

## **Corrigendum to: Familiarity with, perceived accuracy of, and willingness to rely on Undetectable=Untransmittable (U=U) among gay and bisexual men in Australia: results of a national cross-sectional survey**




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The publisher advises that the wrong affiliation was attributed to Sarah K. Calabrese. The correct affiliation should have read:

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# Familiarity with, perceived accuracy of, and willingness to rely on Undetectable=Untransmittable (U=U) among gay and bisexual men in Australia: results of a national cross-sectional survey

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## ABSTRACT

**Background.** The Undetectable=Untransmittable (U=U) message has been promoted since it was demonstrated that viral suppression through HIV treatment prevents sexual transmission between serodiscordant partners (HIV treatment as prevention). Our study assessed familiarity with, perceived accuracy of, and willingness to rely on U=U in a national sample of gay and bisexual men in Australia. **Methods.** We conducted a national, online cross-sectional survey in April–June 2021. Eligible participants were gay, bisexual and queer men and non-binary people who lived in Australia. Logistic regression was used to identify factors associated with familiarity, perceived accuracy and willingness to rely on U=U (by having condomless sex with a partner with HIV who has an undetectable viral load). **Results.** Of 1280 participants, most were familiar with U=U (1006/1280; 78.6%), the majority of whom believed U=U was accurate (677/1006; 67.3%). Both familiarity and perceived accuracy were higher among participants living with HIV, followed by pre-exposure prophylaxis (PrEP) users, HIV-negative participants not taking PrEP, and untested/unknown status participants. Knowing at least one person living with HIV, among other factors, was associated with familiarity and perceived accuracy of U=U; and familiarity was associated with perceived accuracy. Among participants familiar with U=U, less than half were willing to rely on U=U (473/1006; 47.0%). Familiarity with U=U and knowing at least one person living with HIV were associated with willingness to rely on U=U, among other factors. **Conclusions.** We found familiarity with U=U was associated with perceived accuracy and willingness to rely upon it. There is an ongoing need to educate gay and bisexual men (particularly HIV-negative men) about U=U and its benefits.

**Keywords:** attitudes, Australia, biomedical HIV prevention, gay and bisexual men (GBM), HIV prevention, HIV undetectability, men who have sex with men (MSM), treatment as prevention (TasP).

## Introduction

In 2016, the Prevention Access Campaign initiated the global Undetectable equals Untransmittable campaign (U=U; see [preventionaccess.org](https://preventionaccess.org)) to increase awareness about the benefits of HIV treatment as prevention (TasP); that is, a person living with HIV who has achieved and maintained an undetectable viral load (UVL) through antiretroviral therapy (ART) cannot transmit HIV to their sexual partners.<sup>1–3</sup> The U=U message has been widely embraced by the scientific community and global health organisations, including the World Health Organization.<sup>4</sup> The Australian guidelines for healthcare providers who work with people living with HIV also strongly recommend that clinicians discuss U=U with their patients to reduce HIV-related stigma, encourage HIV treatment commencement and adherence, and support their psychosocial needs.<sup>5</sup>

Australian health organisations adopted TasP as part of a ‘combination HIV prevention’ approach and have promoted U=U in community messaging alongside the use of HIV pre-exposure prophylaxis (PrEP), condoms, and HIV testing.<sup>6</sup> In addition to promoting the benefits of U=U for HIV prevention, the international U=U campaign has broader aims to reduce the stigma associated with HIV, improve quality of life for people living with HIV and their partners, and create a more supportive environment in which people more readily seek HIV testing and treatment.<sup>7</sup> Illustrating some of these potential benefits for people living with HIV, an international study found that those who had discussed U=U with their healthcare providers were more likely to achieve viral suppression through ART, have better sexual health, and were more comfortable disclosing their HIV status.<sup>8</sup>

Prior to 2016 and the HIV Prevention Trials Network (HPTN) 052 randomised clinical trial results that informed the U=U campaign, TasP was generally understood to be a strategy for risk reduction rather than a strategy that eliminated risk.<sup>9</sup> Research with communities affected by HIV (e.g. gay and bisexual men (GBM), heterosexual people in high prevalence countries) tended to assess knowledge of TasP as both an interpersonal strategy and a population level one – both the idea that viral suppression prevents transmission between sexual partners, and that achieving high levels of treatment and viral suppression in a population might slow or stop transmission.<sup>10,11</sup> Research on how affected communities understood and engaged with TasP in the early 2010s generally found that there were both low levels of awareness of TasP, and high levels of scepticism that it worked.<sup>12–14</sup> This research also tended to find that people living with HIV had higher levels of knowledge about and belief in TasP, compared with HIV-negative people. More recent reviews suggest that awareness and knowledge of TasP has grown over time in multiple countries and populations, but belief in its effectiveness remains lower than the level of awareness of the strategy.<sup>14</sup> Our research with GBM, Australia’s main HIV-affected population, aligns with international research. We found that the proportion of GBM who believed that TasP was effective increased from 2.6% in 2013 to 38.1% in 2021, with participants with HIV consistently reporting higher levels of belief (9.1% in 2013 to 51.6% in 2021) compared to HIV-negative and untested/unknown status participants (2.0% in 2013 to 37.0% in 2021).<sup>15,16</sup> However, these are relatively low levels of belief in TasP given the strong scientific evidence that viral suppression prevents transmission between serodiscordant couples,<sup>1–3</sup> and the public discussion of these findings in Australia in social and community media, in community-directed education campaigns, and in public forums for GBM and other people affected by HIV, particularly since 2018.<sup>17</sup>

