

Associations between exposure to the U=U message and perceived HIV stigma among both the HIV and non-HIV adult populations in South Africa

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ABSTRACT

INTRODUCTION HIV stigma is a major barrier to care in South Africa, the country with the world's largest HIV epidemic. The educational message 'Undetectable Equals Untransmittable' (U=U) may mitigate stigma. We examined the percentage of South African adults believing the U=U message and the associations with perceived stigma.

METHODS We analyzed data of South Africans aged ≥ 18 years from two sources: 1) The 2017–2018 South African National HIV Prevalence, Incidence, Behavior and Communication Survey (n=26875). HIV status was ascertained using both laboratory confirmation and self-reports. U=U belief was an affirmative response to the statement 'the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV'; and 2) The 2019 Positive Perspectives Study of people living with HIV (PLHIV) on treatment (n=179) was analyzed to describe provider-administered U=U counseling. Data were analyzed using descriptive and multivariable approaches ($p < 0.05$).

RESULTS Overall, 20.0% of South African adults aged ≥ 18

years were HIV seropositive. Only 55.6% of those reporting they were living with HIV believed that the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV (52.9% among non-HIV individuals, $p = 0.1915$). U=U belief among PLHIV was associated with less likelihood of internalizing stigma. For example, the likelihood of refusing to care for a family member with AIDS was significantly lower among PLHIV with vs without belief in U=U (adjusted prevalence ratio, APR=0.38; 95% CI: 0.16–0.92). Among the non-HIV population, U=U belief was also inversely associated with stigma sentiments directed at PLHIV. Among PLHIV on treatment surveyed in the Positive Perspectives study, close to 1 in 3 (30.2%) indicated their healthcare provider had not discussed U=U with them.

CONCLUSIONS The U=U message may help reduce perceived stigma. Incorporating it into HIV policies, guidelines, and service delivery in South Africa may benefit public health.

INTRODUCTION

Different types of stigmas – interpersonal, institutional, and internalized – have extensive effects on the health outcomes and health-seeking behaviors of people living with HIV (PLHIV)¹. PLHIV from disadvantaged groups can experience stigma in multiple, often intersecting ways¹. While South Africa has outlawed HIV-based discrimination², the reality is that bigotry and prejudice may persist even with anti-discrimination laws because it is impossible to legislate how people feel and think. True change can only come from the

volition of the people who affect and are affected by stigma. Studies have suggested that one way people's volition can be changed in relation to HIV stigma is through the educational message, U=U, or Undetectable Equals Untransmittable^{3,4}. Built on strong scientific evidence showing that individuals with undetectable viral loads cannot transmit HIV^{5,6}, the potential effectiveness of the U=U message lies in the fact that it addresses the underlying fear that feeds HIV stigma, namely, that PLHIV might transmit the disease^{7,8}. Among PLHIV, awareness of the U=U message has already been

demonstrated to be empowering and to be associated with increased comfort with sharing their HIV status⁹. The potential impact of the U=U message among the non-HIV population is equally important but less known.

Against a backdrop of low HIV disclosure levels^{10–12}, worrisome levels of resistance to antiretroviral therapy (ART)^{13–15}, and the largest HIV epidemic in the world¹⁶, there is an urgent need for the rapid uptake of the U=U message in South Africa. While seven African countries met the 90–90–90 targets¹⁷, South Africa was not one of them. These 90–90–90 targets aimed to increase the percentage of people living with HIV who were diagnosed, the percentage of those on treatment among those diagnosed, and the percentage virally suppressed among those on treatment to $\geq 90\%$ by 2020¹⁷. South Africa's status in 2020 was 84% diagnosed, 87% of those diagnosed on treatment, and 90% of those treated virally suppressed (which equates to 66% of all PLHIV being virologically suppressed)¹⁸. Addressing stigma is critical to meeting these, and other newer targets, including the proposed fourth 90 target of improving quality of life among PLHIV¹⁹. From a health equity lens, the U=U message may also help in reducing onward transmission, increasing testing, improving linkage to care, and incentivizing treatment adherence among disadvantaged groups such as people of low socio-economic status, undocumented immigrants, commercial sex workers, those living with a disability, and other vulnerable groups.

