The temporal trends in PrEP uptake (e.g., recent PrEP use increased from 4.5% to 10.4%), CAI, and HIV testing remained significant. Similarly, the multivariate GEE model identified the same four factors — study visit, perceived PrEP effectiveness, prior PEP use, and seeking sexual partners online — as significant correlates of recent PrEP use with comparable effect sizes.

## DISCUSSION

This report on a prospective cohort in Qingdao provides crucial longitudinal evidence of the evolving landscape of PrEP use among Chinese MSM. The modest but steady increase in PrEP engagement was a positive signal, suggesting that ongoing promotional efforts have been successful. The proportion of the study group reporting an "ever used" rate of 19.3% is comparable to that of a recent multi-city online survey in China (17.9%) and higher than the rates reported in Shandong Province (9.2%) and Beijing (12.9%) (*2*–*4*). Nevertheless, these rates remain well below those seen in high-income countries, where uptake can exceed 40%, and are still below rates in some Latin American settings, such as Brazil (19.5%), indicating substantial room for programmatic expansion (*5*–*6*).

TABLE 1. Baseline characteristics of MSM participating in the PrEP in Qingdao (January–June 2024).

| Variables | Participants | Follow-up | Lost to Follow-up | $\chi^2$ | *P* |
|---|---|---|---|---|---|
| | *N*=580 | $N_1$=518 (89.3%) | $N_2$=62 (10.7%) | | |
| Age, years | | | | | |
| 18–29 | 168 (29.0) | 155 (29.9) | 13 (21.0) | | |
| ≥30 | 412 (71.0) | 363 (70.1) | 49 (79.0) | 2.15 | 0.142 |
| Marital status | | | | | |
| Single | 449 (77.4) | 396 (76.5) | 53 (85.5) | | |
| Married | 131 (22.6) | 122 (23.5) | 9 (14.5) | 2.59 | 0.108 |
| Education level | | | | | |
| High school graduates or below | 122 (21.0) | 115 (22.2) | 7 (11.3) | | |
| College graduates or above | 458 (79.0) | 403 (77.8) | 55 (88.7) | 3.97 | **0.046** |
| Monthly income, CNY | | | | | |
| <5,000 | 263 (45.3) | 244 (47.1) | 19 (30.7) | | |
| ≥5,000 | 317 (54.7) | 274 (52.9) | 43 (69.3) | 6.05 | **0.014** |
| Avenues for seeking sexual partners | | | | | |
| Offline | 23 (4.0) | 23 (4.4) | 0 (0) | | |
| Online | 557 (96.0) | 495 (95.6) | 62 (100) | 2.97 | 0.090 |
| HIV infection risk perception | | | | | |
| Low/Moderate | 565 (97.4) | 506 (97.7) | 59(95.2) | | |
| High | 15 (2.6) | 12 (2.3) | 3 (4.8) | 1.40 | 0.237 |
| Sexual partners' HIV serostatus | | | | | |
| Negative | 426 (73.4) | 382 (73.7) | 44 (71.0) | | |
| Unknown/Positive | 154 (26.6) | 136 (26.3) | 18 (29.0) | 0.219 | 0.640 |
| Recreational drug usage in the past six months | | | | | |
| No | 148 (25.5) | 126 (24.3) | 9 (14.5) | | |
| Yes | 445 (76.7) | 392 (75.7) | 53 (85.5) | 2.98 | 0.084 |
| CAI in the past six months | | | | | |
| No | 18 (3.1) | 15 (2.9) | 3 (4.8) | | |
| Yes | 562 (96.9) | 503 (97.1) | 59 (95.2) | 0.70 | 0.404 |
| Number of casual sexual partners in the past six months | | | | | |
| <3 | 75 (12.9) | 64 (12.4) | 11 (17.7) | | |
| ≥3 | 505 (87.1) | 454 (87.6) | 51 (82.3) | 1.43 | 0.232 |
| Commercial sex in the past six months | | | | | |
| No | 466 (80.3) | 409 (79.0) | 57 (91.9) | | |
| Yes | 114 (19.7) | 109 (21.0) | 5 (8.1) | 5.90 | **0.016** |
| Group sex in the past six months | | | | | |
| No | 113 (19.5) | 103 (19.9) | 10 (16.1) | | |
| Yes | 467 (80.5) | 415 (80.1) | 52 (83.9) | 0.497 | 0.480 |
| STIs in the past six months | | | | | |
| No | 565 (97.4) | 506 (97.7) | 59 (95.2) | | |
| Yes | 15 (2.6) | 12 (2.3) | 3 (4.8) | 1.40 | 0.237 |
| Perceived PrEP effectiveness | | | | | |
| Not good | 193 (33.3) | 175 (33.8) | 18 (29.0) | | |
| Good | 387 (66.7) | 343 (66.2) | 44 (71.0) | 0.56 | 0.453 |