One issue that may contribute to low levels of belief in TasP is the conflation or overlap between the idea of TasP as an interpersonal strategy (preventing transmission between serodiscordant partners) and a population strategy (reducing

transmission at a population level). Although there is strong scientific evidence that viral suppression prevents transmission between sexual partners (the key element of the U=U message), the effectiveness of TasP at a population level appears to be much less than was initially anticipated,<sup>9,18</sup> with the population strategy undermined by delays in diagnosing people with HIV, and difficulties in people accessing and sustaining treatment.<sup>11</sup> Even in countries with low levels of undiagnosed HIV, high levels of treatment coverage and viral suppression, TasP appears to have reduced but not stopped HIV transmission.<sup>19,20</sup> This disconnect between the interpersonal and population-level strategies may affect how people respond to research about the acceptability or effectiveness of TasP. For instance, our previous research measured belief in the effectiveness of TasP with a three-item scale, with participants asked to rate their level of agreement with three items: ‘An HIV-positive person who is on HIV treatment is unlikely to transmit HIV’, ‘A person with an undetectable viral load cannot pass on HIV’, and ‘If every HIV-infected person was on treatment, the HIV epidemic would be over’.<sup>15,21,22</sup> Although the first two items relate to the likelihood of interpersonal transmission, the third item references TasP as a population strategy, and has consistently had the lowest level of agreement among our participants, lowering the overall level of belief in TasP we recorded.<sup>16</sup> This suggests that it may be worth assessing knowledge and belief in the interpersonal strategy of U=U separately from the population-level concept of TasP.

Since the Prevention Access Campaign coined the term U=U, research has begun to evaluate familiarity or perceived accuracy of the specific U=U message, rather than more general awareness or belief in TasP.<sup>14</sup> A US study of GBM conducted in 2017–18 found that most of the sample knew what undetectable meant (92%), but only half (55%) perceived U=U as accurate.<sup>23</sup> Perceived accuracy was highest among participants living with HIV (84%), followed by HIV-negative participants (54%), and untested/unknown status participants (39%). The proportion of those who agreed that U=U was accurate increased to 60% when those who did not know what undetectable meant were excluded; that is, to 84% of participants living with HIV, 58% of HIV-negative participants and 48% of untested/unknown status participants.<sup>23</sup> Another US-based study conducted in 2018 found lower familiarity with, and perceived accuracy of U=U, with 85% of those surveyed aware of U=U, of whom 43% trusted that U=U was accurate.<sup>24</sup> An international survey conducted in 2019 found that 88% of people living with HIV had heard of U=U,<sup>8</sup> and a Canadian study conducted in 2018 found that 73% of participants were aware of U=U but did not ask about its perceived accuracy.<sup>25</sup>

Previous Australian research has not evaluated familiarity with the specific U=U message or its perceived accuracy. Previous research has assessed the willingness of Australian GBM to have condomless sex with a partner living with HIV who has an undetectable viral load, and found low levels of

willingness,<sup>26–29</sup> particularly among HIV-negative and untested men who do not use PrEP. However, most of this research was conducted before the U=U campaign gathered momentum and did not explicitly ask participants whether they were familiar with the U=U message, believed in its accuracy, or were willing to rely upon an undetectable viral load when having condomless sex with partners living with HIV. We therefore set out to address this gap by assessing demographic and behavioural characteristics associated with knowledge and belief in U=U in our latest survey of Australian GBM.

## Methods

### Study design and participants

The study design and methods have been described elsewhere.<sup>30–32</sup> In brief, data were collected in a national, online, cross-sectional survey of GBM conducted in April–June 2021 using Qualtrics software (Provo, UT, USA). We promoted the survey through community organisations, Facebook groups about HIV prevention, and paid advertisements on Facebook and the dating/hook up app, Grindr. Potential participants were directed to the project website containing study information and a link to the survey. Participants provided consent before starting the survey. In 2021, eligible participants were aged  $\geq 16$  years, did not identify as female, did not identify as heterosexual, and lived in Australia; that is, male or non-binary and gay, bisexual or queer-identified people could participate. The study was approved by the ethics committee of UNSW Sydney (HC16954) and the community organisation ACON's research review panel (2017/04; formerly the AIDS Council of New South Wales).

### Measures

The questionnaire measures have been described previously.<sup>31,32</sup> This analysis focuses on familiarity with, perceived accuracy of, and willingness to rely on U=U (the main outcome measures), some of which were new items in the 2021 survey. We also collected data on demographics, recent sexual practices, HIV status and testing, STI testing and recent diagnoses, use of HIV treatment and PrEP, and how many people living with HIV the participants knew.

#### Familiarity with and perceived accuracy of U=U

We used a two-step approach to measure familiarity with and perceived accuracy of U=U, adapted from Rendina and Parsons.<sup>33</sup> Familiarity was measured with the item, 'How familiar are you with the Undetectable=Untransmittable (U=U) message?'. Response options were 1 = 'Not at all', 2 = 'A little', 3 = 'Somewhat', and 4 = 'Very'. We coded responses 2–4 as being familiar with U=U. Participants who were familiar with U=U were asked how accurate they

believed it to be: 'How accurate do you believe the Undetectable=Untransmittable (U=U) message is?'. Response options were: 1 = 'Completely inaccurate', 2 = 'Inaccurate', 3 = 'I don't know', 4 = 'Accurate', and 5 = 'Completely accurate'. We coded responses 4–5 as believing that U=U was accurate.

#### Willingness to rely on U=U

Willingness to rely on U=U was operationalised as willingness to have condomless sex with a sexual partner who was living with HIV and had an undetectable viral load. All participants were presented with this item: 'I would have sex without condoms with a HIV-positive person who is undetectable'. Responses were collected on a Likert-type scale ranging from 1 = 'Strongly disagree' to 5 = 'Strongly agree'. We coded responses 4–5 as being willing to rely on U=U. We note that for participants using PrEP and most participants living with HIV, this item was not solely measuring willingness to rely on U=U (as they were protected by PrEP, or had an undetectable viral load themselves, respectively). The responses of HIV-negative and untested participants not using PrEP to this item is more indicative of willingness to rely solely on U=U.

