



Trends in Attitudes to and the Use of HIV Pre-exposure Prophylaxis by Australian Gay and Bisexual Men, 2011–2017: Implications for Further Implementation from a Diffusion of Innovations Perspective

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Abstract

Using repeated, national, online, cross-sectional surveys of Australian gay and bisexual men (GBM), we analysed trends related to HIV pre-exposure prophylaxis (PrEP). Specifically, we analysed trends in PrEP use, willingness to use PrEP, and concern about using PrEP during 2011–2017. We assessed support for GBM using PrEP and willingness to have sex with men taking PrEP between 2015 and 2017. For time-based analyses, we used multivariate logistic regression, controlling for sampling variations over time. We constructed new scales assessing reduced concern about HIV among PrEP users and non-users in 2017, and used multivariate logistic regression to identify independent correlates of PrEP use (vs. non-use). The analyses included 4567 HIV-negative and untested participants (2011–2017). PrEP use increased from 0.5% in 2011 to 25.5% in 2017 ($p < 0.001$). Willingness to use PrEP increased from 27.9% in 2011 to 36.5% in 2017 ($p < 0.001$) while concern about using PrEP fell (52.1–36.1%, $p < 0.001$). Support for GBM using PrEP remained stable (52.5% in 2015, 51.9% in 2017, $p = 0.62$), and willingness to have sex with men taking PrEP increased from 34.9% in 2015 to 49.0% in 2017 ($p < 0.001$). In 2017, 22.8% of non-PrEP-users had reduced HIV concern because of PrEP, while 73.6% of PrEP users had reduced HIV concern and greater sexual pleasure because of PrEP. The analysis of PrEP users vs. non-users in 2017 indicated that PrEP users were more sexually active and reported higher risk sexual practices, were more likely to live in New South Wales and Victoria, and to be in full-time employment. They were also more likely to know HIV-positive people and other PrEP users. Diffusion of Innovations theory suggests that future PrEP users in Australia may be less adventurous and require greater reassurance about PrEP's efficacy and legitimacy, to sustain rollout and address current disparities in uptake.

Keywords HIV prevention · Pre-exposure prophylaxis · Attitudes · Behaviour · Acceptability research · Australia

RESUMEN

Utilizando encuestas repetidas, nacionales, en línea y transversales de hombres gay y bisexuales australianos, analizamos las tendencias relacionadas con la profilaxis de pre exposición al VIH (PrEP). Específicamente, analizamos las tendencias en el uso de PrEP, la disposición para usar PrEP y la preocupación sobre el uso de PrEP durante 2011–2017. Evaluamos el apoyo para hombres gay y bisexuales que usan PrEP y la disposición de tener relaciones sexuales con hombres que usan PrEP entre 2015 y 2017. Para los análisis basados en el tiempo, utilizamos la regresión logística multi-variable, controlando las variaciones de muestreo a lo largo del tiempo. Construimos nuevas escalas evaluando la preocupación reducida sobre el VIH entre los usuarios y no usuarios de PrEP en 2017, y utilizamos la regresión logística multi-variable para identificar los correlatos independientes del uso de PrEP (versus el no uso). Los análisis incluyeron 4567 participantes VIH-negativos y no probados (2011–2017). El uso de PrEP aumentó del 0.5% en 2011 al 25.5% en 2017 ($p < 0.001$). La disposición para usar PrEP aumentó del 27.9% en 2011 al 36.5% en 2017 ($p < 0.001$), mientras que la preocupación de usar PrEP disminuyó (52.1–36.1%, $p < 0.001$). Apoyo para los hombres gay o bisexuales usando PrEP se mantuvo estable (52.5% en 2015, 51.9% en 2017, $p = 0.62$), y la disposición de tener relaciones sexuales con hombres usando PrEP aumentó del 34.9% en 2015

49.0% en 2017 ($p < 0.001$). En 2017, el 22.8% de participantes que no usan PrEP redujeron su preocupación del VIH debido a PrEP, mientras que el 73.6% de los participantes que toman PrEP redujeron su preocupación del VIH y reportaron mayor placer sexual debido a PrEP. El análisis de participantes que usan PrEP versus los que no lo usan en 2017 indicó que los usuarios de PrEP eran más activos sexualmente y reportaron prácticas sexuales de mayor riesgo, era más probable que vivían en los estados de Nueva Gales del Sur y Victoria, y que tenían empleo de tiempo completo. También era más probable que conocían a personas VIH positivas y otros usuarios de PrEP. La teoría de la difusión de innovaciones sugiere que los futuros usuarios de PrEP en Australia podrán ser menos aventureros y requerirán más seguridad sobre la eficacia y legitimidad de PrEP, para sostener su implementación y abordar las disparidades actuales en su consumo.

Introduction

HIV pre-exposure prophylaxis (PrEP) is the regular use of antiretroviral drugs to prevent HIV acquisition (using daily or event-driven dosing) [1]. Emtricitabine and tenofovir are the only currently approved drugs for PrEP, with other antiretroviral drugs under study to evaluate their efficacy in preventing HIV infection. The World Health Organization has recommended that PrEP be made available to people at “substantial risk of HIV infection” as part of a combination prevention approach [2, 3]. In Australia, gay and bisexual men (GBM) are the primary HIV-affected population, and PrEP has been made available to them through publicly funded demonstration projects and by the personal importation of generic drugs (often supported by community-based buyers’ clubs) [4–6]. The availability of demonstration projects in particular has resulted in PrEP use increasing from 1–2% of GBM in 2013 to 14–16% in 2017 in the eastern states [7–9].