Continued

| Variables | Participants | Follow-up | Lost to Follow-up | $\chi^2$ | P |
|---|---|---|---|---|---|
| | N=580 | $N_1$=518 (89.3%) | $N_2$=62 (10.7%) | | |
| Number of HIV testing in the past six months | | | | | |
| <3 | 83 (14.3) | 74 (14.3) | 9 (14.5) | | |
| ≥3 | 497 (85.7) | 444 (85.7) | 53 (85.5) | 0.01 | 0.961 |
| Ever used PEP | | | | | |
| No | 459 (79.1) | 411 (79.3) | 48 (77.4) | | |
| Yes | 121 (20.9) | 107 (20.7) | 14 (22.6) | 0.12 | 0.724 |

Note: $P \leq 0.05$ were considered statistically significant and are shown in bold.
Abbreviation: PrEP=pre-exposure prophylaxis; PEP=post-exposure prophylaxis; CAI=condomless anal intercourse; STIs=sexually transmitted infections; CNY=Chinese Yuan.

TABLE 2. Temporal trends of PrEP use and related behaviors among MSM in Qingdao (2024–2025).

| Variables | Baseline (2024/06) | 6-month follow-up (2024/12) | 12-month follow-up (2025/06) | $Z_{trend}$ | P |
|---|---|---|---|---|---|
| Ever used PrEP | 45 (8.7) | 60 (11.6) | 100 (19.3) | 5.05 | **<0.001** |
| Recent PrEP use | 24 (4.6) | 30 (5.8) | 54 (10.4) | 3.67 | **<0.001** |
| Recent PEP use | 16 (3.1) | 12 (2.3) | 15 (2.9) | −0.19 | 0.850 |
| Sexual partners who are HIV-positive or of unknown status in the past six months | 136 (26.3) | 96 (18.5) | 134 (25.8) | −0.15 | 0.884 |
| Recreational drug use in the past six months | 392 (75.7) | 398 (76.8) | 386 (74.5) | −0.43 | 0.664 |
| CAI in the past six months | 503 (97.1) | 507 (97.9) | 466 (90.0) | −5.26 | **<0.001** |
| Number of casual partners ≥3 in the past six months | 454 (87.6) | 461 (89.0) | 452 (87.3) | −0.19 | 0.848 |
| Engagement in commercial sex in the past six months | 109 (21.0) | 105 (20.3) | 99 (19.1) | −0.77 | 0.438 |
| Participation in group sex in the past six months | 415 (80.1) | 426 (82.2) | 410 (79.1) | −0.39 | 0.695 |
| Diagnosis of STIs in the past six months | 12 (2.3) | 16 (3.1) | 7 (1.3) | −1.05 | 0.295 |
| Frequent HIV testing (≥3) in the past six months | 444 (85.7) | 479 (92.5) | 482 (93.1) | 4.01 | **<0.001** |

Note: $P \leq 0.05$ were considered statistically significant and are shown in bold.
Abbreviation: PrEP=pre-exposure prophylaxis; PEP=post-exposure prophylaxis; CAI=condomless anal intercourse; STIs=sexually transmitted infections.

Notably, the simultaneous reduction in CAI and increase in HIV testing contradict concerns about "risk compensation" (*7*). Instead, the observed pattern suggests that PrEP engagement may encourage greater overall health-seeking behaviors. MSM who initiate PrEP are more likely to be health-conscious, motivated to test regularly, and engaged in community prevention services. Although PrEP users exhibit more positive health behaviors, it is still necessary to integrate these in interventions targeting the MSM populations. For instance, PrEP use should be combined with safer sexual practices (e.g., correct condom use) to form a dual protection model. Interventions, such as this "PrEP + safer sex" model, will further improve the effectiveness of HIV prevention and control and reduce the risk of other sexually transmitted infections (STIs).

The strong association between perceived PrEP effectiveness and uptake highlights the importance of accurate, persuasive health communication, aligning with core tenets of behavioral theories, such as Protection Motivation Theory, where the perceived efficacy of a preventive action is a primary driver of behavior change (*8*). Equally important is the "PEP-to-PrEP" transition. Individuals who have previously used PEP often have a repeated risk of HIV exposure. Their experience with antiretroviral medications provides them with familiarity in adherence routines and healthcare engagement, making them ideal candidates for PrEP initiation (*9*). Therefore, multichannel health education should be conducted to clearly convey the high effectiveness of PrEP and correct cognitive biases. In particular, in PEP outpatient services, PrEP publicity and education should be provided simultaneously to individuals seeking consultation. Combined with an assessment of exposure risk, PrEP should be proactively recommended to build a seamless "PEP-to-PrEP" intervention pathway.

