

RESEARCH ARTICLE

Factors associated with perceived accuracy of the *Undetectable = Untransmittable* slogan among men who have sex with men: Implications for messaging scale-up and implementation

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Abstract

Introduction: Recent research has shown high efficacy of HIV treatment for reducing the risk of HIV transmission to sexual partners. As the efficacy of treatment as prevention (TasP) has proliferated, a new messaging campaign, *Undetectable = Untransmittable*, has been gaining popularity. The purpose of this paper was to assess factors associated with the perceived accuracy of this TasP messaging strategy among a large and diverse sample of gay, bisexual, and other men who have sex with men (GBMSM) in order to inform subsequent efforts at large-scale and implementation of the HIV prevention message.

Methods: We conducted a nationwide survey of GBMSM in the U.S. recruited from an online social networking site and a mobile sexual networking app. We analysed data from 12,222 GBMSM separately by HIV status to examine sociodemographic and behavioural factors associated with ratings of the accuracy of the *Undetectable = Untransmittable* message, which included the option to indicate not understanding what “undetectable” meant.

Results: Among HIV-negative and unknown men, multivariable linear regression indicated that being on pre-exposure prophylaxis (PrEP), identifying as gay or queer (versus bisexual or straight), recent serodiscordant condomless anal sex (CAS), testing every six months or more often, less concern about sexually transmitted infection (STI) infection, and lower perceived risk of HIV infection were the factors with the largest independent effect on rating the *Undetectable = Untransmittable* statement as more accurate. Fewer factors emerged as associated with accuracy ratings among HIV-positive participants—reporting an undetectable viral load, a lifetime acquired immune deficiency syndrome (AIDS) diagnosis, and lower concern about STI infection were the factors most strongly associated with rating the statement as more accurate.

Conclusions: The findings of the current study highlight variability in the perceived accuracy of the *Undetectable = Untransmittable* message, suggesting potential subgroups who might benefit from targeted educational campaigns, perhaps broadcast utilizing sexual networking apps. Numerous factors, particularly among HIV-negative and unknown GBMSM, were associated with rating the message as more accurate. In particular, being on PrEP and testing regularly were two of the variables most strongly associated with higher accuracy ratings among HIV-negative GBMSM, suggesting HIV prevention services as potential points of intervention for increasing HIV knowledge and decreasing HIV stigma.

Keywords: treatment as prevention; men who have sex with men; viral load; public health; risk factors

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1 | INTRODUCTION

Since the development of highly effective combination forms of antiretroviral therapy (ART) for HIV infection, questions have circulated regarding whether reductions in HIV viraemia might reduce the likelihood of HIV transmission—a notion typically referred to as *treatment as prevention* (TasP) [1]. The efficacy of TasP has been strongly supported in empirical research, beginning with observational studies on the association between HIV viral load and transmission within serodiscordant couples [2] and the role of community-level viral load

on HIV incidence rates [3]. The HIV Prevention Trials Network (HPTN) 052 study [4,5] was a Phase III randomized clinical trial examining early onset versus delayed ART initiation within serodiscordant couples that, in 2011, published the landmark finding that early initiation of ART was associated with a 96% lower risk of HIV seroconversion within couples [4,6]. Subsequent published analyses of the HPTN 052 data revealed no cases of linked HIV transmission within serodiscordant couples having condomless sex when the HIV-positive partner had a stably suppressed plasma viral load (i.e. less than 200 copies/ml) [7]. In the PARTNER study of 1,166

serodiscordant heterosexual and gay male couples, no linked HIV transmissions from the HIV-positive to the HIV-negative primary partner occurred [8]. Most recently, researchers presented data from the *Opposites Attract* study of 358 serodiscordant male couples and found the same—not a single incident HIV infection linked to the main partner despite high rates of condomless anal sex (CAS) [9,10].

As a result of these groundbreaking findings, momentum has been building among non-governmental organizations, local health departments and notable HIV/acquired immune deficiency syndrome (AIDS) community advocates to disseminate the message that individuals living with HIV with an undetectable viral load cannot transmit the virus to their partners. Notably, the Prevention Access Campaign has been working to popularize the slogan “*Undetectable = Untransmittable*” (colloquially referred to within online social media as simply #UequalsU) as a means of both raising HIV prevention awareness and reducing HIV stigma. The most recent version of their website as of this writing recognizes more than 500 community partner organizations across more than 67 countries who have signed on as supporters of the campaign [11]. These organizations include a large number of community-based, charitable, news, and political organizations (e.g. GMHC, GLAAD, the Human Rights Campaign and TheBody.com within the U.S.; Terrence Higgins Trust, NAM aidsmap and the LGBT Foundation within the U.K.) as well as health officials and local health departments (e.g. New York City Department of Health and Mental Hygiene, Washington, DC Department of Health, and the U.S.-based National Alliance of State & Territorial AIDS Directors) and scientific leaders.

In addition to the increasing number of endorsements for the *Undetectable = Untransmittable* slogan, the notion of TasP has received the support of major health agencies such as the U.S. Centers for Disease Control and Prevention and the National Institute of Allergy and Infectious Diseases [12-14]. However, other biomedical prevention techniques such as pre-exposure prophylaxis (PrEP) have had limited uptake over time despite both strong public health endorsements and relatively high initial acceptability [15-20]. Some barriers to PrEP uptake that have been noted, such as inaccurate knowledge and risk perception [21] as well as community norms about condom use [22,23], may also important to consider as part of the implementation and scale-up of TasP messaging.