In February 2018, the Pharmaceutical Benefits Advisory Committee recommended that the Australian Government should subsidise PrEP and allow any doctor to prescribe it to people at medium or high risk of HIV. The Government subsequently announced that PrEP would be made available through the Pharmaceutical Benefits Scheme from April 2018. It is therefore anticipated that PrEP use will increase further, and shift from the ‘early adoption’ phase in which PrEP use by GBM is relatively unusual to one in which it becomes common practice (the ‘early majority’ phase in Diffusion of Innovations theory) [10]. Diffusion of Innovations (DOI) theory seeks to understand how new ideas, practices and technologies spread through social systems and become accepted or normative [10]. Although it is more commonly used to think about how commercial innovations are promoted and gain market share, DOI has been proposed as a way to understand how HIV prevention methods are adopted [11], and has been used to design large peer-based projects to promote condom use, for example [12]. Referring to DOI theory, together with survey data we have collected from GBM about PrEP, we consider the extent of interest in and

use of PrEP by GBM, the characteristics of early PrEP users, and what this means for further implementation.

Since the first major trial results demonstrated the efficacy of PrEP at protecting GBM and transgender women from HIV [13], and that most users can successfully adhere to the drug regime when they know they are receiving PrEP [14, 15], there has been a proliferation of international research assessing the acceptability of PrEP and factors that may affect its adoption and use [16, 17]. This research has tended to find that younger GBM and those at higher risk of HIV (due to condomless sex, or sex-related drug use, for example) are more interested in using PrEP, and factors such as the potentially high cost of PrEP or concerns about side effects reduce interest in using it. In Australia, we have assessed GBM’s willingness to use PrEP since 2011 [4, 18, 19]. This research found relatively stable levels of interest in using PrEP among HIV-negative and untested men (between 28% in 2011 and 32% in 2015). Interest was concentrated among younger, more sexually active men who were at potentially higher risk of HIV, such as those who had condomless sex with casual partners, men in serodiscordant relationships and those who had previously taken post-exposure prophylaxis (PEP) [4]. Men with fewer concerns about taking medication and side effects were also more willing to use PrEP. Our research found that the proportion of GBM who would use condoms less often if they took PrEP gradually increased, from 8% in 2011 to 16% in 2015 [4]. In 2015, over half of GBM (55%) were supportive of other GBM taking PrEP, and 39% were willing to have sex with someone taking it [4]. Collectively, this research, conducted in a period in which PrEP was not easily available in Australia, suggested to us that there was a minority of GBM who were interested in and would benefit from PrEP, that the chances of decreased condom use (risk compensation) were relatively low, and that there were supportive community attitudes among GBM about PrEP. We were therefore interested to see who came forward to use PrEP as it become more readily available, and whether the profile of the early cohort of PrEP users matched those who were interested in it. We were also mindful that that

the characteristics and needs of PrEP users might shift as implementation proceeded and PrEP use became more common, as suggested in DOI theory [10].

The DOI approach has been used to assess what drives the uptake of new ideas, practices, products, services and technologies within social systems or societies, focusing on the attributes of innovations, the characteristics of actual and potential users, the interpersonal and mass media communication that drives adoption, and the context in which innovations are introduced [10, 20]. Here we would like to focus on the characteristics of PrEP users and potential users during the early stages of implementation. DOI research suggests that the characteristics of the first users of a new technology may differ from subsequent users. ‘Innovators’ and ‘early adopters’ of a new technology, representing up to 16% of the population, have been repeatedly shown to be more adventurous, open to change, risk-taking, socially gregarious, and attracted to new ideas and practices [10]. These two groups can be influential and act as role models for subsequent users. Early adopters are followed by the ‘early majority’ (17–50% of the target population), who are less adventurous and risk-taking, and deliberate for longer before adopting an innovation. The early majority is not overly sceptical or cautious (compared with later adopters), but they may appreciate evidence that an innovation is acceptable and effective, and that its use is becoming normative, before they use it themselves. The DOI approach suggests that openness to innovation and change (characteristic of earlier adopters) is not associated with demographic factors such as age, but it is associated with a higher degree of education and wealth or economic security [10]. In the case of PrEP, it may be useful to assess the characteristics of users and non-users at different points during implementation, in order to identify the changing education and engagement needs of potential users, including disparities in access.

We conducted our latest survey as PrEP use by Australian GBM was in transition between the early adopter and early majority phases, driven by public demonstration projects. As PrEP use continues to expand, we reviewed trends in attitudes to PrEP, levels of use, and the characteristics of early PrEP users compared with their non-using peers. Our aim was to consider how implementation and promotion strategies may need to evolve as the cohort of Australian PrEP users grows and incorporates a broader range of GBM.