TABLE 3. Factors associated with recent PrEP use identified by GEE among MSM in Qingdao (2024–2025).

| Variables | Recent PrEP use | | *OR* (95% *CI*) | *P* | *aOR* (95% *CI*) | *P* |
|---|---|---|---|---|---|---|
| | No ($N_1$=1,446) | Yes ($N_2$=108) | | | | |
| Age, years | | | | | | |
| 18–29 | 388 (93.0) | 29 (7.0) | 1.00 | | | |
| ≥30 | 1,058 (93.1) | 79 (6.9) | 0.98 (0.60, 1.59) | 0.935 | | |
| Marital status | | | | | | |
| Single | 1,107 (92.4) | 91 (7.6) | 1.00 | | 1.00 | |
| Married | 339 (95.2) | 17 (4.8) | 0.59 (0.32, 1.11) | 0.103 | 0.67 (0.36, 1.27) | 0.218 |
| Education level | | | | | | |
| High school graduate or below | 324 (93.9) | 21 (6.1) | 1.00 | | | |
| College graduate or above | 1,122 (92.8) | 87 (7.2) | 1.19 (0.66, 2.15) | 0.562 | | |
| Monthly income, CNY | | | | | | |
| <5,000 | 689 (93.7) | 46 (6.3) | 1.00 | | | |
| ≥5,000 | 757 (92.4) | 62 (7.6) | 1.16 (0.71, 1.91) | 0.553 | | |
| Avenues for seeking sexual partners | | | | | | |
| Offline | 63 (85.1) | 11 (14.9) | 1.00 | | 1.00 | |
| Online | 1,383 (93.4) | 97 (6.6) | 0.33 (0.18, 0.63) | **<0.001** | 0.32 (0.15, 0.67) | **0.002** |
| HIV infection risk perception | | | | | | |
| Low/moderate | 1,420 (93.3) | 102 (6.7) | 1.00 | | 1.00 | |
| High | 26 (81.2) | 6 (18.8) | 3.40 (1.06, 10.86) | **0.038** | 2.99 (0.96, 9.33) | 0.059 |
| Sexual partners' HIV serostatus | | | | | | |
| Negative | 1,109 (93.3) | 79 (6.7) | 1.00 | | | |
| Unknown/positive | 337 (92.1) | 29 (7.9) | 1.30 (0.78, 2.16) | 0.318 | | |
| Recreational drug usage in the past six months | | | | | | |
| No | 352 (93.1) | 26 (6.9) | 1.00 | | | |
| Yes | 1,094 (93.0) | 82 (7.0) | 0.93 (0.55, 1.58) | 0.791 | | |
| CAI in the past six months | | | | | | |
| No | 75 (96.1) | 3 (3.9) | 1.00 | | | |
| Yes | 1,371 (92.9) | 105 (7.1) | 1.65 (0.54, 5.02) | 0.381 | | |
| Number of casual sexual partners in the past six months | | | | | | |
| <3 | 177 (94.6) | 10 (5.4) | 1.00 | | | |
| ≥3 | 1,269 (92.8) | 98 (7.2) | 1.16 (0.62, 2.16) | 0.646 | | |
| Commercial sex in the past six months | | | | | | |
| No | 1,154 (93.0) | 87 (7.0) | 1.00 | | | |
| Yes | 292 (93.3) | 21 (6.7) | 0.96 (0.51, 1.81) | 0.908 | | |
| Group sex in the past six months | | | | | | |
| No | 286 (94.4) | 17 (5.6) | 1.00 | | | |
| Yes | 1,160 (92.7) | 91 (7.3) | 1.09 (0.65, 1.81) | 0.745 | | |
| STIs in the past six months | | | | | | |
| No | 1,413 (93.0) | 106 (7.0) | 1.00 | | | |
| Yes | 33 (94.3) | 3 (5.7) | 0.87 (0.23, 3.29) | 0.840 | | |
| Perceived PrEP effectiveness | | | | | | |
| Not good | 472 (98.7) | 6 (1.3) | 1.00 | | 1.00 | |
| Good | 974 (90.5) | 102 (9.5) | 7.34 (3.12, 17.25) | **<0.001** | 7.43 (3.29, 16.81) | **<0.001** |