In order for successful implementation, TasP messaging will need to be understood by and acceptable to the public. Despite this, and amidst what is already a large increase in dissemination efforts, little is currently known about public perceptions of the message. One study of more than 700 gay, bisexual and other men who have sex with men (GBMSM) collected from 2012 to 2016 showed that only about half of the sample was aware of TasP; of them, the majority of HIV-negative men were either unaware or sceptical of it, with only 6% believing in its accuracy [24,25]. Another study of GBMSM in Australia showed an increase in belief of TasP from 2.6% in 2013 to 13.1% in 2015, though the increase was primarily driven by increases among HIV-positive men in the sample [26]. Terrence Higgins Trust issued a press release citing data from a 2017 YouGov survey of 2022 British adults in which they found that only 9% were aware that individuals with an undetectable viral load cannot transmit the virus to partners [27]. In addition to differences between HIV-positive and HIV-negative

individuals, research has demonstrated that engaging in condomless sex is associated with stronger beliefs in TasP [28,29].

Given the significant potential for TasP messaging to increase HIV-related knowledge and reduce HIV stigma if disseminated effectively, the present study aimed understand sociodemographic and behavioural factors associated with perceived accuracy of the *Undetectable = Untransmittable* message among a nationwide sample of GBMSM in the U.S.

2 | METHOD

Data for this study were taken from a large nationwide survey of GBMSM conducted over a four-week period between May and June, 2017.

2.1 | Participants and procedures

Between 17 May and 10 June 2017, we utilized advertisements to target the recruitment of GBMSM from two venues, one of the most popular geotargeted sexual networking apps for GBMSM and one of the most popular social networking websites for the general population (i.e. Facebook). On the sexual networking app, the advertisement was pushed as a message in the chat inboxes of all users within the U.S. and remained for a period of 7 days, unless manually deleted sooner. On the social networking site, we utilized targeted banner advertisements for approximately four weeks—ads were targeted to people who were men, residing in the U.S., aged 18 or older, and believed to be GBMSM based on either a same-sex interest listed within their profile or a range of interests predetermined by the site to be relevant to the lesbian, gay, bisexual, and transgender community. Both ads contained a background image as well as brief text, including language that they could “enter to win a \$50 Amazon.com gift card” and that there was “no participation necessary” to enter.

Upon clicking on the ad, participants were informed that the survey would take approximately 10 to 15 minutes to complete and provided the option to begin immediately or enter their email address to receive a link to complete at a later time. Upon beginning the survey, participants were presented with a brief online consent form and given the options providing consent, declining, or declining with the option to receive the instructions for entering the random gift card drawing without completion. All participants had a 1 in 100 chance of receiving a \$50 gift card and those who were interested were able to separately provide an email address that was not linked to their data. During the first few questions of the survey, participants were screened for and informed if they did not meet eligibility, which was defined as: (1) 18 years of age or older; (2) residing within the U.S.; (3) having had same-sex sexual activity within the past year; and (4) identifying as male (including both cisgender and transgender males). All procedures were reviewed and approved by the Human Research Protections Program of The City University of New York.

2.2 | Measures

Participants completed a variety of measures, which are described below and several of which are included within the [Appendix](#).

2.2.1 | Sociodemographic characteristics

We recorded whether participants were recruited from the social networking site or the sexual networking app. Participants self-reported their age, race/ethnicity, gender identity, sexual orientation, zip code (which we recoded into the four primary regions of the U.S.), educational attainment, preferred sexual position and their relationship status; for men in relationships, we asked the HIV status of their main partner, which we subsequently recoded into being in a seroconcordant or serodiscordant relationship. Participants reported their levels of “outness” about their sexual orientation on a four-point scale ranging from 1 (*not at all*) to 4 (*completely*).

2.2.2 | Club drug use

Participants were asked whether they had used cocaine, crack, crystal meth, ecstasy, GHB and ketamine in the last six months, and we recoded their responses into a single dichotomous indicator of any club drug use in the past six months.

2.2.3 | Serodiscordant CAS

Participants were asked about the number of casual male sexual partners they had in the prior six months who were the same HIV status as them and those who were a different status or whose status they did not know. Following this, participants were asked the number of times they engaged in insertive and receptive anal sex with and without a condom with these partners. We utilized these count data to create a single dichotomous indicator of whether the participant reported any CAS with a serodiscordant (i.e. different or unknown status) casual male partner in the prior six months.

2.2.4 | Biomedical status

Participants were first asked to report their HIV status as positive, negative, or unknown (*I don't know*), after which HIV-negative and status-unknown individuals were asked if they were currently prescribed PrEP and HIV-positive individuals were asked if their most recent viral load test was undetectable, detectable, or unknown (*Not sure/don't remember*). We combined the answers from these questions to form five distinct groups based on biomedical status: (1) HIV-negative and on PrEP; (2) HIV-negative and not on PrEP; (3) HIV-positive and undetectable; (4) HIV-positive and detectable; and (5) HIV status unknown. There were a total of 13 men currently prescribed PrEP who reported their HIV status as unknown and were treated as part of the first group (i.e. HIV-negative and on PrEP).

2.2.5 | HIV and sexually transmitted infection prevention and treatment

Participants were asked to report on how concerned they were about contracting a sexually transmitted infection (STI) other than HIV, with response options ranging from 1 (*not at all concerned*) to 5 (*very concerned*). HIV-negative and unknown-status participants were also asked to complete a single item validated for assessing perceived risk of contracting HIV [30], with responses ranging from 0 (*zero*) to 5 (*very large*) and reported on the frequency with which they received

HIV testing, ranging from 0 (*never*) to 6 (*every two weeks*), which we recoded into a single dichotomous indicator of testing every six months or more frequently. HIV-positive participants were asked to report whether they had ever received an AIDS diagnosis and respond to a single validated item for assessing antiretroviral adherence [31] ranging from 1 (*very poor*) to 6 (*excellent*), which was dichotomized as excellent versus less than excellent based on the scale's use in prior research.

2.2.6 | Perceived accuracy of the Undetectable = Untransmittable message

Participants were asked, “With regard to HIV-positive individuals transmitting HIV through sexual contact, how accurate do you believe the slogan *Undetectable = Untransmittable* is?” Responses were on a Likert-type scale from 1 (*Completely inaccurate*) to 4 (*Completely accurate*) as well as a fifth, mutually exclusive option (*I don't know what “undetectable” means*).

