ABSTRACT

Objective Antiretroviral therapy (ART) nearly eliminates HIV transmission. Yet information on treatment as prevention (TasP) has been slow to diffuse in sub-Saharan Africa. We assessed TasP knowledge among university students in South Africa.

Methods We conducted a cross-sectional survey of first-year university students at a large public university in Johannesburg, South Africa, all of whom would have recently completed secondary school HIV curricula. Respondents were asked to consider the likelihood of HIV transmission in a serodiscordant couple having condomless sex with and without virally suppressive ART. Beliefs were elicited using a 0–20 visual scale. Perceived TasP efficacy was computed as the relative reduction in risk associated with virally suppressive ART. We compared beliefs with estimates from the scientific literature and assessed associations with demographics, HIV testing history and qualitative measures of HIV knowledge and risk perception.

Results The analysis included 365 university students ages 18–25 years (48% female, 56% from Gauteng Province). On average, perceived annual risk of HIV transmission with virally suppressive ART was 73%; the objective risk is <1%. On average, respondents perceived that virally suppressive ART reduced annual transmission risk by 17%; the objective reduction in risk is >96%. We observed no differences in perceived TasP efficacy by participant characteristics and testing history. Perceived TasP efficacy was correlated with the (correct) belief that HIV risk increases with sexual frequency.

Conclusions University students in South Africa underestimated the prevention benefits of HIV treatment. Low knowledge of TasP could limit demand for HIV testing and treatment among young adults.

INTRODUCTION

The HIV Prevention Trials Network (HPTN)-052 trial and multiple large cohort studies showed that antiretroviral therapy (ART) eliminates HIV transmission if the infected partner is virally suppressed. Treatment as prevention (TasP) has motivated countries to expand ART coverage in order to reduce HIV incidence. However, there remain significant gaps in HIV testing and treatment, particularly among young adults.

Despite scientific consensus on the efficacy of TasP, little is known about the diffusion of TasP information to young adults in countries where HIV is endemic. Studies have found increases in TasP knowledge in the 2010s among male sexual minority populations in North America, Europe and Australia. However, data from sub-Saharan Africa are scarce. Evidence from South Africa, Zambia and Uganda suggest low familiarity with TasP in rural areas. However, information may have diffused faster in urban areas, among young adults, and among those with access to secondary-school HIV education and university health services.

We set out to measure beliefs about TasP among first-year university students in Johannesburg, South Africa. All South African university students would have received HIV education throughout their primary and secondary schooling, as South Africa has provided HIV education under the Integrated School Health Programme since 2000. We elicited participants’ beliefs about the probability of HIV transmission in a serodiscordant couple, varying whether the HIV-infected partner was on ART and virally suppressed. We computed TasP efficacy as the perceived reduction transmission risk with ART. We assessed the association of perceived TasP efficacy with respondent characteristics and beliefs.

METHODS

Procedures We surveyed first-year students, aged 18–25 years, between August and October 2017 at a large, public university in Johannesburg, South Africa. Students in common areas of university campus (e.g., library, canteen and lunch area) were invited to participate. We excluded students who had completed secondary school more than 3 years ago, those who had been a university student for more than 1 year and those who were not comfortable communicating in English. After providing written informed consent, study participants completed a self-administered, paper-based questionnaire. This study was nested as part of a larger study, the HIV/ TB Knowledge, Risk Perceptions and Barriers to Accessing Care study.

Measures We assessed beliefs about the likelihood of HIV transmission in four scenarios using a Visual Analogue Scale (online supplemental table 1).