### Statistical analyses

Frequencies and proportions are reported for demographic and behavioural variables. Pearson's chi-squared ( $\chi^2$ ) tests identified bivariable associations between the main outcome measures, HIV status and PrEP use. Multivariable logistic regression was used to identify independent associations of demographic and behavioural variables with the key outcomes (i.e. familiarity with, perceived accuracy of, and willingness to rely on U=U), with each outcome variable dichotomised; for example, familiar vs unfamiliar, perceived to be accurate vs inaccurate. Independent variables that were statistically significant at the bivariable level were block entered into the multivariable analyses. Statistical assumptions were assessed, including model diagnostics for logistic regression, none of which were violated. Variables in the regression models had no missing observations. We report unadjusted and adjusted odds ratios (OR and aOR) with 95% confidence intervals (CI). Statistical significance was set at  $P < 0.05$  (two-tailed), which was also the cut-off point for the selection of independent variables in the multivariable analyses. Analyses were conducted using Stata ver. 16.1 (StataCorp, College Station, TX, USA).

### Compliance with ethical standards

The questionnaire and methodology for this study were approved by the Human Research Ethics Committee of UNSW Sydney (HC16954) and endorsed by the community organisation, ACON (2017/04). Informed consent was obtained from

all individual participants included in the study prior to their participation in the questionnaire.

## Results

A total of 1280 participants completed the survey in 2021. The median age of the 1280 participants was 38 years (IQR = 30–52), 1038 (80.8%) identified as gay, 1261 (98.5%) were male, 916 (71.6%) were Australian born, 747 (58.4%) were university educated, 770 (60.2%) reported full-time employment, and 897 (70.1%) lived in the capital city of their state or territory. The greatest proportions of overseas-born participants originated from Europe (8.9% of the total sample), followed by South-East and East Asia (5.6%), and Oceania (excluding Australia; 4.1%). Most participants lived in one of Australia's three most populous states: New South Wales (482; 37.7%), Victoria (318; 24.8%), or Queensland (209; 16.3%). In total, 1059 participants (82.7%) were HIV negative, 95 (7.4%) were HIV positive, and 126 (9.8%) were untested or did not know their status. Of the 1059 HIV-negative participants, 466 (44.0%) were taking PrEP at the time of the survey. Nearly all participants with HIV reported that they were on HIV treatment (94/95; 99.0%) and had an undetectable viral load (92/95; 96.8%).

### Familiarity with U=U

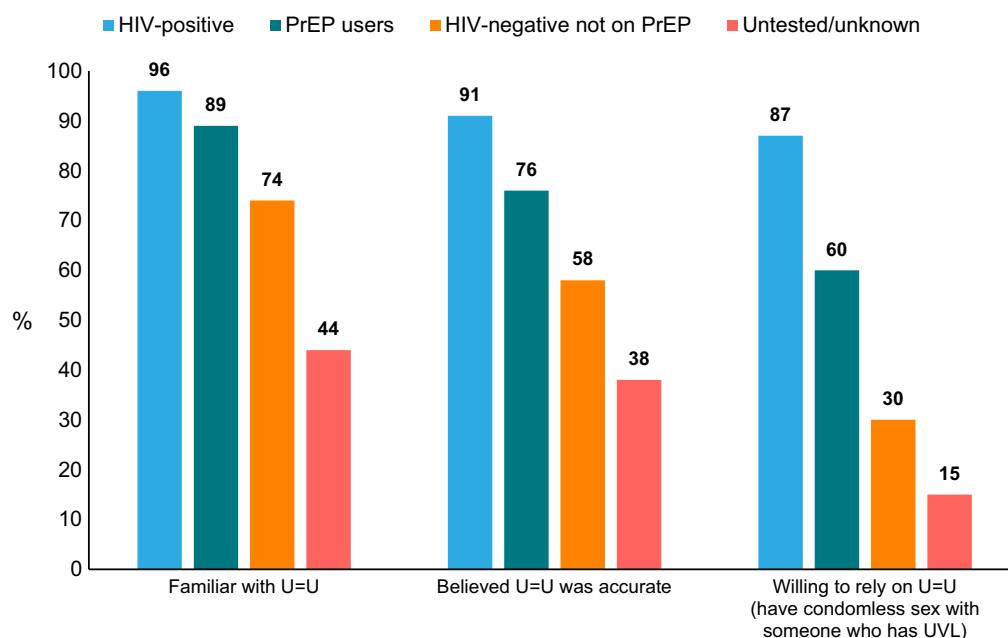
Of the 1280 participants, 274 (21.4%) were 'not at all' familiar with U=U, 238 (18.6%) were 'a little' familiar, 305 (23.8%) were 'somewhat' familiar, and 463 (36.2%) were

'very' familiar with U=U; that is, 1006 (78.6%) participants had heard of U=U before the survey. Fig. 1 shows differences in familiarity with U=U (dichotomised as 'not at all familiar' vs everyone else) by HIV status and PrEP use,  $\chi^2(3, 1280) = 139.06, P < 0.001$ . Participants living with HIV were most familiar with the U=U message (91/95; 95.8%), followed by PrEP users (421/472; 89.2%), HIV-negative participants not taking PrEP (441/593; 74.4%), and participants who were untested or did not know their HIV status (53/120; 44.2%).

Table 1 shows factors associated with familiarity with U=U. Participants with HIV and PrEP users were more likely to be familiar with U=U compared to HIV-negative participants not taking PrEP, whereas untested and unknown HIV status participants were less likely to be familiar with U=U. Participants who knew at least one person living with HIV were also more likely to be familiar with U=U, compared to those who did not know anyone living with HIV. Participants who identified as bisexual compared to gay, and those living outside of capital cities, were less likely to be familiar with U=U.