The U=U movement is still in its infancy in South Africa. In 2020, The South Africa HIV Survivors and Partners Network, as part of a concerted effort to advance the U=U campaign locally, mobilized >100 women living with HIV as U=U ambassadors and convened several HIV-related civil society organizations⁴. A key challenge noted so far has been low awareness of the U=U message among advocates and partner organizations⁴. Evidence from South Africa on awareness and the impact of the U=U message in the broader population will be critical to help inform clinical and public health practice, programs, and policy. Consequently, this study had two objectives: 1) to assess unmet treatment needs among PLHIV and compare self-rated health and perceived stigma between PLHIV and the non-HIV population; and 2) to estimate the percentage of PLHIV and the non-HIV population reporting belief in the U=U message, and the relationship between belief and perceived stigma within the separate strata (i.e. HIV and non-HIV populations).

METHODS

Data sources

Data came from two sources. 1) The South African National HIV Prevalence, HIV Incidence, Behavior and Communication Survey, wave 5 (SABSSM-V); and 2) The Positive Perspectives Survey of PLHIV, wave 2 (PP2). SABSSM-V was used to analyze HIV seroprevalence, U=U belief prevalence and impact of the U=U message, while PP2 was used to examine unmet needs related to ART as well as PLHIV-reported receipt of U=U counseling from their HCPs.

SABSSM-V

We analyzed the SABSSM-V conducted between December 2016 and January 2018²⁰. This household survey was designed to yield nationally representative estimates of the non-institutionalized South African population using a multi-stage, cluster sampling design (household response rate=82.2%). Of 39132 eligible individuals, 93.6% agreed to be interviewed and 61.1% provided a blood specimen for HIV-testing, in addition to the completed questionnaires. Our analytical sample comprised persons aged ≥ 18 years ($n=26875$). Data on laboratory-confirmed HIV status was present for 17256 adults aged ≥ 18 years.

PP2

We analyzed data for 179 PLHIV on ART aged ≥ 18 years from South Africa who participated in PP2^{9,21–23}. In total, 44 were recruited from ongoing panels of PLHIV; 114 from non-governmental organizations (NGOs), patient associations, patient advocacy groups, patient support groups, or HIV charities, and 21 via social media (Facebook). The survey was web-based and administered in English, Afrikaans, Zulu, and Sotho. Ethical review was provided by the Sefako Makgatho Research Ethics Committee (no. SMUREC/M/223/2019).

Measures

SABSSM-V

HIV status

Blood spots were collected on filter paper from a finger prick and transported to a laboratory for testing²⁴. Three enzyme immunoassays (Roche Elecsys HIV Ag/Ab assay, Roche Diagnostics, Mannheim, Germany, and Genscreen Ultra HIV Ag/Ab assay, Bio-Rad Laboratories, California, US) were used to test for HIV infection. When two enzyme immunoassays agreed, this confirmed a result; where there was a disagreement, the third test broke the tie. Since HIV testing was anonymous, survey respondents could not be provided with their results. This blinding of the laboratory results provided a unique opportunity to compare laboratory-confirmed vs self-reported HIV status. Given that HIV stigma is intricately tied with first being aware of ones HIV-positive status, we were interested in exploring whether perceived stigma and other subjective measures of overall health and wellbeing differed among PLHIV aware of their HIV status (i.e. status-aware PLHIV); PLHIV not aware of their HIV-status (i.e. status-unaware PLHIV), and people not living with HIV. Our definition of 'awareness' of HIV status was based strictly on self-report as a cognitive marker, and not on any biomarker (e.g. ART analytes in the bloodstream)²⁴, since we were interested in just the psychosocial aspects of being conscious of ones HIV status. Self-reported HIV status was defined based on either of the following: 1) respondents indicated they were previously tested for HIV and reported the result of their last test as 'Positive'; and 2) respondents answered 'Yes' when asked 'Do you currently have any of the following illnesses? – HIV'.

U=U beliefs and HIV stigma

Belief in U=U-related constructs was assessed, including the belief that the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV; that ART could prevent vertical HIV transmission; that a woman living with HIV could give birth to an HIV-negative baby; but that conversely, untreated pregnant women living with HIV could transmit HIV to their unborn children.