Method

Participants and Procedures

Data were collected as part of the PrEPARE Project, a longitudinal study of Australian GBM’s attitudes to biomedical HIV prevention, particularly PrEP [4, 18, 19]. Ethical

approval was sought from and granted by the UNSW Human Research Ethics Committee (refs. HC11034 and HC16954) and the Research Ethics Review Committee of the community organisation ACON (ref. 2017/04). After pilot testing, national, online, cross-sectional surveys of GBM were conducted in April–May 2011, June–July 2013, April–May 2015 and April–May 2017. The 2011–2015 surveys were conducted using NETQ survey software (NetQuestionnaires Nederland BV), the 2017 survey using KeySurvey (WorldAPP, Braintree, MA). We used adaptive, conditional questioning and the randomised presentation of attitudinal items in blocks. The 2017 survey contained 78 items, spread over multiple pages, and was advertised on Facebook (using paid advertising) and email lists aimed at GBM. Consenting participants from the 2015 survey were invited by email to participate in the 2017 survey. Potential participants were directed to the survey website, <http://prepareproject.csrh.org>, which explained the purpose of the study, the time required to complete the survey (up to 20 min), the investigator team, data security and confidentiality and provided access to the online questionnaire. Participants were asked to provide consent at the start of the survey. Participants were eligible if they were at least 18 years old, male (cisgender or transgender), lived in Australia and were gay or bisexual. Participants could use a back button to review or change their answers. No incentive was offered for participation. After recruitment was completed, data were downloaded and stored on a password-protected server at UNSW.

Measures

A core set of questions has been used in all four survey rounds [4, 18, 19]. Key variables for this analysis included self-reported HIV status (HIV-negative, untested/unknown, HIV-positive) and PrEP use (lifetime use and current use at the time of the survey). We also used a range of covariates including demographic variables such as age (in years), gender (cisgender or transgender), sexual identity (gay, bisexual or other), state or territory of residence, residential location (capital city, other city or regional location), country of birth (grouped by region), education level, and employment status. We asked participants about the HIV status of their current regular male partner, if participants had one at the time of the survey, and anal intercourse and condom use with regular and casual male partners in the previous 6 months. We included the total number of male sex partners in the previous 6 months, whether participants had been diagnosed with a sexually transmitted infection in the previous year or had ever taken PEP, and the recent use of party drugs for sex or injecting drug use. We also asked participants to assess their perceived likelihood of acquiring HIV (classified as unlikely/neutral vs. likely), and how many HIV-positive people and PrEP users that they knew. The full

Table 1 Bivariate and multivariate logistic regression analyses examining covariates of current PrEP use among respondents in 2017

	Never taken PrEP (n = 773) %	Currently taking PrEP (n = 242) %	Bivariate OR (95% CI)	Multivariate AOR (95% CI)
Mean age (SD)	35.9 (12.6)	37.3 (9.5)	1.01 (1.00–1.02)	–
Sexual identity				
Gay	94.8	95.0	1.00	–
Bisexual/other	5.2	5.0	1.05 (0.54–2.03)	–
State or territory				
New South Wales	28.5	38.0	1.00	1.00
Victoria	30.0	40.5	1.01 (0.72–1.42)	1.06 (0.67–1.69)
Queensland	17.7	14.5	0.61 (0.39–0.95)*	0.96 (0.53–1.74)
Other jurisdictions	23.8	7.0	0.22 (0.13–0.38)***	0.35 (0.17–0.70)**
Residential location				
Capital city	67.0	79.3	1.00	1.00
Other city	12.5	9.1	0.61 (0.37–1.00)	0.82 (0.43–1.57)
Regional, rural or remote	20.4	11.6	0.48 (0.31–0.74)**	0.82 (0.46–1.46)
Country of birth				
Australia/New Zealand	85.5	79.8	1.00	–
Europe/North America	7.4	11.2	1.62 (1.00–2.64)	–
Asia	4.4	4.5	1.11 (0.55–2.23)	–
Elsewhere	2.7	4.5	1.79 (0.85–3.79)	–
Education level				
Up to year 12	32.6	21.9	1.00	1.00
Trade certificate	25.4	23.1	1.36 (0.89–2.07)	1.20 (0.69–2.10)
University degree	42.0	55.0	1.95 (1.36–2.78)***	1.59 (0.97–2.59)
Employment status				
Full-time	59.8	78.9	1.00	1.00
Part-time	12.5	7.0	0.42 (0.25–0.73)**	0.54 (0.26–1.10)
Student	12.7	5.4	0.32 (0.18–0.59)***	0.57 (0.26–1.23)
Social security/retired/other	15.0	8.7	0.44 (0.27–0.72)**	0.47 (0.23–0.94)*
HIV status of regular male partner				
No partner	42.7	38.4	1.00	1.00
HIV-negative	45.1	52.9	1.30 (0.96–1.77)	1.04 (0.64–1.66)
Untested/unknown status	8.5	2.1	0.27 (0.11–0.69)**	0.29 (0.09–0.92)*
HIV-positive	3.6	6.6	2.03 (1.05–3.91)*	1.16 (0.44–3.01)
Anal intercourse with regular male partners				
No partner/no intercourse	37.6	23.6	1.00	1.00
Consistent condom use	12.4	3.3	0.43 (0.20–0.92)*	0.47 (0.17–1.27)
Any condomless intercourse	49.9	73.1	2.34 (1.67–3.27)***	1.23 (0.73–2.08)
Anal intercourse with casual male partners				
No partner/no intercourse	40.8	9.9	1.00	1.00
Consistent condom use	24.7	8.3	1.37 (0.74–2.55)	1.00 (0.47–2.12)
Any condomless intercourse	34.5	81.8	9.73 (6.18–15.32)***	3.47 (1.94–6.21)***
No. of male sex partners in last 6 months				
Up to 10	82.9	44.2	1.00	1.00
> 10	17.1	55.8	6.13 (4.47–8.40)***	2.48 (1.59–3.86)***
Diagnosed with STI in last 12 months				
No	86.9	42.1	1.00	1.00
Yes	13.1	57.9	9.13 (6.57–12.70)***	3.89 (2.56–5.92)***
Ever taken PEP				
No	85.9	62.0	1.00	1.00