### Perceived accuracy of U=U

Of the 1006 participants who were familiar with the U=U message, 9 (0.9%) rated U=U as 'completely inaccurate', 39 (3.9%) rated it as 'inaccurate', 281 (27.9%) responded they 'did not know', 393 (39.1%) rated U=U as 'accurate', and 284 (28.2%) rated it as 'completely accurate'; that is, 677 (67.3%) participants believed the U=U message was accurate or completely accurate. Fig. 1 shows differences in



**Fig. 1.** Familiarity with, perceived accuracy of, and willingness to rely on Undetectable=Untransmittable (U=U) by HIV status and PrEP use. UVL, undetectable viral load.

**Table 1.** Factors associated with familiarity with the Undetectable=Untransmittable (U=U) message among 1280 participants.

	Total N = 1280	No n = 274	Yes n = 1006	OR (95% CI)	P-value	aOR (95% CI)	P-value
<b>Age (years)</b>							
<30	310 (24.2)	94 (34.3)	216 (21.5)	Ref		Ref	
≥30	970 (75.8)	180 (65.7)	790 (78.5)	1.91 (1.43–2.56)	<0.001	0.82 (0.56–1.20)	0.302
<b>Sexuality</b>							
Gay	1034 (80.8)	185 (67.5)	849 (84.4)	Ref		Ref	
Bisexual/pansexual	193 (15.1)	80 (29.2)	113 (11.2)	0.31 (0.22–0.43)	<0.001	0.56 (0.38–0.81)	<b>0.002</b>
Queer/another term	53 (4.1)	9 (3.3)	44 (4.4)	1.07 (0.51–2.22)	0.866	1.42 (0.62–3.25)	0.406
<b>State/territory</b>							
NSW	482 (37.7)	97 (35.4)	385 (38.3)	Ref		Ref	
Vic	318 (24.8)	57 (20.8)	261 (25.9)	1.15 (0.80–1.66)	0.44	1.27 (0.85–1.90)	0.247
Qld	209 (16.3)	45 (16.4)	164 (16.3)	0.92 (0.62–1.37)	0.674	1.19 (0.76–1.88)	0.442
Other states/territories	271 (21.2)	75 (27.4)	196 (19.5)	0.66 (0.47–0.93)	0.018	0.80 (0.55–1.18)	0.26
<b>Residential location</b>							
Capital city	897 (70.1)	158 (57.7)	739 (73.5)	Ref		Ref	
Other city/regional, rural or remote area	383 (29.9)	116 (42.3)	267 (26.5)	0.49 (0.37–0.65)	<0.001	0.69 (0.50–0.96)	<b>0.026</b>
<b>Education level</b>							
High school/trade certificate	533 (41.6)	155 (56.6)	378 (37.6)	Ref		Ref	
University degree	747 (58.4)	119 (43.4)	628 (62.4)	2.16 (1.65–2.84)	<0.001	1.32 (0.96–1.82)	0.082
<b>Employment status</b>							
Employed full time	770 (60.2)	143 (52.2)	627 (62.3)	Ref		Ref	
Employed part time	196 (15.3)	52 (19.0)	144 (14.3)	0.63 (0.44–0.91)	0.014	0.88 (0.57–1.34)	0.55
Student/unemployed/other	314 (24.5)	79 (28.8)	235 (23.4)	0.68 (0.50–0.93)	0.015	0.82 (0.57–1.17)	0.272
<b>HIV status and PrEP use</b>							
Untested/unknown	120 (9.4)	67 (24.5)	53 (5.3)	0.27 (0.18–0.41)	<0.001	0.19 (0.04–0.84)	<b>0.028</b>
HIV negative not on PrEP	593 (46.3)	152 (55.5)	441 (43.8)	Ref		Ref	
HIV negative taking PrEP	472 (36.9)	51 (18.6)	421 (41.8)	2.85 (2.02–4.01)	<0.001	1.89 (1.24–2.89)	<b>0.003</b>
HIV positive	95 (7.4)	4 (1.5)	91 (9.0)	7.84 (2.83–21.70)	<0.001	5.05 (1.76–14.47)	<b>0.003</b>
<b>Time since last HIV test</b>							
≤12 months	886 (69.2)	142 (51.8)	744 (74.0)	Ref		Ref	
>12 months	278 (21.7)	70 (25.5)	208 (20.7)	0.57 (0.41–0.78)	0.001	0.93 (0.53–1.65)	0.811
Never tested for HIV	116 (9.1)	62 (22.6)	54 (5.4)	0.17 (0.11–0.25)	<0.001	3.52 (0.73–16.88)	0.116
<b>Time since last STI test</b>							
≤12 months	853 (66.6)	129 (47.1)	724 (72.0)	Ref		Ref	
>12 months	262 (20.5)	66 (24.1)	196 (19.5)	0.53 (0.38–0.74)	<0.001	0.91 (0.51–1.61)	0.744
Never tested for STIs	165 (12.9)	79 (28.8)	86 (8.5)	0.19 (0.14–0.28)	<0.001	0.61 (0.34–1.10)	0.099
<b>Number of male sex partners (last 6 months)</b>							
None	175 (13.7)	53 (19.3)	122 (12.1)	Ref		Ref	
1–5	610 (47.7)	151 (55.1)	459 (45.6)	1.32 (0.91–1.91)	0.142	1.21 (0.76–1.94)	0.423
6–10	209 (16.3)	38 (13.9)	171 (17.0)	1.95 (1.21–3.15)	0.006	1.09 (0.58–2.05)	0.789
>10	286 (22.3)	32 (11.7)	254 (25.2)	3.45 (2.11–5.62)	<0.001	1.20 (0.61–2.37)	0.591

(Continued on next page)