Continued

| Variables | Recent PrEP use | | *OR* (95% *CI*) | *P* | *aOR* (95% *CI*) | *P* |
|---|---|---|---|---|---|---|
| | No ($N_1$=1,446) | Yes ($N_2$=108) | | | | |
| Number of HIV testing in the past six months | | | | | | |
| <3 | 145 (97.3) | 4 (2.7) | 1.00 | | 1.00 | |
| ≥3 | 1,301 (92.6) | 104 (7.4) | 3.13 (0.77, 12.68) | 0.109 | 2.86 (0.77, 10.62) | 0.117 |
| Ever used PEP | | | | | | |
| No | 1,172 (94.4) | 69 (5.6) | 1.00 | | 1.00 | |
| Yes | 274 (87.5) | 39 (12.5) | 2.28 (1.33, 3.91) | **0.003** | 2.20 (1.28, 3.80) | **0.005** |
| Study visit | | | | | | |
| Baseline (2024/06) | 494 (95.4) | 24 (4.6) | 1.00 | | | |
| 6-month follow-up (2024/12) | 488 (94.2) | 30 (5.8) | 0.79 (0.55, 1.13) | 0.201 | 0.79 (0.54, 1.17) | **0.235** |
| 12-month follow-up (2025/06) | 464 (89.6) | 54 (10.4) | 1.89 (1.25, 2.86) | **0.003** | 1.76 (1.15, 2.69) | **0.009** |

Note: The study design consisted of a baseline visit followed by visits at 6-month intervals. "6-month follow-up" refers to data collected in December 2024, and "12-month follow-up" refers to data collected in June 2025. The columns "Recent PrEP Use: No and Yes" represent the pooled number of observations (person-visits) across three study visits, consistent with the GEE analysis structure. The percentages represent the proportion of observations within each category (row percentages). Variables included in the multivariate model were: marital status, venues for seeking sexual partners, HIV infection risk perception, perceived PrEP effectiveness, number of HIV testing in the past six months, ever PEP use, and study visit, whose *P*-values were ≤0.2 in the univariate analyses. *P*-values ≤0.05 were considered statistically significant and are shown in bold.

Abbreviation: GEE=generalized estimating equation; PrEP=pre-exposure prophylaxis; PEP=post-exposure prophylaxis; CAI=condomless anal intercourse; STIs=sexually transmitted infections; *OR*=odds ratio; a*OR*=adjusted odds ratio; *CI*=confidence interval; CNY=Chinese Yuan.

The most urgent finding for public health practice is the "online paradox". Digital platforms that facilitate sexual networking for the majority of MSM appear to fail as conduits for biomedical prevention. In China, online platforms have become the dominant venue for partner-seeking, representing both opportunities and challenges for HIV prevention. Digital spaces are vast but fragmented and often lack structured health promotion. While offline venues, such as bars and community events, facilitate peer outreach and CBOs-led interventions, online users may remain disconnected from prevention services (*10*). To bridge this gap, it is necessary to fully leverage the communication advantages of digital channels. Based on existing HIV testing service functions, additional popular PrEP science columns, user guides, and consultation portals should be set up to develop online platforms as important carriers for PrEP publicity and service connections.

This study had four main limitations. First, the use of snowball sampling may limit the generalizability of our findings to the broader MSM population in Qingdao. Second, the primary outcome, any PrEP use in the past six months, is a broad measure of engagement and does not quantify adherence, which is the ultimate determinant of efficacy. Therefore, the 10.4% recent use rate should be interpreted as a measure of engagement rather than as full protective coverage. Additionally, measures such as perceived PrEP effectiveness were limited to binary scales, precluding a detailed understanding of the specific reasons driving these perceptions, which warrants further qualitative investigation. Finally, although we used a prospective study design, the analysis of associations remained cross-sectional, precluding a definitive causal inference.

Sustained efforts are required to integrate PrEP into combination prevention strategies to achieve the national goal of ending the HIV epidemic. Based on these findings, public health strategies in China should prioritize strengthening health education, institutionalizing the PEP-to-PrEP bridge, and developing targeted digital interventions to close the gap between online social networking and access to biomedical prevention.

**Conflicts of interest**: No conflicts of interest.

**Ethical statements**: Approved by the Ethics Committee of the National Center for AIDS/STD Control and Prevention and the Chinese Center for Disease Control and Prevention (Approval No. X151113388, dated June 18, 2024), and conformed to the ethical principles of the Declaration of Helsinki (2024). Written informed consent was obtained from all participants before enrollment in the study.

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