Table 1 (continued)

	Never taken PrEP (n = 773) %	Currently taking PrEP (n = 242) %	Bivariate OR (95% CI)	Multivariate AOR (95% CI)
Yes	14.1	38.0	3.74 (2.69–5.19)***	2.28 (1.46–3.55)***
Party drug use for the purpose of sex in last 6 months				
No	85.3	66.5	1.00	1.00
Yes	14.7	33.5	2.91 (2.08–4.06)***	0.85 (0.52–1.41)
Injected drugs in last 6 months				
No	97.4	92.6	1.00	1.00
Yes	2.6	7.4	3.03 (1.57–5.82)**	0.94 (0.37–2.39)
Perceived likelihood of acquiring HIV				
Unlikely/neutral	95.7	97.9	1.00	–
Likely	4.3	2.1	0.47 (0.18–1.23)	–
Personal experience in using condoms				
Negative/neutral (score < 4)	91.6	97.9	1.00	1.00
Positive (score ≥ 4)	8.4	2.1	0.23 (0.09–0.58)**	0.62 (0.21–1.86)
No. of HIV-positive people known				
None	31.7	10.3	1.00	1.00
1–5	45.8	52.9	3.54 (2.24–5.60)***	1.49 (0.84–2.65)
6–10	5.8	11.6	6.10 (3.26–11.40)***	2.43 (1.04–5.67)*
> 10	6.3	21.1	10.20 (5.78–18.01)***	2.44 (1.09–5.48)*
Don't know	10.3	4.1	1.23 (0.56–2.66)	0.66 (0.26–1.69)
No. of PrEP users known				
None	20.3	4.5	1.00	1.00
1–5	41.5	33.5	3.60 (1.87–6.95)***	1.66 (0.77–3.59)
6–10	6.0	21.1	15.82 (7.63–32.83)***	4.32 (1.77–10.53)**
> 10	10.1	36.4	16.10 (8.13–31.88)***	3.03 (1.29–7.13)*
Don't know	22.1	4.5	0.92 (0.39–2.18)	0.84 (0.31–2.27)

PrEP = pre-exposure prophylaxis, OR = odds ratio, AOR = adjusted odds ratio, SD = standard deviation

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

list of variables and their categories can be seen in Table 1. Scales were identified in the 2011 survey and subsequently repeated to assess willingness to use PrEP (7 items, Cronbach's $\alpha = 0.78$ – 0.86), concern about using PrEP (2 items, $\alpha = 0.64$ – 0.72), and personal experience in using condoms (9 items, $\alpha = 0.88$ – 0.91) [4, 19]. Two scales created in the 2015 round were repeated again in 2017: support for GBM taking PrEP (7 items, $\alpha = 0.87$ – 0.88) and willingness to have sex with men taking PrEP (3 items, $\alpha = 0.60$ – 0.64) [4].

Using principal components factor analysis, two new scales were identified in the 2017 round, after separately analysing the responses of men who had and hadn't used PrEP. PrEP users and non-users were presented a common set of attitudinal items, with additional items that were relevant to each group i.e. PrEP users were presented additional items relevant to their personal experience of using PrEP, non-users were presented additional items related to what they thought about other people using PrEP. This meant that it was possible for the factor analysis for each

group to identify scales that contained items in common, which is what we found. The first scale, which we called *reduced HIV concern because of PrEP* ($\alpha = 0.71$), was identified in the responses of HIV-negative and untested men who had never taken PrEP (non-users):

- (1) I am less worried about getting HIV because of PrEP
- (2) I am less worried about having sex without condoms because of PrEP
- (3) HIV is less of a threat because more people are taking PrEP

The second scale, which we called *reduced HIV concern and increased pleasure because of PrEP* ($\alpha = 0.78$), was identified in the responses of HIV-negative participants who were taking PrEP at the time of the survey (PrEP users):

- (1) I am less worried about getting HIV because of PrEP

- (2) I am less worried about having sex without condoms because of PrEP
- (3) Being on PrEP makes me feel confident about sex
- (4) Sex is more pleasurable now I am on PrEP.

Items 1 and 2 in both scales were presented to all participants. Item 3 in the first scale was only presented to non-users. Items 3 and 4 in the second scale were only presented to PrEP users. We interpreted the presence of items 1 and 2 in both scales as suggesting a common experience of reduced HIV concern due to PrEP for both users and non-users. As in previous rounds, all attitudinal items were scored from 1 = Strongly disagree to 5 = Strongly agree. Scale scores were calculated from the mean of the items in the scale (ranging from 1 to 5) with a mean score of ≥ 4 indicating positive agreement with the subject of the scale e.g. a PrEP user scoring ≥ 4 on the second scale was classified as having more sexual pleasure and reduced concern about HIV because of PrEP. This was the scoring method used in our previous publications [4, 18, 19].

Data Analyses

The database was inspected manually for duplicate or suspicious entries (identical IP addresses, responses or free text). Stata version 13.1 (StataCorp LP, College Station, TX, USA) was used for statistical analysis. The threshold for statistical significance was set at $p < 0.05$. The characteristics of participants in the 2011, 2013, 2015 and 2017 samples were compared using linear regression (age in years) and logistic regression (categorical variables) to identify changes in the sample profile over time and potentially confounding variables (with each sociodemographic characteristic as the dependent variable and survey year as the independent variable). Beta coefficients, odds ratios (OR) and 95% confidence intervals (CI) are reported.