**Table 1.** (Continued).

	Total N = 1280	No n = 274	Yes n = 1006	OR (95% CI)	P-value	aOR (95% CI)	P-value
Sex with casual male partners (last 6 months)							
Any condomless sex	677 (52.9)	107 (39.1)	570 (56.7)	Ref		Ref	
No casual partners/no anal sex	455 (35.5)	122 (44.5)	333 (33.1)	0.51 (0.38–0.69)	<0.001	1.01 (0.66–1.55)	0.955
Consistent condom use	148 (11.6)	45 (16.4)	103 (10.2)	0.43 (0.29–0.65)	<0.001	0.84 (0.53–1.34)	0.468
STI diagnosis in last 12 months	284 (22.2)	29 (10.6)	255 (25.3)	2.87 (1.90–4.32)	<0.001	1.39 (0.85–2.26)	0.184
Knows ≥1 person living with HIV	737 (57.6)	85 (31.0)	652 (64.8)	4.10 (3.07–5.46)	<0.001	2.48 (1.78–3.46)	<0.001

Note: data are n (%). Bolded values indicate statistical significance at  $P < 0.001$  (two-tailed). Ref denotes the reference category for categorical variables, i.e., the baseline against which other levels of the variable were compared. Bivariable analyses showed that participants' country of birth (i.e. Australia vs overseas) was not related to familiarity with U=U and this variable was excluded from further analyses.

perceived accuracy of U=U (dichotomised as 'accurate' and 'completely accurate' vs all else) by HIV status and PrEP use,  $X^2(3, 1006) = 74.80$ ,  $P < 0.001$ . Most participants living with HIV rated the U=U message as accurate (83/91; 91.2%), followed by PrEP users (318/421; 75.5%), HIV-negative participants not taking PrEP (256/441; 58.0%), and participants who were untested or did not know their HIV status (20/53; 37.7%).

Table 2 shows factors associated with perceived accuracy of U=U. Participants who were more familiar with U=U had far greater odds of perceiving the U=U message as accurate, as did participants who knew at least one person living with HIV. By contrast, people who lived outside of Australia's three most populous states (compared to participants in New South Wales), and separately, participants who reported consistent condom use compared to any condomless sex in the last 6 months, were less likely to perceive U=U as accurate.

### Willingness to rely on U=U

Of the 1006 participants who were familiar with the U=U message, 473 (47.0%) were willing to have condomless anal sex with a partner who had an undetectable viral load (i.e. to rely on U=U). Among those familiar with U=U, there were differences in willingness to have condomless sex with a partner who was undetectable, by HIV status and PrEP use,  $X^2(3, 1006) = 158.59$ ,  $P < 0.001$ . Fig. 1 shows that greater proportions of participants living with HIV were willing to have condomless sex with a partner who was undetectable (80/91; 87.9%), followed by PrEP users (251/421; 59.6%), HIV-negative participants not taking PrEP (134/441; 30.4%), and participants who were untested or did not know their HIV status (8/53; 15.1%); that is, the proportion of HIV-negative and untested participants not on PrEP who were familiar with U=U and willing to rely on it during sex was 15.1–30.4%. When we restricted the sample to those who were both familiar with U=U and believed that the U=U message was accurate, the proportions in each subgroup who were willing to have condomless sex with a partner who was undetectable

increased. However, the differences in willingness by HIV status and PrEP use remained similar. Among those who were familiar with U=U and who believed U=U was accurate ( $n = 677$ ), greater proportions of participants living with HIV were willing to have condomless sex with a partner with HIV who was undetectable (75/83; 90.4%), followed by PrEP users (230/318; 72.3%), HIV-negative participants not taking PrEP (112/256; 43.8%), and participants who were untested or did not know their HIV status (5/20; 25.0%;  $X^2(3, 677) = 90.82$ ,  $P < 0.001$ ). Among the same group of participants who were familiar with U=U and believed U=U was accurate ( $n = 677$ ), willingness to have condomless sex with a partner who was undetectable was higher among participants who believed U=U was completely accurate (239/284; 84.2%), compared with participants who believed U=U was only 'accurate' (183/393; 46.6%;  $X^2(1, 677) = 99.22$ ,  $P < 0.001$ ).

Table 3 shows factors associated with willingness to have condomless sex with a partner with HIV who was undetectable among the 1006 participants who were familiar with U=U. Participants who were more familiar with U=U had far greater odds of being willing to have condomless sex with a partner who was undetectable, as were participants who knew at least one person living with HIV and university-educated participants. By contrast, the following groups were less willing to have condomless sex with a partner who was undetectable: people who lived outside of Australia's three most populous states (compared to participants in New South Wales), people aged >30 years, and people who reported consistent condom use.

### Discussion

This was the first study to assess familiarity with, perceived accuracy of, and willingness to rely on the specific U=U message in a national sample of GBM in Australia. We found that most participants were familiar with U=U, but fewer believed it was accurate and were willing to rely upon it.

**Table 2.** Factors associated with perceived accuracy of Undetectable=Untransmittable ('U=U') among 1006 participants who were familiar with U=U.