We were interested in contrasting the impact of the U=U message on perceived stigma against the impact of ignorant narratives of how HIV is transmitted. Participants were asked: 'Can a person get HIV by sharing food with someone who is living with HIV?'. As outcomes, several indicators of stigma were assessed: 'If you knew that a shopkeeper or food seller had HIV, would you buy food from them?'; 'Would you buy fresh vegetables from a shopkeeper or vendor if you knew that this person had HIV?'; 'Would you want to keep the HIV-positive status of a family member a secret?'; 'Are you comfortable talking to at least one member of your family about HIV/AIDS?'; 'Would you be willing to care for a family member with AIDS?'; 'If a teacher has HIV but is not sick, should he or she be allowed to continue teaching?'; 'If a pupil has HIV but not sick, should he or she be allowed to continue to go to school?'; 'Do you think children living with HIV should be able to attend school with children who are HIV-negative?'; 'Is it a waste of money to train or give a promotion to someone with HIV/AIDS?'; and would you say 'A person would be foolish to marry a person who is living with HIV/AIDS'.

Self-rated health

Respondents were classified as having optimal overall health if they answered 'excellent' or 'good' to the question: 'In general, would you say that your health is excellent, good, fair, or poor?'. Respondents were also asked about their mental and emotional well-being during the past 30 days, including whether they felt 'tired out', 'nervous', 'hopeless', 'depressed', 'sad', or 'worthless'.

PP2

Medication-related concerns

Respondents' concerns regarding short-, medium-, and long-term impacts of their HIV treatment were measured, including worries about long-term side effects, potential interactions with other medications, impact on body and/or body shape, impact on overall health and well-being, and unknown long-term impact.

Communication with healthcare providers (HCPs)

The survey assessed perceived comfort discussing with HCPs concerns about various salient treatment-related issues, including preventing transmission, their emotional well-being, as well as their privacy and not disclosing their HIV status. Participants were also asked whether their HCP had told them of 'U=U'.

Analysis

Data from SABSSM-V were weighted to yield nationally representative results for all South African adults aged ≥ 18 years. Prevalence estimates were calculated overall and by various demographic characteristics. Among those reporting they were not living with HIV (regardless of their laboratory test), we assessed every and past-year HIV screening, overall and by various clinical, demographic, and risk profiles.

Based on agreement between laboratory-confirmed and self-reported HIV status, participants aged ≥ 18 years were classified into 3 groups of: negative laboratory test and self-reported non-HIV status (i.e. not living with HIV, $n=23371$); positive laboratory test and self-reported non-HIV status (i.e. status-unaware PLHIV, $n=1912$); and positive laboratory test and a self-report of living with HIV (i.e. status-aware PLHIV, $n=1496$). We excluded $n=96$ adults with a negative laboratory test and a self-report of living with HIV as potential misclassification cases. Adjusted prevalence ratios (APR) were calculated in a multivariable Poisson regression model to compare stigma perceptions between the groups, using status-aware PLHIV as the reference category. Adjusted prevalence ratios were also computed to measure the relationship between U=U-related beliefs and perceived stigma, separately for PLHIV and the non-HIV population (self-reported statuses). All adjusted analyses controlled for age, gender, urbanicity, and race/ethnicity.

Data from the PP2 survey were analyzed using percentages and means. Subgroup differences were assessed qualitatively because of the limited sample size. All statistical analyses were performed using Stata V14.

RESULTS

Characteristics of the South African adult population (SABSSM-V)

Of South African adults aged ≥ 18 years, 69.4% were from urban areas, 60.1% were aged 18–39 years, 86.4% were heterosexual, 78.6% were Black Africans, and 52.6% were women. Overall, 95.7% were native-born, 3.2% were documented migrants, and 1.1% were undocumented migrants/asylum seekers/refugees/other (Table 1).

HIV prevalence and screening (SABSSM-V)

Of South African adults aged ≥ 18 years during 2017–2018, 20.0% were HIV seropositive. Seroprevalence was highest in KwaZulu-Natal (27.1%), those living in tribal areas (24.3%), aged 40–49 years (30.1%), Black Africans (24.4%), undocumented migrants/asylum seekers/refugees/other (29.4%), women (24.4%), those never married (23.6%), those with ≤ 6 th grade education (27.1%), and those with comorbidity (24.8%).