Multivariate logistic regression was used to assess trends in PrEP use, willingness to use PrEP and concern about using PrEP across the four survey rounds (2011–2017). For each of these analyses, the dependent variable was the outcome of interest in binary format (e.g. PrEP use vs. non-use), with survey year as the primary independent variable, plus any sociodemographic or behavioural variables that had changed during 2011–2017.

Multivariate logistic regression was also used to assess change in levels of support for GBM using PrEP and willingness to have sex with men taking PrEP between 2015 and 2017. The dependent variable was the outcome of interest in binary format (e.g. support for men using PrEP vs. unsupportive), with survey year as the primary independent variable, plus sociodemographic or behavioural variables that had changed between 2015 and 2017.

Finally, we used multivariate logistic regression to identify independent associations with PrEP use, comparing PrEP users and HIV-negative and untested men who had never used PrEP before (analyses restricted to the 2017 sample). For all multivariate analyses, we report adjusted odds ratios (AOR) and 95% CI.

Results

Sample Characteristics

Valid responses were received from 4971 participants between 2011 and 2017 (2011: $n = 1283$; 2013: $n = 1316$; 2015: $n = 1251$; 2017: $n = 1121$). The proportion of HIV-negative respondents increased from 71.6% in 2011 to 84.0% in 2017 (odds ratio [OR] = 1.13, 95% confidence interval [CI] 1.10–1.16, $p < 0.001$), the proportion of untested and unknown HIV status respondents decreased from 18.9% in 2011 to 8.6% in 2017 (OR = 0.86, 95% CI 0.83–0.89, $p < 0.001$) and the proportion of HIV-positive respondents was 9.5% in 2011 and 7.4% in 2017 (OR = 0.97, 95% CI 0.92–1.01, $p = 0.16$). The remaining analyses exclude HIV-positive respondents and focus on the responses of 4567 HIV-negative and untested men.

Focusing on the 4567 HIV-negative and untested men included in the following analyses, the mean of age of respondents was 32.7 years (SD = 11.3, range 18–81) and most respondents (99.0%) were cisgender men. Most respondents identified as gay (93.6%), were born in Australia (80.2%), lived in a capital city (72.5%) and were in full-time employment (59.5%). Almost half (46.6%) had completed a university degree. The majority of respondents lived in New South Wales (33.2%), Victoria (27.8%) and Queensland (18.5%), with smaller numbers of respondents living in Western Australia (8.0%), South Australia (6.6%), the Australian Capital Territory (3.2%), Tasmania (2.0%) and Northern Territory (0.7%). A small proportion of respondents (2.4%) identified as Aboriginal or Torres Strait Islander. Almost two-thirds of respondents reported having been tested for HIV within the previous 12 months (64.7%), half (50.5%) reported condomless anal intercourse (CAI) with regular male partners in the previous 6 months, and almost one-third (32.0%) reported CAI with casual male partners in the previous six months.

Forty-three respondents (0.9%) were trans men. Trans men were slightly younger than cisgender men ($M = 30.0$ vs. 33.5 years, $t = 1.194$, $p = 0.05$), were less likely to identify as gay (62.8% vs. 94.2%) and more likely to identify as bisexual (25.6% vs. 4.7%) or other (11.6% vs. 1.1%; $\chi^2 = 73.6$, $p < 0.001$). Trans men were less likely to be HIV-negative (72.1% vs. 76.8%) or HIV-positive (2.3% vs. 8.2%) and more likely to be untested than cisgender men (25.6% vs. 15.0%;

$\chi^2 = 5.10$, $p = 0.08$), although this was not a statistically significant difference.

Between 2011 and 2017 in the overall sample ($N = 4567$), there was a statistically significant increase in the mean age of respondents ($M = 30.6$ years in 2011, $M = 36.3$ years in 2017; $B = 0.91$, 95% CI 0.76–1.06, $p < 0.001$), and the proportion of respondents who identified as gay (91.8% in 2011, 94.8% in 2017; OR = 1.14, 95% CI 1.07–1.20, $p < 0.001$), were full-time employed (58.8% in 2011, 64.5% in 2017; OR = 1.04, 95% CI 1.02–1.07, $p = 0.002$), had tested for HIV in the previous 12 months (59.4% in 2011, 73.8% in 2017; OR = 1.12, 95% CI 1.09–1.15, $p < 0.001$), had CAI with regular male partners in the previous six months (45.4% in 2011, 55.5% in 2017; OR = 1.08, 95% CI 1.05–1.11, $p < 0.001$) and had CAI with casual male partners in the previous six months (25.6% in 2011, 45.6% in 2017; OR = 1.17, 95% CI 1.14–1.20, $p < 0.001$). There was a decline in the proportion of respondents who reported living in the capital city of their state or territory (75.7% in 2011, 70.3% in 2017; OR = 0.94, 95% CI 0.91–0.97, $p < 0.001$). All these variables were included as control variables in subsequent multivariate trend analyses.

Trends in PrEP Use

The proportion of HIV-negative and untested men who reported having ever taken PrEP increased from 0.5% ($n = 6$) in 2011 to 25.5% in 2017 ($n = 265$; AOR = 2.68, 95% CI 2.34–3.07, $p < 0.001$). This is shown in Fig. 1. Among 2017 respondents, 23.3% ($n = 242$) were currently taking PrEP. Almost all of these men ($n = 238$) reported that they were

HIV-negative. Four PrEP users reported they had been tested for HIV in the past month but did not know their test results, which may reflect the regular screening that PrEP users are recommended to receive in Australian prescribing guidelines [21].