	Total N = 1006	No n = 329	Yes n = 677	OR (95% CI)	P-value	aOR (95% CI)	P-value
<b>Age (years)</b>							
<30	216 (21.5)	78 (23.7)	138 (20.4)	Ref			
≥30	790 (78.5)	251 (76.3)	539 (79.6)	1.21 (0.89–1.66)	0.229		
<b>Sexuality</b>							
Gay	849 (84.4)	261 (79.3)	588 (86.9)	Ref		Ref	
Bisexual	113 (11.2)	56 (17.0)	57 (8.4)	0.45 (0.30–0.67)	<0.001	0.73 (0.44–1.22)	0.229
Queer/another term	44 (4.4)	12 (3.6)	32 (4.7)	1.18 (0.60–2.33)	0.627	0.81 (0.34–1.94)	0.64
<b>State/territory</b>							
NSW	385 (38.3)	104 (31.6)	281 (41.5)	Ref			
Vic	261 (25.9)	93 (28.3)	168 (24.8)	0.67 (0.48–0.94)	0.02	0.66 (0.42–1.02)	0.063
Qld	164 (16.3)	58 (17.6)	106 (15.7)	0.68 (0.46–1.00)	0.05	0.78 (0.46–1.30)	0.341
Other states/territories	196 (19.5)	74 (22.5)	122 (18.0)	0.61 (0.42–0.88)	0.008	0.59 (0.37–0.94)	<b>0.026</b>
<b>Residential location</b>							
Capital city	739 (73.5)	224 (68.1)	515 (76.1)	Ref			
Other city/regional, rural or remote area	267 (26.5)	105 (31.9)	162 (23.9)	0.67 (0.50–0.90)	0.007	0.96 (0.64–1.42)	0.82
<b>Education level</b>							
High school/trade certificate	378 (37.6)	163 (49.5)	215 (31.8)	Ref			
University degree	628 (62.4)	166 (50.5)	462 (68.2)	2.11 (1.61–2.76)	<0.001	1.42 (1.00–2.03)	0.053
<b>HIV status and PrEP use</b>							
Untested/unknown	53 (5.3)	33 (10.0)	20 (3.0)	0.44 (0.24–0.79)	0.006	0.67 (0.09–5.25)	0.703
HIV negative not on PrEP	441 (43.8)	185 (56.2)	256 (37.8)	Ref			
HIV negative taking PrEP	421 (41.8)	103 (31.3)	318 (47.0)	2.23 (1.67–2.99)	<0.001	1.32 (0.86–2.02)	0.208
HIV positive	91 (9.0)	8 (2.4)	83 (12.3)	7.50 (3.54–15.87)	<0.001	2.41 (0.98–5.94)	0.055
<b>Time since last HIV test</b>							
≤12 months	744 (74.0)	220 (66.9)	524 (77.4)	Ref			
>12 months	208 (20.7)	77 (23.4)	131 (19.4)	0.71 (0.52–0.99)	0.041	1.11 (0.53–2.30)	0.788
Never tested for HIV	54 (5.4)	32 (9.7)	22 (3.2)	0.29 (0.16–0.51)	<0.001	1.86 (0.22–15.82)	0.57
<b>Time since last STI test</b>							
≤12 months	724 (72.0)	206 (62.6)	518 (76.5)	Ref			
>12 months	196 (19.5)	75 (22.8)	121 (17.9)	0.64 (0.46–0.89)	0.008	0.86 (0.42–1.76)	0.677
Never tested for STIs	86 (8.5)	48 (14.6)	38 (5.6)	0.31 (0.20–0.50)	<0.001	0.71 (0.32–1.56)	0.397
<b>Number of male sex partners (last 6 months)</b>							
None	122 (12.1)	50 (15.2)	72 (10.6)	Ref			
1–5	459 (45.6)	174 (52.9)	285 (42.1)	1.14 (0.76–1.71)	0.535	1.44 (0.79–2.63)	0.24
6–10	171 (17.0)	47 (14.3)	124 (18.3)	1.83 (1.12–3.00)	0.016	1.66 (0.76–3.59)	0.2
>10	254 (25.2)	58 (17.6)	196 (29.0)	2.35 (1.47–3.74)	<0.001	1.49 (0.69–3.22)	0.312
<b>Sex with casual male partners (last 6 months)</b>							
Any condomless sex	570 (56.7)	158 (48.0)	412 (60.9)	Ref		Ref	
No casual partners/no anal sex	333 (33.1)	117 (35.6)	216 (31.9)	0.71 (0.53–0.95)	0.020	1.18 (0.71–1.95)	0.521
Consistent condom use	103 (10.2)	54 (16.4)	49 (7.2)	0.35 (0.23–0.53)	<0.001	0.52 (0.30–0.92)	<b>0.023</b>
STI diagnosis in last 12 months	255 (25.3)	60 (18.2)	195 (28.8)	1.81 (1.31–2.51)	<0.001	1.13 (0.71–1.79)	0.616
Knows ≥1 person living with HIV	677 (67.3)	191 (51.1)	496 (76.1)	3.04 (2.31–4.00)	<0.001	1.49 (1.04–2.14)	<b>0.032</b>

(Continued on next page)



**Table 2.** (Continued).

	<b>Total N = 1006</b>	<b>No n = 329</b>	<b>Yes n = 677</b>	<b>OR (95% CI)</b>	<b>P-value</b>	<b>aOR (95% CI)</b>	<b>P-value</b>
Self-rated familiarity with U=U							
A little familiar	238 (23.7)	185 (56.2)	53 (7.8)	Ref			
Somewhat familiar	305 (30.3)	107 (32.5)	198 (29.2)	6.46 (4.39–9.50)	<0.001	6.29 (4.19–9.46)	<0.001
Very familiar	463 (46.0)	37 (11.2)	426 (62.9)	40.19 (25.52–63.28)	<0.001	29.19 (18.11–47.04)	<0.001

Note: data are *n* (%). Bolded values indicate statistical significance at  $P < 0.001$  (two-tailed). Ref denotes the reference category for categorical variables, i.e., the baseline against which other levels of the variable were compared. Bivariable analyses showed that participants' country of birth was not related to perceived accuracy of U=U and this variable was excluded from further analyses.