Participants were asked: ‘Consider a woman who does not have HIV. Imagine she has sex one time...’
with a man who is HIV-infected and they do not use a condom. Choose a number from 0 to 20 to reflect how likely you think it is that she will become infected with HIV'. Participants were also asked to consider the likelihood after a year of weekly condomless sex (52 times). We then asked participants to consider the likelihood of HIV transmission (after 1 and 52 sex acts) in an alternate scenario ‘with a man who is HIV-infected but who is taking ARVs every day and is virally suppressed’. We transformed all responses to a 0%–100% scale, multiplying by 5. We defined perceived efficacy of TasP as the relative (percent reduction in transmission risk due to virally suppressive ART after 52 condomless sex acts.

The four transmission scenarios were chosen to reflect realistic situations that we could benchmark to the scientific literature. In a meta-analysis of studies from low-income countries, the actual HIV transmission probability from a man to a woman was estimated to be 0.3%.18 After 52 condomless sex acts, the proportion of HIV acquisition is 14.5%, computed as $1 - (1 - 0.003)^{52}$. The HPTN-052 trial found a 96% reduction in infection risk,19 implying a 0.01% risk after 1 sex act and a 0.6% risk of HIV transmission after 52 condomless sex acts with a partner on ART and virally suppressed. The PARTNERS and Opposites Attract studies indicate the true transmission risk when virally suppressed is zero (or very close to zero).3

Data were additionally collected on respondents’ age, gender, location of secondary school, receipt of financial aid, residence in student housing, source of health insurance, food insecurity, and an asset index.20 Participants were asked when they last had an HIV test. HIV knowledge was assessed using an index of 42 items,11 split at the median into high and low knowledge. HIV risk perception was assessed using an abridged version of the Napper Scale (online supplemental table 2).21 split at the median into low-risk and high-risk perception. Finally, we collected data on beliefs related to the effect of sexual frequency and ART on transmission (online supplemental table 3). Details on all measures are described elsewhere.17

Data analysis
We plotted the distributions of perceived likelihood of HIV transmission in the different scenarios and we computed the mean and 10th, 25th, 50th, 75th and 90th percentiles of these distributions. We assessed absolute differences in perceived transmission risk associated with frequency of sex acts (1 condomless sex act vs 52 condomless sex acts) and with virally suppressive ART (52 condomless sex acts vs 52 condomless sex acts on ART). We summarised perceived TasP efficacy in two ways. First, we computed the population-average perceived TasP efficacy: 100%–100% × (perceived 1-year transmission risk with ART/average perceived 1-year transmission risk without ART). This quantity is most comparable to the HPTN-052 trial, which reported the ratio of infection rates in treated and control groups. Second, we computed individual-level perceived TasP efficacy as the percent reduction in perceived transmission risk with ART for each respondent. Some participants reported higher transmission likelihood with ART, compared with without ART; these responses were bottom-coded at 0% prevention efficacy of TasP. We plotted the distribution of individual-level perceived TasP efficacy as a histogram and assessed differences in perceived TasP efficacy by respondent characteristics and beliefs. Stata/SE V14.2 was used for all analyses (online supplemental files 2, 3).
Transmission risk with virally suppressive ART

Participants perceived lower risk of transmission when the HIV-infected partner was on virally suppressive ART (figure 1); however, perceived risk remained high. Over three-quarters (77%) of respondents perceived a 50% or greater likelihood of contracting HIV after just 1 sex act with a person with HIV who was on ART and virally-suppressed. The average perceived risk of transmission was 65.1% in 1 sex act and 73.1% in 52 sex acts when the HIV-positive partner was on ART and virally suppressed. The objective risk in these scenarios is zero (or very close to zero). The population-average perceived efficacy of TasP was 16.8%, compared with the 96% reported in the HPTN-052 trial (table 1).

Figure 2 shows the distribution of individuals’ beliefs about TasP efficacy on a relative scale (for risk differences, see online supplemental figure 1). Two respondents reported zero risk of transmission without ART and thus TasP efficacy was not defined; they are excluded from the reported results. Of 363 respondents, 160 (44.1%) did not report lower perceived transmission risk if the HIV-infected partner was on ART and virally suppressed. The median respondent perceived a 10% reduction in transmission risk with ART (table 1). Just 16.3% (59/363) believed there was a 50% or greater reduction in transmission risk with virally suppressive ART, and just 2.8% (10/363) of respondents believed that there was a 96% or greater reduction in risk.