Among respondents taking PrEP at the time of the 2017 survey ($n = 242$), the majority were taking it daily (97.5%), three respondents were taking a temporary break from PrEP, two were taking it before and after sex (event-based dosing), and one was taking it every second day. Thirty-four percent of current PrEP users had been taking it for less than 6 months, 38.4% for between 6 and 12 months and 27.7% for more than 12 months. Most respondents reported obtaining PrEP via a research study or demonstration project (83.1%). Respondents also reported obtaining PrEP online from overseas (34.3%), via their GP (25.2%), and three respondents reported obtaining it from an HIV-positive person or somebody else on PrEP (these categories are not mutually exclusive).

Trends in Attitudes Towards PrEP

The following analyses are restricted to HIV-negative and untested men who had never taken PrEP ($n = 4257$). The proportion of respondents willing to use PrEP increased from 27.9% in 2011 to 36.5% in 2017 (AOR = 1.08, 95% CI 1.04–1.11, $p < 0.001$). The proportion of respondents who were concerned about using PrEP decreased from 52.1% in 2011 to 36.1% in 2017 (AOR = 0.89, 95% CI 0.86–0.92, $p < 0.001$). These trends are shown in Fig. 1.

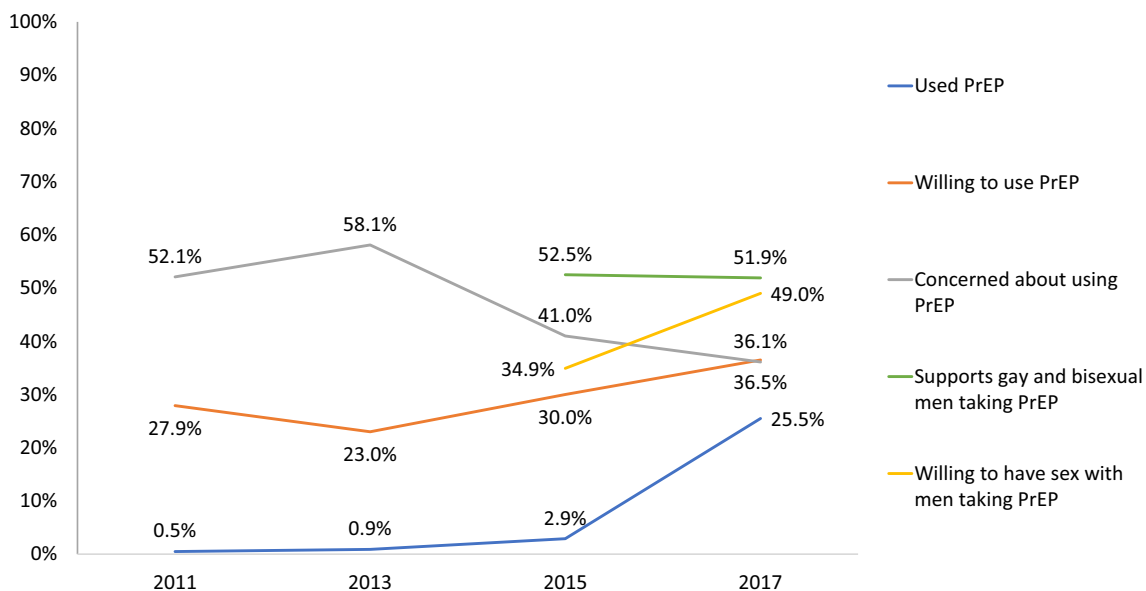


Fig. 1 Trends in attitudes to and use of PrEP among HIV-negative and untested participants, 2011–2017

Between 2015 and 2017, support for GBM using PrEP (among HIV-negative and untested men who had not used PrEP before) remained stable (52.5% in 2015, 51.9% in 2017; AOR = 1.02, 95% CI 0.93–1.13, $p=0.62$), while willingness to have sex with men taking PrEP increased from 34.9% to 49.0% (AOR = 1.41, 95% CI 1.27–1.56, $p<0.001$).

Reduced Concerns About HIV

Among HIV-negative and untested/unknown status participants who had never taken PrEP in the 2017 survey ($n=773$), the mean score on the scale measuring reduced HIV concern from PrEP was 3.1 (SD = 0.9). Based on a score of ≥ 4 on the scale, 22.8% of these participants were categorised as having reduced HIV concern because of PrEP, and 77.2% were categorised as neutral or not having reduced HIV concern due to PrEP.

Among men taking PrEP at the time of the survey in 2017 ($n=265$), the mean score on the scale measuring reduced HIV concern and sexual pleasure from PrEP was 4.2 (SD = 0.7). Based on a score of ≥ 4 on the scale, 73.6% of participants who were taking PrEP at the time of the survey were categorised as having reduced HIV concern and more sexual pleasure because of PrEP, and 26.4% were categorised as neutral or not having reduced HIV concern or more sexual pleasure due to PrEP.

Comparison of PrEP Users and Non-users

Table 1 shows the comparison of PrEP users and non-users from the 2017 survey ($n=1015$). HIV testing history was excluded from the analysis because nearly all current PrEP users (97.1%) had been tested for HIV in the 3 months prior to survey, compared with 34.5% of men who had never previously taken PrEP. There were no significant differences between PrEP users and non-users in terms of age, gender, sexual identity, country of birth, and perceived likelihood of acquiring HIV. Focusing on the results of the multivariate analysis, current PrEP users were more likely to be resident in the more populous eastern states (particularly New South Wales and Victoria) than the other states and territories, and to be in full-time employment. PrEP users were less likely to have an untested or unknown HIV status regular partner, more likely to report condomless anal intercourse with casual partners, a higher number of recent male sex partners, a recent diagnosis with a sexually transmitted infection, and previous experience of taking PEP. PrEP users were also more likely than non-users to know a larger number of HIV-positive people and PrEP users. We note that at a bivariate level, PrEP users were less likely than non-users to reside in regional, rural or remote areas and were more likely to be university educated, report sex-related drug use,

and injecting drug use. However, these differences did not remain statistically significant in the multivariate model.