2.3 | Statistical Analyses

All analyses were conducted in SPSS Version 24. We began by examining the sociodemographic characteristics of the sample and comparing those characteristics between the HIV-negative/unknown-status and HIV-positive participants using chi-square tests of independence. Following this, analyses about the perceived accuracy of the message were conducted separately for HIV-positive and HIV-negative/unknown-status men due to established differences in their views on TasP and the different factors that were examined for each (e.g. HIV prevention practices for HIV-negative and unknown versus HIV treatment factors for HIV-positive). For HIV-negative/unknown individuals, we conducted two multivariable models with the same set of predictors: (1) a binary logistic regression examining whether or not men reported they were unsure what “undetectable” meant (and thus did not rate the accuracy of the message); and (2) a linear regression of the accuracy ratings among those who rated the message (i.e. those who did *not* respond that they were unsure what undetectable meant). Only 19 (0.01%) of HIV-positive men reported they were unsure what an undetectable viral load was, and the single largest factor associated with this was whether they reported their own status as being undetectable. As a result, we conducted only one model with HIV-positive participants—a linear regression of the accuracy ratings for HIV-positive men, excluding those 19 who reported being unsure what an undetectable status meant.

3 | RESULTS

A total of 18,909 individuals reached the survey consent form, of whom 17,954 (94.9%) provided consent. Of those, 1,335 (7.4%) did not provide sufficient data to determine eligibility, 2,068 (11.5%) were deemed ineligible, 3,487 (19.4%) were eligible but only partially completed survey, and 11,064 (61.6%) completed the survey in its entirety. We removed a total of 30 completed surveys that were duplicate responses of previously completed surveys. Despite some not having completed

the entire survey, which included several measures at the end that are not included in these analyses, a total of 12,222 GBMSM provided full data on those measures included in this manuscript and thus constituted the analytic sample.

The sociodemographic characteristics and differences between the two groups split by HIV status are presented within Table 1. There was a diverse representation of race/ethnicity, geographic region, and educational attainment; most

of the sample was HIV-negative and not on PrEP, cisgender male, gay-identified, versatile with regard to sexual positioning and single. We observed significant differences between the two groups across all of the sociodemographic characteristics examined. Findings indicated that, compared to HIV-negative or unknown men, a greater proportion of HIV-positive men were recruited from the sexual networking app, were men of colour, were cisgender, identified as gay or queer, were from

Table 1. Demographic characteristics and comparisons by status

	Full sample (N = 12,222) n (%)	HIV status comparisons	
		HIV-negative or unknown (N = 10,140) n (%)	HIV-positive (n = 2082) n (%)
Biomedical status			N/A
HIV-negative on PrEP	1364 (11.2)	1364 (13.5)	0 (0.0)
HIV-negative not on PrEP	7765 (63.5)	7765 (76.6)	0 (0.0)
HIV status unknown	1011 (8.3)	1011 (10.0)	0 (0.0)
HIV-positive undetectable	1788 (14.6)	0 (0.0)	1788 (85.9)
HIV-positive detectable	294 (2.4)	0 (0.0)	294 (14.1)
Recruitment source			$\chi^2 (1) = 10.56^{**}$
Social networking website	2405 (19.7)	2049 (20.2)	356 (17.1)
Sexual networking app	9817 (80.3)	8091 (79.8)	1726 (82.9)
Race/ethnicity			$\chi^2 (3) = 194.99^{***}$
Black	1265 (10.4)	880 (8.7)	385 (18.5)
Latino	2735 (22.4)	2269 (22.4)	466 (22.4)
White	6486 (53.1)	5472 (54.0)	1014 (48.7)
Other/multiracial	1736 (14.2)	1519 (15.0)	217 (10.4)
Gender			$\chi^2 (1) = 27.74^{***}$
Cisgender male	12,045 (98.6)	9967 (98.3)	2078 (99.8)
Transgender male	177 (1.4)	173 (1.7)	4 (0.2)
Sexual orientation identity			$\chi^2 (2) = 108.41^{***}$
Gay or queer	10,012 (81.9)	8140 (80.3)	1872 (89.9)
Bisexual	2006 (16.4)	1817 (17.9)	189 (9.1)
Straight/other	204 (1.7)	183 (1.8)	21 (1.0)
Region			$\chi^2 (4) = 42.72^{***}$
Northeast	2304 (18.9)	1932 (19.1)	372 (17.9)
Midwest	2258 (18.5)	1947 (19.2)	311 (14.9)
South	4208 (34.4)	3374 (33.3)	834 (40.1)
West	3342 (27.3)	2797 (27.6)	545 (26.2)
Other/unknown	110 (0.9)	90 (0.9)	20 (1.0)
Educational attainment			$\chi^2 (3) = 10.77^*$
High school or less	2765 (22.6)	2295 (22.6)	470 (22.6)
Some college	5440 (44.5)	4456 (43.9)	984 (47.3)
4-year college degree	2643 (21.6)	2219 (21.9)	424 (20.4)
Postgraduate degree	1374 (11.2)	1170 (11.5)	204 (9.8)
Sexual position			$\chi^2 (2) = 86.40^{***}$
Top	1860 (15.2)	1674 (16.5)	186 (8.9)
Versatile	8303 (67.9)	6831 (67.4)	1472 (70.7)
Bottom	2059 (16.8)	1635 (16.1)	424 (20.4)
Relationship status			$\chi^2 (2) = 387.86^{***}$
Single	7980 (65.3)	6628 (65.4)	1352 (64.9)
Partnered, seroconcordant	3136 (25.7)	2808 (27.7)	328 (15.8)
Partnered, serodiscordant	1106 (9.0)	704 (6.9)	402 (19.3)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

the South, had some college or less, identified their sexual position as versatile or bottom, and were partnered in serodiscordant relationships. Furthermore, HIV-positive men were significantly older ($M = 39.3$, $SD = 11.6$) than HIV-negative or unknown-status men ($M = 31.2$, $SD = 11.6$), $t(2993) = -29.07$, $p < 0.001$. A much greater proportion of HIV-negative and unknown-status men reported not understanding what an undetectable viral load was and thus not rating the accuracy of the message; of those who did rate the message, the majority of HIV-negative and unknown-status men viewed the message as inaccurate, whereas the majority of HIV-positive men viewed the message as accurate.