Among individuals reporting they were not living with HIV (regardless of their laboratory-confirmed HIV status), 77.1% reported ever receiving an HIV test, and 52.6% reported past-year HIV testing. As revealed in Figure 1, past-year HIV testing varied among groups at high risk, including

Table 1. Percentage living with HIV among all South African adults and those accessing HIV screening among those who reported not living with HIV, South African National HIV, Behavior, And Health Survey, 2017–2018

Characteristics	% (n)	% With positive HIV test	% Reporting they had ever had an HIV test among those reporting they were not living with HIV	% Reporting they had a past-year HIV test among those reporting they were not living with HIV
Total	100 (26875)	20.0 (18.9–21.1)	77.1 (76.1–78.1)	52.6 (51.5–53.8)
Province				
Western Cape	12.8 (2112)	12.0 (9.8–14.1)	76.9 (74.5–79.3)	41.2 (38.5–43.9)
Eastern Cape	10.8 (1986)	21.9 (18.0–25.7)	69.5 (66.5–72.5)	45.9 (42.6–49.1)
Northern Cape	2.1 (1435)	13.0 (9.7–16.3)	74.7 (71.6–77.8)	48.8 (45.2–52.3)
Free State	4.8 (1157)	23.2 (19.5–27.0)	83.6 (80.7–86.4)	54.2 (50.2–58.2)
KwaZulu-Natal	18.2 (8750)	27.1 (24.1–30.0)	71.5 (69.4–73.7)	49.5 (47.1–51.8)
North-West	6.9 (1712)	23.1 (19.3–26.9)	82.4 (80.0–84.9)	63.3 (60.1–66.5)
Gauteng	27.4 (4405)	17.5 (15.0–20.1)	81.3 (79.0–83.5)	55.1 (52.2–58.0)
Mpumalanga	7.8 (3214)	24.3 (21.1–27.5)	80.9 (78.4–83.4)	63.2 (60.2–66.3)
Limpopo	9.4 (1630)	16.3 (13.2–19.3)	73.8 (70.7–76.8)	57.4 (53.9–60.8)
Geographical location				
Urban	69.4 (15050)	18.3 (17.0–19.7)	79.2 (78.0–80.4)	52.8 (51.3–54.3)
Rural informal (tribal areas)	25.3 (8433)	24.3 (21.9–26.7)	72.3 (70.5–74.1)	54.3 (52.3–56.3)
Rural (farms)	5.4 (2918)	21.8 (17.5–26.1)	71.5 (68.4–74.7)	42.7 (39.4–46.1)
Age (years)				
18–29	32.9 (9027)	13.9 (12.2–15.6)	75.5 (73.9–77.1)	56.5 (54.5–58.4)
30–39	27.2 (6044)	28.4 (25.7–31.0)	83.5 (81.6–85.5)	58.2 (55.6–60.7)
40–49	15.8 (4173)	30.1 (26.9–33.3)	82.9 (80.6–85.2)	55.2 (52.2–58.2)
50–59	12.4 (3680)	18.3 (15.5–21.1)	79.7 (77.3–82.1)	47.4 (44.4–50.4)
≥60	11.7 (3951)	6.2 (4.8–7.6)	58.7 (56.0–61.5)	32.4 (29.8–35.1)
Sexual orientation				
Heterosexual	86.4 (21540)	20.6 (19.4–21.8)	77.4 (76.4–78.4)	52.7 (51.5–53.9)
Bisexual	1.6 (282)	15.6 (7.6–23.7)	76.8 (68.1–85.4)	51.9 (42.3–61.4)
Gay	6.4 (2424)	15.2 (11.2–19.3)	73.6 (68.3–78.8)	56.1 (50.0–62.2)
Lesbian	5.6 (2595)	20.6 (15.8–25.3)	74.4 (69.6–79.1)	46.5 (40.8–52.3)
Race				
Black African	78.6 (19939)	24.4 (23.0–25.8)	78.3 (77.2–79.4)	56.7 (55.3–58.0)
White	9.6 (1489)	1.6 (0.1–3.0)	72.7 (69.4–76.0)	33.2 (29.6–36.8)
Colored	8.9 (3114)	7.7 (5.7–9.8)	77.0 (74.9–79.1)	47.0 (44.5–49.6)
Indian/Asian	2.9 (1814)	0.5 (0.1–1.0)	63.0 (57.1–68.9)	33.5 (28.1–38.8)
Education level				
No school	7.7 (2469)	23.4 (19.5–27.3)	62.2 (58.5–65.9)	41.1 (37.4–44.9)
≤ 6th grade	11.1 (2766)	27.1 (22.9–31.4)	68.6 (65.6–71.6)	45.1 (41.8–48.4)
7th to 12th grade	66.6 (13293)	23.4 (21.9–25.0)	79.1 (77.8–80.3)	54.0 (52.4–55.6)
Further studies incomplete	3.5 (555)	10.0 (4.3–15.8)	86.5 (81.8–91.1)	61.9 (54.8–69.1)
Further studies completed ^a	10.9 (1812)	8.6 (5.5–11.7)	85.3 (82.8–87.9)	51.4 (47.7–55.2)