Beliefs about TasP efficacy did not vary by demographic characteristics, socioeconomic status, HIV testing history nor HIV knowledge (online supplemental table 3). There was a modest and marginally significant increase in perceived efficacy among respondents who agreed with the statement: ‘ART reduces transmission risk’ (p=0.075). Higher perceived TasP efficacy was associated with lower perceived HIV risk (p=0.016). Higher perceived TasP efficacy was also associated with the belief that having less risk reduces infection risk (p<0.001), suggesting that an orientation towards a biological understanding of transmission may be important for people to assimilate information on TasP into their beliefs.

DISCUSSION

Nearly a decade after HPTN-052 showed that HIV treatment prevents transmission of the virus, young adults in South Africa remain largely unaware of these benefits. Although all South African university students would have received HIV education throughout their primary and secondary schooling, we found beliefs about HIV transmission that differed markedly from the scientific literature. We found that (1) respondents overestimated the probability of HIV transmission; (2) respondents underestimated the efficacy of HIV TasP; and (3) as a result, respondents vastly overestimated the likelihood of transmission when on ART and virally suppressed. The perceived annual risk of transmission with ART was 73%. The objective risk is less than 1%. As one respondent wrote, ‘Taking ARVs doesn’t matter. As long you are infected, it is very likely [for your partner] to get infected’.

Misperceptions about transmission risks are perhaps unsurprising. Historically, HIV education campaigns have exaggerated the virulence of HIV22 emphasizing that you can get HIV from just one condomless sex act. Emphasis on this message may have contributed to the widespread belief23 that HIV transmission...
in one sex act is not just possible but likely. In many countries including South Africa, the prevention benefits of ART are not widely emphasised in public health messaging, school-based HIV curricula, nor HIV counselling.28 Although stable serodiscordant couples in HIV care are increasingly counselled on TasP, this represents a small fraction of young adults at risk. Consistent with the lack of emphasis on TasP in clinical settings, we found no differences in TasP knowledge by recent use of HIV testing nor by gender (despite gender disparities in care-seeking). Younger participants who were more recently in secondary school had marginally higher TasP knowledge than older participants, but the difference was not statistically significant.

Misperceptions may have significant impact on behaviour. Overestimating transmission may lead to fatalism23 and may contribute to greater HIV stigma and lower testing.26 Underestimating TasP efficacy could reduce the perceived benefits of treatment, particularly among people entering HIV care early in infection.27 Studies from the USA indicate that integrating TasP education into HIV counselling can improve adherence.28 In a cluster-randomised trial in Malawi, providing communities with information on TasP reduced stigma and increased HIV testing.29 A study in South Africa found that providing information on TasP increased HIV testing among men.30 Although there are reasons to be cautious in messaging on TasP, for example, potential for spread of other sexually-transmitted infections if people reduce condom use, providing information on the low risk of transmission on ART has potential to increase perceived benefits of ART, leading to greater treatment uptake, lower population viraemia, and fewer new HIV infections.31

Our analysis has some limitations. First, the study was a voluntary response sample. Although quite diverse in terms of demographic and socioeconomic characteristics, the sample was not designed to be representative of all students at the university, nor of all university students in South Africa. Second, it is possible that respondents may have interpreted the transmission probability questions in a qualitative way, reporting general feelings about the likelihood of an event rather than beliefs about the statistical probability of it occurring. Nevertheless, these data offer a more fine-grained picture of transmission beliefs than previously reported for this population.