Table 2 reports on the two regressions among HIV-negative or unknown-status men. With regard to being unsure what an undetectable viral load was, several factors were significantly associated including biomedical status, Latino race/ethnicity, sexual orientation, education, sexual position, frequency of HIV testing, age, level of "outness" about sexual orientation and perceived risk of HIV infection. Of those who understood what an undetectable viral load was sufficiently enough to respond to rate the slogan's accuracy ($n = 9462$, 93.3%), we examined the same set of variables in predicting the accuracy ratings. Numerous factors were significantly associated with the ratings, with the largest effects ($|\beta| > 0.05$) being as follows: HIV-negative men on PrEP (versus negative and not on PrEP), gay or queer men (versus bisexual or straight), men reporting recent serodiscordant CAS, and men reporting HIV testing every six months or more often rated the statement as *more* accurate; those with some college education or less, those with greater concern about STI infection, and those with greater perceived risk of HIV infection rated the statement as *less* accurate.

Table 3 reports on the linear regression of accuracy ratings among the HIV-positive participants, excluding the 19 (0.03%) who reported being unsure what an undetectable viral load was. Far fewer factors emerged as significant or of similar effect size as those for HIV-negative men. Those with a detectable viral load and those who reported greater concern about STI infection rated the statement as *less* accurate while those from the Northeast and West (versus the South) and those who reported recent serodiscordant CAS rated the statement as *more* accurate.

4 | DISCUSSION

In the present study, we analysed data from a large nationwide sample of GBMSM to better understand perceptions of the TasP slogan "*Undetectable = Untransmittable*" to help inform efforts at its large-scale implementation. The majority of HIV-positive men rated the message as accurate, whereas the majority of HIV-negative and unknown-status men viewed the message as inaccurate. Even among the HIV-positive men, nearly one-third rated the message as somewhat or completely inaccurate. A much larger number of factors predicted the accuracy ratings among HIV-negative and unknown men than they did among HIV-positive men. However, both groups shared three significant factors that independently predicted accuracy ratings: biomedical status, engaging in serodiscordant CAS, and less concern about other STIs. Taken together, the findings of the present study have several implications that

may help improve the dissemination of the *Undetectable = Untransmittable* message to the general public, which we highlight below.

Wide acceptance of TasP messaging has the potential to shift public discourse away from HIV-diagnosed individuals as vectors of transmission, thus reducing stigma and promoting greater knowledge about HIV. Belief in TasP messaging could lead to changes in legal and public health policies, such as HIV non-disclosure criminalization laws, that represent a structural form of HIV stigma, and could also have downstream effects on interpersonal and internalized forms of stigma via shifting public attitudes [32]. However, one of the primary findings is that the majority of HIV-negative and unknown-status men view the message as being inaccurate, thus lowering the potential acceptability and efficacy of the message in reaching these audiences and having the intended effect. These findings were in line with prior international research on beliefs about TasP more generally in which researchers identified that the majority of HIV-negative participants expressed disbelief or scepticism about the efficacy of TasP [24-26].

Although fewer than half of HIV-negative GBMSM perceiving the message as accurate at the time of this study, the findings suggest some potential points of intervention that could help to increase its acceptance. Specifically, some of the variables most strongly associated with the perceived accuracy of the message were biomedical status (i.e. being on PrEP) and receiving HIV testing every six months or more often. This suggests that HIV prevention services such as PrEP navigation and HIV testing are having the intended consequence of increasing HIV prevention knowledge. While individuals are receiving such services, education about TasP might be disseminated and regular clients might be receptive to the message and being trained as "key opinion leaders" [33] to disseminate information about the *Undetectable = Untransmittable* message to peers. Nearly three-quarters of men in this sample reported HIV testing at least once per year, which is consistent with prior research [34], suggesting that dissemination of TasP messaging during these visits would have broad and relatively rapid reach.

Having *lower* perceived risk of HIV infection and *lower* concern about other STIs were both associated with perceiving the message as *more* accurate among the HIV-negative and unknown-status men. People with greater knowledge about HIV are better able to accurately understand HIV and STI transmission risk and feel higher self-efficacy for protecting themselves, and thus it may be that it is individuals with low-to-moderate risk perception (which may be accurate) also are those who correctly understood the accuracy of the *Undetectable = Untransmittable* message to be higher [35]. Alternatively, an unmeasured confounding variable such as HIV treatment optimism or prevention fatigue may be contributing to both lower levels of perceived risk and to higher perceived accuracy of the message [36]. In addition to these factors, having engaged in recent serodiscordant CAS was a strong and independent predictor of higher perceived accuracy, as has been identified in prior research on beliefs about TasP [28,29]. Similar to HIV risk perception, individuals who better understand TasP and other aspects of HIV prevention may more accurately perceive and feel in control of their own HIV transmission risk, thus leading to what may appear to be greater risk compensation (though behaviours could objectively be lower risk and this could simply be masked by