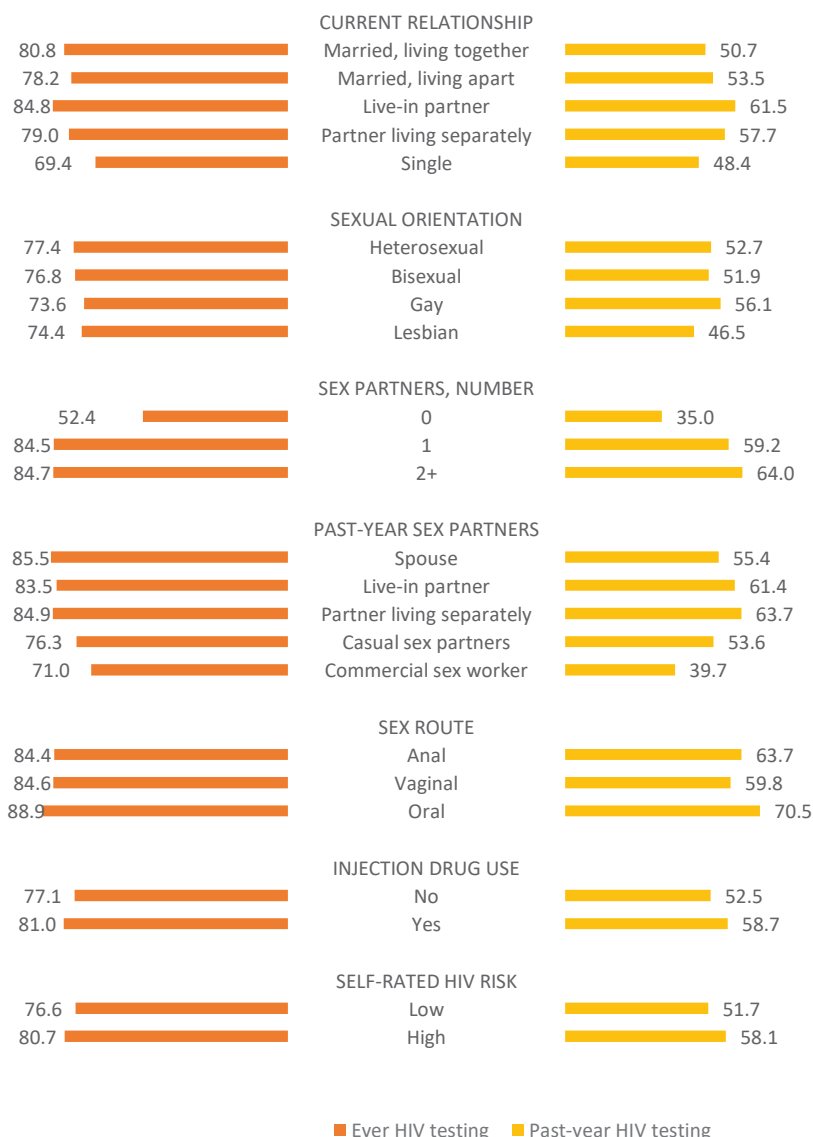
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Table 1. Continued