Familiarity with U=U in the sample was concentrated among participants with HIV and PrEP users, and participants who knew at least one person living with HIV. Consistent with previous studies, our findings reaffirm that there is greater awareness of the U=U message in the social networks of GBM who are more engaged with HIV prevention and sexual health services, such as people living with HIV and PrEP users.<sup>23,24</sup>

Over three-quarters of GBM in our study had heard of (were familiar with) the U=U message, two-thirds of those who were familiar with U=U believed it was accurate, and nearly half those who believed U=U was accurate were willing to rely upon it. Our measure of familiarity differed from other studies. For example, in a US study conducted in 2017–18, participants either rated how accurate U=U was or instead selected if they were unsure what undetectable meant; this measure therefore inferred that 92% of the sample knew what undetectable meant, but did not ask specifically about knowledge of U=U.<sup>23</sup> Another US study conducted in 2018 found that 85% of participants were aware of the specific U=U message.<sup>24</sup> The level of perceived accuracy of U=U in our sample (67%) was higher compared to the aforementioned US studies, at 60% of participants in the first study who knew what undetectable meant<sup>23</sup> and 43% of the participants in the second study who were aware of U=U.<sup>24</sup> The greater perceived accuracy of U=U observed in our study was likely due to it being conducted a number of years later. Similarly, the level of familiarity with and perceived accuracy of U=U among people living with HIV in our study (96% and 91% respectively) was higher than that found in Australian and international research conducted in 2017–19.<sup>8,28,34</sup> These results suggest that awareness of and belief in U=U continue to grow over time,<sup>14</sup> and that most GBM living with HIV in Australia now believe that U=U is accurate, which is likely to be beneficial in supporting their health and sense of wellbeing.<sup>14</sup> Willingness to have condomless sex with a person with HIV who had an undetectable viral load was our measure of willingness to rely on U=U, which we stratified by HIV status and PrEP use. Our results showed the highest level of confidence in relying on U=U recorded to date among GBM in Australia.<sup>26,27,29</sup>

Consistent with previous research, we found that knowledge of and belief in U=U was concentrated among people living with HIV, followed by PrEP users.<sup>15,23</sup> The lowest levels of familiarity, perceived accuracy and willingness to rely upon U=U were among HIV-negative and untested men who were not using PrEP (some of the groups who might benefit from greater knowledge of U=U). As familiarity was independently associated with both belief in U=U's accuracy, and willingness to rely upon it, this suggests that education efforts should continue to focus (as a first step) on raising awareness of U=U among HIV-negative and untested men (particularly among those who do not use PrEP). However, we acknowledge that asking someone who does not know their HIV status to learn about U=U may be missing some important intermediate steps, such as confirming basic knowledge about HIV prevention and transmission, explaining why testing is useful, and the efficacy of contemporary HIV treatments in maintaining health and wellbeing. Previous Australian research suggests that, compared with previously tested GBM, those who have never tested for HIV are more likely to be younger, identify as bisexual, be more afraid of testing positive, not know where to test, and live outside inner city areas,<sup>35–38</sup> which overlaps with some of our findings about who was less likely to know about, believe in or rely on U=U. Improving basic knowledge of HIV, how to access supportive services and encouraging testing may be important factors for encouraging discussions about U=U among untested GBM. This is most likely to be achieved through community-level health promotion and education campaigns. International research suggests that HIV-negative people may be concerned about relying on U=U because it involves them trusting that a partner living with HIV is adherent to treatment and has accurate knowledge of their viral load,<sup>14,39</sup> for that reason, researchers have suggested it may be easier to rely on U=U in relationships where trust has already been established rather than broaching a potentially difficult conversation about U=U with casual sex partners.<sup>39,40</sup>

We acknowledge the limitations of our analyses. We recruited a convenience sample that may not be representative of GBM nationally,<sup>41</sup> and may have had an overrepresentation of PrEP users. This means the levels of familiarity, perceived