Table 2. Multivariable analyses among HIV-negative and unknown participants

	Unsure what “undetectable” means (n = 10,140)			Accuracy rating (n = 9462)		
	B	AOR	AOR 95% CI	B	B 95% CI	β
Biomedical Status (ref. = Negative, not on PrEP)						
Negative, on PrEP	−0.51	0.60**	[0.43, 0.85]	0.39	[0.33, 0.45]	0.13***
HIV status unknown	0.47	1.59***	[1.25, 2.03]	0.06	[−0.01, 0.14]	0.02
Recruitment source (ref. = social networking site)						
Sexual networking app	−0.20	0.82	[0.67, 1.01]	0.12	[0.07, 0.17]	0.05***
Race/ethnicity (ref. = White)						
Black	0.01	1.01	[0.75, 1.38]	0.16	[0.09, 0.24]	0.05***
Latino	0.29	1.33**	[1.09, 1.63]	0.12	[0.07, 0.17]	0.05***
Other/multiracial	0.02	1.02	[0.80, 1.30]	0.07	[0.01, 0.13]	0.03*
Gender (ref. = cisgender male)						
Transgender male	0.20	1.22	[0.73, 2.06]	−0.07	[−0.23, 0.08]	−0.01
Sexual orientation identity (ref. = bisexual/straight)						
Gay or queer	−0.21	0.81*	[0.66, 1.00]	0.14	[0.09, 0.20]	0.06***
Region (ref. = South)						
Northeast	0.12	1.13	[0.90, 1.42]	0.00	[−0.06, 0.06]	0.00
Midwest	−0.11	0.90	[0.71, 1.14]	0.01	[−0.05, 0.07]	0.00
West	0.05	1.05	[0.86, 1.29]	0.02	[−0.04, 0.07]	0.01
Other/unknown	0.59	1.80	[0.92, 3.50]	0.21	[−0.01, 0.42]	0.02
Educational attainment (ref. = high school or less)						
Some college	−0.20	0.82*	[0.68, 0.98]	−0.12	[−0.18, −0.07]	−0.06***
4-year college degree	−0.61	0.54***	[0.42, 0.70]	−0.06	[−0.12, 0.00]	−0.03*
Postgraduate degree	−0.58	0.56**	[0.40, 0.78]	−0.01	[−0.08, 0.06]	0.00
Sexual position (ref. = versatile)						
Top	−0.07	0.93	[0.74, 1.18]	0.00	[−0.05, 0.06]	0.00
Bottom	0.21	1.23*	[1.00, 1.51]	−0.01	[−0.07, 0.04]	0.00
Relationship status (ref. = single)						
Partnered, seroconcordant	−0.06	0.95	[0.78, 1.15]	−0.04	[−0.09, 0.01]	−0.02
Partnered, serodiscordant	−0.13	0.88	[0.63, 1.22]	0.17	[0.09, 0.25]	0.04***
Recent club drug use (ref. = no)						
Yes	0.09	1.09	[0.87, 1.36]	0.07	[0.02, 0.12]	0.03*
Recent serodiscordant CAS (ref. = no)						
Yes	0.11	1.11	[0.89, 1.39]	0.21	[0.16, 0.26]	0.08***
Frequency of HIV testing (ref. = < every six months)						
Every six months or more often	−0.38	0.69***	[0.57, 0.82]	0.17	[0.13, 0.22]	0.09***
Age (per 10 years)	−0.09	0.91*	[0.84, 0.99]	0.04	[0.02, 0.06]	0.05***
Level of “outness”	−0.14	0.87**	[0.80, 0.96]	0.04	[0.03, 0.07]	0.04**
Concern about STI infection	0.04	1.04	[0.98, 1.11]	−0.08	[−0.09, −0.06]	−0.10***
HIV risk perception	−0.25	0.78***	[0.71, 0.84]	−0.07	[−0.09, −0.05]	−0.07***

AOR, adjusted odds ratio; B, unstandardized beta; β, standardized beta.
 * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

insufficient detail in the collection of these aggregated sexual behaviour data). For example, they may engage in serodiscordant CAS with undetectable partners specifically because they are aware of its extremely low risk.

Perceived accuracy of the message was higher among HIV-positive GBMSM, though nearly one-third rated it as being at least somewhat inaccurate. The three strongest independent predictors of HIV-positive GBMSM viewing the message as being more accurate were reporting an undetectable viral

load, reporting recent serodiscordant CAS, and reporting lower concern about other STIs. The finding regarding undetectable viral load highlights an area that requires further study—namely whether HIV-positive individuals who are not stably suppressed may feel excluded or negatively impacted by the *Undetectable = Untransmittable* message. It is possible that such individuals already feel shame or guilt about not being virally suppressed and have concerns that they will become an even greater target of stigma as a result of not

Table 3. Multivariable analyses among HIV-positive participants

	Accuracy rating (n = 2063)		
	B	B 95% CI	β
Biomedical Status (ref. = Positive, undetectable)			
Positive, detectable	-0.15	[-0.25, -0.05]	-0.07**
Recruitment source (ref. = social networking site)			
Sexual networking app	0.03	[-0.09, 0.15]	0.01
Race/ethnicity (ref. = White)			
Black	0.12	[-0.01, 0.25]	0.05
Latino	0.01	[-0.11, 0.12]	0.00
Other/multiracial	0.12	[-0.03, 0.27]	0.04
Gender (ref. = cisgender male)			
Transgender male	-0.26	[-1.25, 0.73]	-0.01
Sexual orientation identity (ref. = bisexual/straight)			
Gay or queer	0.08	[-0.08, 0.23]	0.02
Region (ref. = South)			
Northeast	0.13	[0.01, 0.25]	0.05*
Midwest	0.11	[-0.02, 0.24]	0.04
West	0.12	[0.01, 0.23]	0.05*
Other/unknown	0.40	[-0.04, 0.85]	0.04
Educational attainment (ref. = high school or less)			
Some college	-0.05	[-0.16, 0.06]	-0.02
4-year college degree	-0.01	[-0.14, 0.13]	0.00
Postgraduate degree	0.02	[-0.15, 0.18]	0.01
Sexual position (ref. = versatile)			
Top	0.00	[-0.15, 0.15]	0.00
Bottom	0.00	[-0.11, 0.11]	0.00
Relationship status (ref. = single)			
Partnered, seroconcordant	-0.07	[-0.20, 0.05]	-0.03
Partnered, serodiscordant	0.03	[-0.09, 0.14]	0.01
Recent club drug use (ref. = no)			
Yes	-0.07	[-0.17, 0.03]	-0.03
Recent serodiscordant CAS (ref. = no)			
Yes	0.24	[0.15, 0.33]	0.12***
Lifetime AIDS diagnosis (ref. = no)			
Yes	-0.03	[-0.13, 0.08]	-0.01
ART medication adherence (ref. = excellent)			
Less than excellent	0.07	[-0.02, 0.17]	0.04
Not prescribed ART	-0.12	[-0.34, 0.10]	-0.03
Age (per 10 years)	0.01	[-0.04, 0.05]	0.01
Level of "outness"	0.06	[0.00, 0.11]	0.05
Concern about STI infection	-0.07	[-0.10, -0.04]	-0.10***