A recent systematic review found that 31 studies measured TasP knowledge globally, from 2008 to 2020.13 However, just two were quantitative studies of community-based samples in sub-Saharan Africa. In 2013, 65% of survey participants in rural Malawi perceived that ART had no impact on transmission risk.29 In 2017, young adults in rural South Africa perceived a 75% annual risk of HIV transmission in a mixed status couple using TasP, similar to the findings in this study.32 Our study participants were urban university students who had all recently completed the secondary school curriculum in South Africa—a population one might expect to have high access to health information. To our knowledge, this is the first study on TasP knowledge in an urban African setting.

In South Africa, young adults are at high risk of HIV infection and have among the lowest rates of engagement with HIV care.33 Addressing knowledge gaps regarding the prevention benefits of treatment through campaigns such as Undetectable=Untransmittable (U=U) could encourage greater HIV testing and care-seeking in this population. Educational institutions offer valuable opportunities to provide accurate information to young adults about the benefits and limitations of TasP and to reduce stigma associated with HIV treatment.

Handling editor Adam Huv Bourne

Acknowledgements The authors thank the staff and students at the universities who supported and participated in the study. A special note of thanks to Alice Kono, Busi Sithole, Melda Musina, Portia Ngwenya, Vinolia Ntjikelene, Barbara Xhosa and Given Malete for their support and help with data collection, quality assurance and data management.

Contributors JB and DE jointly conceptualised the study. DE designed and oversaw the study procedures. JB designed the survey instruments and analysis plan with input from DO. NM oversaw data collection and management. DE, JB, and NM wrote the first draft. All authors contributed to critically revising the paper, gave final approval of the version to be published and agreed to be accountable for all aspects of the work. JB is the study’s guarantor.

Funding Funding for this study was provided by National Institutes of Health National Institute of Mental Health awards R34-MH122323 (JB) and K01-MH105320 (JB) and Eunice Kennedy Shriver National Institute of Child Health and Human Development award R01-HD084233 (JB). The contents of the article are the responsibility of the authors and do not necessarily reflect the views of the US government. The funders had no role in the study design, collection, analysis and interpretation of the data, in manuscript preparation or the decision to publish.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The study was approved by the human research ethics committee (medical) of the University of the Witwatersrand (certificate number M161019).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. Stata data and .do file are available as supplementary information for replication purposes.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/.

ORCID iD Jacob Bor http://orcid.org/0000-0002-5112-8536

Key messages

► HIV treatment prevents onward transmission of the virus; however, it is unknown whether information about HIV treatment-as-prevention has diffused to young adults in South Africa.

► We conducted a cross-sectional survey of first-year university students to determine beliefs about HIV transmission with and without virally suppressive HIV treatment.

► Respondents perceived a 73% annual transmission risk in a serodiscordant couple even if the HIV-infected partner was virally suppressed; the true risk is <1%.

► Respondents perceived that HIV treatment reduced transmission by 17% on average, much lower than the 96% efficacy demonstrated in the HIV Prevention Trials Network-052 trial.

► Gaps in knowledge about HIV treatment-as-prevention may contribute to suboptimal care-seeking and persistent HIV stigma among young adults.

REFERENCES

1. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med 2011;365:493–505.

2. Cohen MS, Chen YQ, McCauley M, et al. Antiretroviral therapy for the prevention of HIV-1 transmission. N Engl J Med 2016;375:380–9.

3. Rodger AJ, Cambiano V, Braun T, 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;316:171.
Serodiscordance in couples with an HIV-positive partner: evidence from rural South Africa. Population Association of America Annual Meeting; April 27, 2018, Denver, CO, 2018.

32 Bor J, Barosky J, Flanagan D. Beliefs about the benefits of HIV treatment in the era of "treat all": evidence from rural South Africa. Population Association of America Annual Meeting; April 27, 2018, Denver, CO, 2018.

33 Evans D, Musavka N, Nattey C, et al. Knowledge, risk perception and access to healthcare services for HIV and tuberculosis among university students in Johannesburg, South Africa. SAJHCH 2018;12:19–31.