Discussion

Our analysis of attitudinal and behavioural trends between 2011 and 2017 shows a number of changes as PrEP use by GBM entered the early majority phase of use in Australia. PrEP use rapidly increased, particularly between 2015 and 2017, and was reported by nearly a quarter of HIV-negative and untested men in 2017. This is the highest level of PrEP use reported among GBM in Australia to date and among the highest levels of use reported among men who have sex with men overseas [7–9, 22–27]. The majority of the men we surveyed were receiving PrEP through research studies and demonstration projects, which had rapidly scaled up during 2016–2017 [5, 6]. Most were taking PrEP daily, as recommended in the Australian prescribing guidelines that were current at the time [21]. We note that a substantial minority (over a third) of PrEP users had imported PrEP drugs from overseas. This is a legal but potentially cumbersome option in Australia which some used in the period before public demonstration projects were available and a public subsidy was approved [4].

We found that attitudes towards PrEP among Australian GBM have become more positive over time. Willingness to use PrEP has gradually increased since 2013, and was reported by over a third of HIV-negative and untested men in 2017. Internationally, this is a relatively low level of interest in using PrEP, which was estimated to be 58% among men who have sex with men from 68 studies conducted up to 2016 [28]. However, as we have previously noted, our measure of willingness to use PrEP (a seven item scale) is relatively conservative [19], taking into account factors such as perceived need to use PrEP and willingness to pay (which have been identified as critical influences on interest in using PrEP) [16, 17]. As willingness to use PrEP has increased in Australia, concern about using it has fallen, although concern was still expressed by over a third of Australian HIV-negative and untested men in 2017. This underscores that PrEP may not be attractive to all GBM, particularly those who are apprehensive about taking medication or side effects. These concerns may lessen as familiarity with and confidence in PrEP increases in the population, and it becomes increasingly normative to use PrEP. There may in fact be a social cost to not using PrEP, if a majority of one's social network (or potential sex partners) are using it. Our attitudinal data also show stable levels of support for GBM using PrEP among non-users, and increasing willingness to have sex with men on PrEP. These data suggest that Australian GBM have largely rejected negative views of PrEP, in contrast to some contexts like the United States where

considerable efforts have had to be expended to counter stigmatising views of PrEP [29].

Two new scales constructed from the 2017 survey data measured the degree to which participants had reduced concerns about HIV (and having condomless sex) as a result of PrEP, and the degree to which PrEP users also felt more confident having sex. A fifth of non-PrEP-users indicated they were less worried about HIV and having condomless sex because more people were using PrEP. This minority of GBM appears to be expressing a form of ‘prevention optimism’; a belief that they are indirectly protected from HIV because of the greater use of PrEP by others [30]. We don’t believe this type of optimistic thinking in relation to PrEP has been documented before. We think it is important to track these beliefs over time, as they could contribute to community-level risk compensation; the reduced use of condoms by non-PrEP-users in settings in which PrEP use is increasing [30, 31]. Community-level risk compensation has been observed in San Francisco, Melbourne and Sydney, coincident with rapidly increasing PrEP use by GBM [22, 32]. How unrealistic optimism and reduced condom use by non-users might limit the population benefits of PrEP remains unknown [30, 32]. In contrast to non-PrEP-users, nearly three-quarters of PrEP users were less worried about HIV and having condomless sex, were more confident and rated sex as more pleasurable because of PrEP. This accords with international research which has found that PrEP users experience relief from the fear of HIV once they start using PrEP [33, 34], and use condoms less often over time as they become more confident that PrEP is effective [14, 15, 34, 35].

Our analysis of the characteristics of PrEP users in comparison with non-users in 2017 indicates the successful targeting of PrEP to men at higher risk of HIV at this relatively early stage of roll-out, and that the sexual behaviour of PrEP users tends to differ from that of non-users. In terms of sexual behaviour, PrEP users were much more likely to report condomless sex, particularly with casual partners, a higher number of sex partners, a recent course of PEP and diagnoses with sexually transmitted infection (STI). These characteristics broadly reflect the Australian prescribing guidelines for PrEP, which aim to target men at higher risk of HIV [21], but they also reflect post-PrEP behaviour i.e. once taking PrEP, men may become sexually active and more likely to have condomless sex [14, 15, 35]. The higher rate of STIs among PrEP users, also observed in other studies [1], is likely to both reflect a higher risk of acquiring a STI (due to condomless sex, for example), but also that most early PrEP users in Australia were required to have quarterly STI screening when they attended a clinic to receive their next PrEP prescription [5, 6, 35].

The comparison of PrEP users and non-users in 2017 also identified some geographic and socioeconomic disparities.