B, unstandardized beta; β , standardized beta.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

being “covered” by the message. Just as with the HIV-negative and unknown men, it remains unclear the exact mechanism through which serodiscordant CAS is associated with the perceived accuracy of the message for HIV-positive men, though it seems plausible that the mechanism would be consistent across groups.

Finally, it is worth noting that this entire sample consisted of GBMSM recruited through online and mobile networking

venues. Among HIV-negative and status-unknown men, recruitment from the sexual networking app was associated with stronger belief in the accuracy of the message as compared with those from the social networking site. The ability to utilize targeted advertisements on apps such as these suggests they may serve as key “hotspots” in which to implement educational campaigns regarding TasP and HIV prevention more broadly.

4.1 | Study Strengths and Limitations

The study had numerous strengths and limitations that are worth noting. We recruited a large and relatively diverse sample of GBMSM from across the U.S., which allowed us to look at a variety of important factors in association with the perceived accuracy of the *Undetectable = Untransmittable* message. Nonetheless, recruiting such a large sample required limited interaction techniques, meaning that all of the data were cross-sectional and self-reported; we were unable to verify factors such as biomedical status and STI diagnoses and unable to examine potential mechanisms of the associations over time. This is the first published study that we are aware of to examine perceived accuracy of this specific message, though relying on this message specifically may also limit the generalizability of the findings to TasP messaging more broadly. Moreover, we did not measure prior exposure to the message, which limits our ability to account for such effects. We focused on GBMSM given their disproportionate burden of HIV within the U.S., though future studies examining this topic among other populations are warranted. Finally, although we utilized several standard procedures for ensuring valid results in online research, including providing only a random chance for compensation and conducting de-duplication checks, this was nonetheless an anonymous online survey and thus some degree of caution should be taken when considering the results.

5 | CONCLUSIONS

The *Undetectable = Untransmittable* TasP message was perceived as being inaccurate by the majority of HIV-negative and status-unknown participants and by nearly one-third of HIV-positive individuals, suggesting a need for further educational strategies and targeted dissemination. Compared to prior studies on TasP, the present findings do highlight the possibility that beliefs about TasP have increased in the past few years [24–26], which may be due in large part to the campaign to disseminate the *Undetectable = Untransmittable* message by the Prevention Access Campaign. It is worth noting that this study was conducted before this message received endorsement by major public health entities like the U.S. Centers for Disease Control and Prevention, and research is needed to explore the impact of these endorsements and the increased dissemination it is receiving on social media and its integration within sexual networking app profiles. The sociodemographic and behavioural differences in perceived accuracy of the message can be helpful in highlighting subgroups for whom further work is needed to enhance the implementation and dissemination of TasP messaging in order to improve HIV prevention and reduce HIV stigma. We identified several variables significantly associated with perceived accuracy, particularly among HIV-negative men, and findings suggest that HIV prevention services (e.g. routine HIV testing, PrEP care) might be used as a point of entry for identifying and training individuals who may be most receptive to disseminating the message through their networks. Moreover, online and mobile networking venues may be ideal venues in which to implement educational campaigns around TasP. As implementation of the campaign progresses, it remains critical to

consider how it may impact HIV-positive individuals who are not virally suppressed and to continue working to reduce stigma and discrimination for all HIV-positive persons regardless of their biomedical status. Future longitudinal research, including that with other groups such as heterosexual men and women, is needed to study the reach of TasP messaging and its impact on public attitudes and behaviours to further inform the implementation of this and other HIV prevention messaging campaigns.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHORS' CONTRIBUTIONS

HJR was responsible for study design, data collection, data analysis, interpreting the results and drafting of the manuscript. JTP was responsible for study design and revising the manuscript. Both authors read, revised and approved a final version of the manuscript.

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REFERENCES

1. Smith K, Powers KA, Kashuba AD, Cohen MS. HIV-1 treatment as prevention: the good, the bad, and the challenges. *Curr Opin HIV AIDS*. 2011;6(4):315.
2. Attia S, Egger M, Müller M, Zwahlen M, Low N. Sexual transmission of HIV according to viral load and antiretroviral therapy: systematic review and meta-analysis. *AIDS*. 2009;23(11):1397–404.
3. Das M, Chu PL, Santos G-M, Scheer S, Vittinghoff E, McFarland W, et al. Decreases in community viral load are accompanied by reductions in new HIV infections in San Francisco. *PLoS One*. 2010;5(6):e11068.
4. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011;365(6):493–505.
5. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Antiretroviral therapy for the prevention of HIV-1 transmission. *N Engl J Med*. 2016;375(9):830–9.
6. Cohen MS, McCauley M, Gamble TR. HIV treatment as prevention and HPTN 052. *Curr Opin HIV AIDS*. 2012;7(2):99.