**Table 3.** Willingness to rely on U=U among 1006 participants who were familiar with it.

	Total N = 1006	No n = 533	Yes n = 476	OR (95% CI)	P-value	aOR (95% CI)	P-value
Age (years)							
<30	216 (21.5)	142 (26.6)	74 (15.6)	Ref		Ref	
≥30	790 (78.5)	391 (73.4)	399 (84.4)	1.96 (1.43–2.68)	<0.001	0.49 (0.31–0.79)	<b>0.003</b>
Sexuality							
Gay	849 (84.4)	429 (80.5)	420 (88.8)	Ref		Ref	
Bisexual	113 (11.2)	81 (15.2)	32 (6.8)	0.40 (0.26–0.62)	<0.001	0.76 (0.45–1.28)	0.3
Queer/another term	44 (4.4)	23 (4.3)	21 (4.4)	0.93 (0.51–1.71)	0.822	0.75 (0.31–1.79)	0.518
State/territory							
NSW	385 (38.3)	185 (34.7)	200 (42.3)	Ref		Ref	
Vic	261 (25.9)	147 (27.6)	114 (24.1)	0.72 (0.52–0.98)	0.039	0.65 (0.42–1.02)	0.06
Qld	164 (16.3)	84 (15.8)	80 (16.9)	0.88 (0.61–1.27)	0.497	0.76 (0.46–1.25)	0.277
Other states/territories	196 (19.5)	117 (22.0)	79 (16.7)	0.62 (0.44–0.88)	0.008	0.59 (0.37–0.95)	<b>0.031</b>
Education level							
High school/trade certificate	378 (37.6)	223 (41.8)	155 (32.8)	Ref		Ref	
University degree	628 (62.4)	310 (58.2)	318 (67.2)	1.48 (1.14–1.91)	0.003	1.48 (1.04–2.11)	<b>0.031</b>
HIV status and PrEP use							
Untested/unknown	53 (5.3)	45 (8.4)	8 (1.7)	0.41 (0.19–0.89)	0.024	0.57 (0.07–4.73)	0.606
HIV negative not on PrEP	441 (43.8)	307 (57.6)	134 (28.3)	Ref		Ref	
HIV negative taking PrEP	421 (41.8)	170 (31.9)	251 (53.1)	3.38 (2.55–4.48)	<0.001	1.19 (0.56–2.50)	0.65
HIV positive	91 (9.0)	11 (2.1)	80 (16.9)	16.66 (8.59–32.31)	<0.001	1.63 (0.19–14.20)	0.659
Time since last HIV test							
≤12 months	744 (74.0)	363 (68.1)	381 (80.5)	Ref		Ref	
>12 months	208 (20.7)	126 (23.6)	82 (17.3)	0.62 (0.45–0.85)	0.003	1.19 (0.56–2.50)	0.65
Never tested for HIV	54 (5.4)	44 (8.3)	10 (2.1)	0.22 (0.11–0.44)	<0.001	1.63 (0.19–14.20)	0.659
Time since last STI test							
≤12 months	724 (72.0)	342 (64.2)	382 (80.8)	Ref		Ref	
>12 months	196 (19.5)	125 (23.5)	71 (15.0)	0.51 (0.37–0.70)	<0.001	0.83 (0.40–1.72)	0.618
Never tested for STIs	86 (8.5)	66 (12.4)	20 (4.2)	0.27 (0.16–0.46)	<0.001	0.66 (0.30–1.46)	0.306
Number of male sex partners (last 6 months)							
None	122 (12.1)	78 (14.6)	44 (9.3)	Ref		Ref	
1–5	459 (45.6)	292 (54.8)	167 (35.3)	1.01 (0.67–1.54)	0.948	1.33 (0.73–2.45)	0.355
6–10	171 (17.0)	83 (15.6)	88 (18.6)	1.88 (1.17–3.03)	0.009	1.55 (0.71–3.37)	0.272
>10	254 (25.2)	80 (15.0)	174 (36.8)	3.86 (2.45–6.07)	<0.001	1.43 (0.66–3.10)	0.367
Sex with casual male partners (last 6 months)							
Any condomless sex	570 (56.7)	238 (44.7)	332 (70.2)	Ref		Ref	
No casual partners/no anal sex	333 (33.1)	210 (39.4)	123 (26.0)	0.42 (0.32–0.55)	<0.001	1.12 (0.67–1.86)	0.670
Consistent condom use	103 (10.2)	85 (15.9)	18 (3.8)	0.15 (0.09–0.26)	<0.001	0.49 (0.27–0.86)	<b>0.014</b>
STI diagnosis in last 12 months	255 (25.3)	97 (18.2)	158 (33.4)	2.25 (1.68–3.02)	<0.001	1.08 (0.68–1.73)	0.732
Knows ≥1 person living with HIV	652 (64.8)	259 (48.6)	393 (83.1)	5.20 (3.87–6.98)	<0.001	1.74 (1.19–2.54)	<b>0.004</b>
Self-rated familiarity with U=U							
A little familiar	238 (23.7)	193 (36.2)	45 (9.5)	Ref		Ref	
Somewhat familiar	305 (30.3)	192 (36.0)	113 (23.9)	2.52 (1.69–3.76)	<0.001	6.44 (4.27–9.72)	< <b>0.001</b>
Very familiar	463 (46.0)	148 (27.8)	315 (66.6)	9.13 (6.25–13.33)	<0.001	29.94 (18.52–48.40)	< <b>0.001</b>

Note: data are n (%). Bolded values indicate statistical significance at  $P < 0.001$  (two-tailed). Ref denotes the reference category for categorical variables, i.e., the baseline against which other levels of the variable were compared. Bivariable analyses showed that participants' country of birth was not related to willingness to rely on U=U and this variable was excluded from further analyses.

accuracy and willingness to rely on U=U we measured could have been overestimated in the whole sample (although we stratified by HIV status and PrEP use to compensate for this). We asked participants to self-rate their familiarity with U=U, but did not seek to assess their knowledge of U=U against any objective criteria. Participants also self-rated the accuracy of U=U based on their own understanding of it, which may or may not have been correct. For example, consistent with early health messaging, they may have understood U=U to mean ‘effectively no risk’ or ‘minimal risk,’ and rated U=U as completely accurate believing it to reflect something other than 0% risk. It would be beneficial to explore relative levels of perceived risk among participants in future studies. Next, measuring willingness to have condomless sex with a person with an undetectable viral load is a crude way to assess willingness to rely upon U=U that does not consider other contextual factors, levels of trust, or how intimate relationships affect condom use.<sup>32</sup> For PrEP users in particular, the measure of willingness to have condomless sex with an undetectable partner does not really assess reliance on U=U (as they may be relying on PrEP as much as or more than U=U). Willingness to rely on U=U among HIV-negative and untested GBM not using PrEP is probably the truer measure of willingness to rely solely on U=U in this sample. In addition, there is likely to be a gap between hypothetical willingness to rely on U=U and what GBM do in practice, and it would be beneficial to assess how many GBM report condomless sex with partners living with HIV and how this relates to beliefs about U=U. Future research could also explore the extent to which some HIV-negative GBM prefer to rely on an individual prevention strategy under their own control, such as PrEP or condom use, and how such a preference might influence reliance on U=U for HIV prevention. Finally, our analysis is useful for assessing community knowledge of U=U and identifying some groups who may benefit from greater education about the strategy. However, we did not assess what would make it easier for GBM to learn about or believe in U=U. We also did not explore specific fears and concerns about the strategy, such as potential uncertainty about partners sustaining an undetectable viral load and psychosocial barriers to relying on U=U, which qualitative studies have raised.<sup>39,42</sup> This could be investigated in future research.

## Conclusion

International research suggests that encouraging greater awareness of U=U appears to lead to higher levels of belief in the strategy.<sup>14</sup> This may be useful for combination prevention efforts, highlighting that there are a range of effective ways to prevent HIV. Knowledge of U=U may be particularly critical for people living with HIV and their partners, reassuring them that serodiscordant sex can be safe.<sup>43</sup> Our

results suggest that GBM living with HIV in Australia are now largely convinced of U=U’s efficacy, which is a welcome development. Knowledge of U=U appears to have grown among other GBM, but there is an ongoing need to continue to familiarise people with U=U and convince them of its safety.

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