While PrEP use was unrelated to age, gender, sexual identity or country of birth, PrEP users were more likely than non-users to reside in New South Wales and Victoria, Australia’s most populous states with the largest populations of GBM [36], and in capital cities where the majority of Australians (and GBM) live and where the majority of HIV infections occur [37]. New South Wales and Victoria implemented large publicly-funded PrEP demonstration projects targeted at GBM at high risk of HIV (particularly in inner city areas), through which PrEP access was free (New South Wales) or subsidised (Victoria) [5, 6]. Recently published data suggest the concentrated uptake of PrEP, particularly in gay-friendly, inner city suburbs of Sydney, has led to substantial declines of HIV infections in those areas but not other parts of the city [38]. Now that PrEP is listed on the Pharmaceutical Benefits Scheme (and can be prescribed by any doctor), it is assumed that PrEP use will rise in the other states and territories, and outside of cities. It is, of course, possible that PrEP use may fall in New South Wales now that PrEP users who were in the demonstration project need to pay for prescriptions. Our analysis found that GBM who were university educated and in full-time employment were more likely to be using PrEP than other men, particularly those on welfare benefits or social security (although education was not independently related to PrEP use in the multivariate analysis). This is consistent with Diffusion of Innovations (DOI) theory, which has found in multiple studies that early adopters tend to be better educated and more economically privileged than later adopters [10]. Concerns about the cost of PrEP have been raised in international acceptability research, although not consistently across studies [16, 17, 28]. These reviews also found that interest in PrEP can be higher among those with lower education levels and lower incomes, perhaps illustrating a gap between hypothetical acceptability research and what actually drives PrEP uptake in practice. Whether socioeconomic disparities will lessen now that PrEP is publicly subsidised in Australia will require close attention, to ensure that access to this effective HIV prevention method is not hampered by geography or social disadvantage.

Finally, we note that in 2017 PrEP users were more likely than non-users to know a large number of HIV-positive people and other PrEP users. While we did not investigate participants’ social networks in depth, this suggests to us that early adopters of PrEP in Australia may have come from social networks in which there was a greater awareness of PrEP and biomedical HIV prevention. Our previous research has found that HIV-positive gay men and their partners are among those who know the most about PrEP in Australia [39]. Our current results suggest an affiliation effect, in which early adopters of PrEP seek out others who are already using it (because they share a similar experience) and an influencing effect, in which PrEP users encourage

the people they know to consider using it (although we cannot demonstrate this directly from our results). Our results appear to be consistent with DOI theory, in which innovations spread preferentially through networks of like-minded people who are open to change [10]. This would be worthy of further investigation.

We acknowledge the limitations of our research. Our national, cross-sectional samples of GBM are unlikely to be representative. They were similar to behavioural surveillance samples of GBM, including a good representation of participants with demographic and behavioural characteristics similar to GBM with undiagnosed HIV or recent HIV diagnoses, suggesting we recruited a sample that included GBM who were at higher risk of HIV or STIs [7–9, 31, 32, 40, 41]. The branding of the study (which was focused on PrEP) means we may have over-recruited men on PrEP, making the estimate of PrEP use unreliable. However, to correct for some of the weaknesses of cross-sectional data, in the analyses of trends we adjusted for variations in the sample over time. We measured aggregated sexual behaviour (in the preceding 6 months) and STI diagnoses in the previous year, so we could not (for example) distinguish between behaviour or diagnoses that occurred before and after PrEP use. Although we referred to DOI theory to think about how PrEP rollout might change over time in Australia, we did not design the study questionnaire with DOI theory in mind. We therefore could not assess some elements of DOI theory that can affect uptake and diffusion, such as whether early PrEP users were perceived as influential opinion leaders and the characteristics of GBM's social networks that might drive or impede uptake [10, 12]. It should also be borne in mind that DOI theory may imply that the spread of an innovation continues until it is used by an entire target population, but it is unknown what proportion of GBM will eventually use PrEP.

In summary, our national survey data show rapidly increasing PrEP use among Australian GBM, particularly between 2015 and 2017. Willingness to use PrEP has increased, while community support for PrEP users has remained solid. A minority of non-PrEP-users expressed optimism that they were safer from HIV because of PrEP use by others. This is worth continued monitoring, as it may help to explain the community-level risk compensation that has been observed to a limited degree in Australia and overseas as PrEP use increases [22, 30, 32]. Our analysis of PrEP users and non-users indicated that PrEP users were more sexually active than non-users, and were more likely to be in social networks featuring larger numbers of HIV-positive men and other PrEP users. We recommend further research on the role of peers and social networks in driving PrEP uptake. Our analysis indicated disparities in PrEP uptake at this early stage of implementation, with PrEP use concentrated in New South Wales and Victoria (where large, free or subsidised PrEP demonstration projects were conducted)

and among men who were university educated and in full-time employment. DOI theory suggests that the next wave of PrEP users in Australia may be less adventurous and require greater reassurance about PrEP's efficacy and legitimacy, in order to sustain rollout and further uptake [10]. After PrEP's public listing in Australia, all PrEP users will need to pay for prescriptions. Whether this will lessen or exacerbate the disparities in PrEP access we observed will require close attention, in order to maximise the benefits of this relatively new prevention technology in Australia.

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Data Availability Deidentified raw data supporting the conclusions of this manuscript will be made available by the authors, without undue reservation, to any qualified researcher.

Compliance with Ethical Standards

Conflict of Interest The authors have no conflicts of interest to declare.

Ethics Approval This study was carried out in accordance with the National Statement on Ethical Conduct in Human Research, from the National Health and Medical Research Council, Australia. All participants indicated informed consent at the start of the online questionnaire. The study design was approved by the Human Research Ethics Committee of the University of New South Wales and the Research Ethics Review Committee of the community organisation ACON.

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