7. Eshleman SH, Hudelson SE, Redd AD, Swanstrom R, Ou S-S, Zhang XC, et al. Treatment as prevention: characterization of partner infections in the HIV prevention trials network 052 trial. *J Acquir Immune Defic Syndr*. **2017**;74(1):112–6.

8. Rodger AJ, Cambiano V, Bruun T, Vernazza P, Collins S, Van Lunzen J, et al. Sexual activity without condoms and risk of HIV transmission in serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. *JAMA*. **2016**;316(2):171–81.

9. Bavinton BR, Jin F, Prestage G, Zablotska I, Koelsch KK, Phanuphak N, et al. The Opposites Attract Study of viral load, HIV treatment and HIV transmission in serodiscordant homosexual male couples: design and methods. *BMC Public Health*. **2014**;14(1):917.

10. Grulich AE, Bavinton BR, Jin F, Prestage G, Zablotska I, Koelsch K, editors. HIV transmission in male serodiscordant couples in Australia, Thailand and Brazil. Seattle, Washington: 22nd Conference on Retroviruses and Opportunistic Infections; **2015**.

11. Prevention Access Campaign. U=U Community Partners 2017. [cited 2017 Dec 7]. Available from: <https://www.preventionaccess.org/community>

12. Fauci AS. Federal Perspectives on Research, Prevention, and Treatment. Washington, DC: United States Conference on AIDS; **2017**.

13. Fauci AS, Goodenow MM. NIH Statement on World AIDS Day 2017 [cited 2017 Dec 7] Available from: <https://www.nih.gov/news-events/news-releases/nih-statement-world-aids-day-2017>

14. McCray E, Mermin JH. Dear Colleague: Information from CDC's Division of HIV/AIDS Prevention. **2017** [cited 2017 Dec 7]. Available from: <https://www.cdc.gov/hiv/library/dcl/dcl/092717.html>

15. Krakower DS, Mimiaga MJ, Rosenberger JG, Novak DS, Mitty JA, White JM, et al. Limited awareness and low immediate uptake of pre-exposure prophylaxis among men who have sex with men using an internet social networking site. *PLoS One*. **2012**;7(3):e33119.

16. Eaton LA, Driffin DD, Bauermeister J, Smith H, Conway-Washington C. Minimal awareness and stalled uptake of pre-exposure prophylaxis (PrEP) among at risk, HIV-negative, black men who have sex with men. *AIDS Patient Care STDS*. **2015**;29(8):423–9.

17. Kelley CF, Kahle E, Siegler A, Sanchez T, Del Rio C, Sullivan PS, et al. Applying a PrEP continuum of care for men who have sex with men in Atlanta, Georgia. *Clin Infect Dis*. **2015**;61(10):1590–7.

18. Holloway IW, Dougherty R, Gildner J, Beougher SC, Pulsipher C, Montoya JA, et al. Brief report: PrEP uptake, adherence, and discontinuation among California YMSM using geosocial networking applications. *J Acquir Immune Defic Syndr*. **2017**;74(1):15–20.

19. Parsons JT, Rendina HJ, Lassiter JM, Whitfield TH, Starks TJ, Grov C. Uptake of HIV pre-exposure prophylaxis (PrEP) in a national cohort of gay and bisexual men in the United States. *J Acquir Immune Defic Syndr*. **2017**;74(3):285–92.

20. Rolle C-P, Rosenberg ES, Siegler AJ, Sanchez TH, Luisi N, Weiss K, et al. Challenges in translating PrEP interest into uptake in an observational study of young black MSM. *J Acquir Immune Defic Syndr*. **2017**;76(3):250–8.

21. Liu A, Cohen S, Follansbee S, Cohan D, Weber S, Sachdev D, et al. Early experiences implementing pre-exposure prophylaxis (PrEP) for HIV prevention in San Francisco. *PLoS Med*. **2014**;11(3):e1001613.

22. Young I, Flowers P, McDaid LM. Barriers to uptake and use of pre-exposure prophylaxis (PrEP) among communities most affected by HIV in the UK: findings from a qualitative study in Scotland. *BMJ Open*. **2014**;4(11):e005717.

23. Auerbach JD, Kinsky S, Brown G, Charles V. Knowledge, attitudes, and likelihood of pre-exposure prophylaxis (PrEP) use among US women at risk of acquiring HIV. *AIDS Patient Care STDS*. **2015**;29(2):102–10.

24. Card KG, Armstrong HL, Lachowsky NJ, Cui Z, Sereda P, Carter MA, et al. Belief in treatment as prevention and its relationship to HIV status and behavioral risk. *J Acquir Immune Defic Syndr*. **2018**; 77(1):8–16.

25. Carter A, Lachowsky N, Rich A, Forrest JI, Sereda P, Cui Z, et al. Gay and bisexual men's awareness and knowledge of treatment as prevention: findings from the Momentum Health Study in Vancouver, Canada. *J Int AIDS Soc*. **2015**;18(1):20039.

26. Holt M, Lea T, Schmidt H-M, Murphy D, Rosengarten M, Crawford D, et al. Increasing belief in the effectiveness of HIV treatment as prevention: results of repeated, national surveys of Australian gay and bisexual men, 2013–15. *AIDS Behav*. **2016**;20(7):1564–71.

27. We must listen to science, not stigma. People on effective HIV treatment cannot pass on the virus [press release]. Terrence Higgins Trust, June 29, 2017. **2017**.

28. Prati G, Zani B, Pietrantoni L, Scudiero D, Perone P, Cosmaro L, et al. PEP and TasP awareness among Italian MSM, PLWHA, and high-risk heterosexuals

and demographic, behavioral, and social correlates. *PLoS One*. **2016**;11(6):e0157339.

29. Bavinton BR, Holt M, Grulich AE, Brown G, Zablotska IB, Prestage GP. Willingness to act upon beliefs about 'Treatment as Prevention' among Australian gay and bisexual men. *PLoS One*. **2016**;11(1):e0145847.

30. Napper LE, Fisher DG, Reynolds GL. Development of the perceived risk of HIV scale. *AIDS Behav*. **2012**;16(4):1075–83.

31. Feldman B, Fredericksen R, Crane P, Safren S, Mugavero M, Willig JH, et al. Evaluation of the single-item self-rating adherence scale for use in routine clinical care of people living with HIV. *AIDS Behav*. **2013**;17(1):307–18.

32. Earnshaw VA, Chaudoir SR. From conceptualizing to measuring HIV stigma: a review of HIV stigma mechanism measures. *AIDS Behav*. **2009**;13(6):1160.

33. Kelly JA. Popular opinion leaders and HIV prevention peer education: resolving discrepant findings, and implications for the development of effective community programmes. *AIDS Care*. **2004**;16(2):139–50.

34. Rendina HJ, Jimenez RH, Grov C, Ventuneac A, Parsons JT. Patterns of lifetime and recent HIV testing among men who have sex with men in New York City who use Grindr. *AIDS Behav*. **2014**;18(1):41–9.

35. Newcomb ME, Mustanski B. Cognitive influences on sexual risk and risk appraisals in men who have sex with men. *Health Psychol*. **2014**;33(7):690.

36. Rowniak S. Safe sex fatigue, treatment optimism, and serosorting: new challenges to HIV prevention among men who have sex with men. *J Assoc Nurses AIDS Care*. **2009**;20(1):31–8.

APPENDIX

QUANTITATIVE MEASURES

- 1 What is your birth year and month? [Dropdown: January to December] [Dropdown: 1900 to 2005]
- 2 Do you consider yourself Hispanic or Latino? Yes/No
- 3 Which racial or ethnic group do you belong to? (Please select all that apply)
 - a American Indian or Alaska Native
 - b Asian
 - c Black/African American
 - d Native Hawaiian or Other Pacific Islander
 - e White
 - f Other (Please specify): _____
- 4 Which of the following best describes your current employment status?
 - a Full-time (40 hours per week)
 - b Part-time (less than 40 hours per week)
 - c Part-time work - full-time student
 - d Permanent or temporary disabled and NOT working
 - e Permanent or temporary disabled BUT working "off the books" (or "under the table")
 - f Unemployed -- Student
 - g Unemployed -- Other
- 5 Which best describes your total yearly income during the last year?
 - a Less than \$10,000
 - b \$10,000 to \$19,999
 - c \$20,000 to \$29,999
 - d \$30,000 to \$39,999
 - e \$40,000 to \$49,999
 - f \$50,000 to \$74,999
 - g \$75,000 to \$99,999
 - h \$100,000 to \$149,999
 - i \$150,000 to \$199,999
 - j \$200,000 to \$249,999

- k \$250,000 or more
- 6 What's the highest grade of school you have completed?
- a Some high school
 - b High School Diploma or GED
 - c Some College or Associates Degree
 - d Currently enrolled in college
 - e 4-Year College Degree (BA, BS, BFA)
 - f Graduate School
- 7 Which best describes your gender identity?
- a Male
 - b Female
 - c Transgender male (female-to-male)
 - d Transgender female (male-to-female)
 - e Other (Please specify): _____
- 8 Which best describes how you identify your sexual orientation?
- a Gay, Queer, or Homosexual
 - b Bisexual
 - c Heterosexual/Straight
 - d Other (Please specify): _____
- 9 What is the zip code of your home address? _____
- 10 How "out" would you say you are with regard to your sexual orientation?
- a Not at all
 - b Somewhat
 - c Mostly
 - d Completely
- 11 Have you engaged in some form of sexual activity with a man in the past year?
- a Yes
 - b No
- 12 Which sexual position do you identify as?
- a Top
 - b Versatile/Top
 - c Versatile
 - d Versatile/Bottom
 - e Bottom
- 13 What is your HIV status?
- a Negative
 - b Positive
 - c I don't know

[If HIV-positive, skip 14 to 16]

- 14 When was the last time you received an HIV test?
- a Within the last month
 - b 1 to 3 months ago
 - c 3 to 6 months ago
 - d 6 to 12 months ago
 - e 1 to 2 years ago
 - f More than 2 years ago
 - g I've never been tested
- 15 I think my chances of getting infected with HIV are
- a Zero

- b Almost zero
 - c Small
 - d Moderate
 - e Large
 - f Very large
- 16 Have you ever been prescribed HIV medications (e.g. Truvada) for use as PrEP (HIV pre-exposure prophylaxis)?
- a Yes, I am currently prescribed PrEP
 - b Yes, but I am no longer prescribed PrEP
 - c No, I've never been prescribed PrEP

[If HIV-negative/unknown, skip 17 to 20]

- 17 Have you begun taking HIV medication (i.e., antiviral medications)?
- d Yes
 - e No

[If not prescribed ARV, skip 18]

- 18 Over the last four weeks, how good a job did you do at taking your HIV medication in the way you were supposed to?
- a Very poor
 - b Poor
 - c Fair
 - d Good
 - e Very good
 - f Excellent
- 19 What were the results of your most recent viral load test?
- a Undetectable
 - b Detectable
 - c Not sure/don't remember
- 20 Have you ever received an AIDS diagnosis?
- a Yes
 - b No
 - c I don't know
- 21 With regard to HIV-positive individuals transmitting HIV through sexual contact, how accurate do you believe the slogan "Undetectable = Untransmittable" is?
- a Completely accurate
 - b Somewhat accurate
 - c Somewhat inaccurate
 - d Completely inaccurate
 - e I don't know what "undetectable" means
- 22 How concerned are you about getting a sexually transmitted infection other than HIV (e.g., gonorrhoea, chlamydia, herpes, syphilis, etc.)?
- a Not at all concerned
 - b Somewhat not concerned
 - c Neither
 - d Somewhat concerned
 - e Very concerned