Characteristics	% (n)	% With positive HIV test	% Reporting they had ever had an HIV test among those reporting they were not living with HIV	% Reporting they had a past-year HIV test among those reporting they were not living with HIV
Don't know	0.2 (39)	11.0 (-1.6–23.5)	67.4 (44.2–90.6)	39.0 (15.1–63.0)
Past-month income source				
Salary/earnings	36.5 (7526)	18.8 (16.8–20.8)	83.1 (81.6–84.6)	55.1 (53.1–57.1)
Contributions by family members or relatives	3.4 (727)	22.7 (16.5–29.0)	77.8 (72.6–83.1)	53.5 (47.3–59.8)
Government pensions/grants	10.0 (3201)	18.9 (15.9–22.0)	67.4 (64.4–70.4)	43.8 (40.6–47.0)
Grants/donations by private welfare organizations	4.8 (1262)	23.8 (19.0–28.7)	69.1 (64.8–73.5)	45.0 (40.3–49.6)
Other	4.4 (845)	24.1 (18.1–30.1)	77.0 (71.9–82.2)	48.7 (42.8–54.7)
No monthly income	41.0 (10157)	21.4 (19.6–23.2)	74.8 (73.3–76.4)	53.7 (51.9–55.5)
Nationality				
South African	95.7 (22903)	20.4 (19.2–21.6)	77.1 (76.2–78.1)	52.8 (51.7–54.0)
Documented migrant	3.2 (490)	20.4 (12.9–27.8)	81.4 (76.1–86.8)	49.7 (42.1–57.3)
Undocumented migrant/asylum seeker/refugee/other	1.1 (199)	29.4 (16.5–42.2)	61.4 (48.1–74.6)	45.5 (33.1–57.9)
Sex				
Man	47.4 (11085)	15.2 (13.6–16.8)	73.1 (71.5–74.7)	48.9 (47.1–50.7)
Woman	52.6 (15756)	24.4 (22.8–26.0)	80.8 (79.7–82.0)	56.1 (54.7–57.6)
Marital status				
Married	31.2 (6908)	14.4 (12.6–16.1)	80.8 (79.3–82.4)	50.5 (48.5–52.6)
Never married	59.7 (14402)	23.6 (22.0–25.2)	76.3 (75.0–77.6)	55.5 (54.0–57.0)
Divorced/separated/widowed	9.1 (2453)	20.6 (17.2–24.1)	69.3 (66.1–72.5)	41.7 (38.3–45.1)
Living arrangements				
Married, living with husband/wife	28.6 (6301)	14.0 (12.2–15.8)	80.8 (79.2–82.4)	50.7 (48.5–52.8)
Married, living apart	14.5 (3406)	24.2 (21.0–27.4)	78.2 (75.6–80.9)	53.5 (50.2–56.7)
Living together with boyfriend/girlfriend/civil union	8.2 (1719)	24.3 (20.2–28.5)	84.8 (81.6–88.1)	61.5 (57.2–65.7)
In a steady relationship but not living together	19.2 (4744)	25.5 (22.8–28.3)	79.0 (76.9–81.2)	57.7 (55.0–60.3)
Single, not in a steady relationship	29.5 (7483)	20.3 (18.0–22.5)	69.4 (67.5–71.3)	48.4 (46.3–50.5)
Disability				
Yes	3.2 (904)	23.2 (13.7–32.7)	67.7 (61.9–73.6)	37.7 (31.8–43.6)
No	96.7 (22803)	20.4 (19.3–21.6)	77.4 (76.4–78.4)	53.1 (51.9–54.3)
Don't know	0.1 (24)	13.1 (-10.9–37.2)	70.5 (42.1–99.0)	57.2 (25.6–88.9)
Non-HIV comorbidity^b				
Yes	21.8 (5872)	24.8 (22.4–27.2)	78.2 (76.4–80.1)	50.7 (48.4–53.0)
No	78.2 (21003)	18.8 (17.5–20.1)	76.8 (75.7–77.9)	53.2 (51.8–54.5)

Data are either given as frequency and percentage, or mean percentage and range. ^a Diploma/undergraduate degree/other post school completed, or further degree completed. ^b Comorbidities ever diagnosed, included hypertension, diabetes, tuberculosis, cancer, and heart disease.

Figure 1. HIV testing among adults aged ≥18 years reporting they were HIV-negative, by various risk indicators, South African National HIV, Behavior, And Health Survey, 2017–2018 (N=21483)



The analytical indicator included those who reported they were HIV-negative, regardless of whether their blood test showed them positive. The indicators past-year sex partners and sex route only assessed among those reporting they were sexually active within the past 12 months.

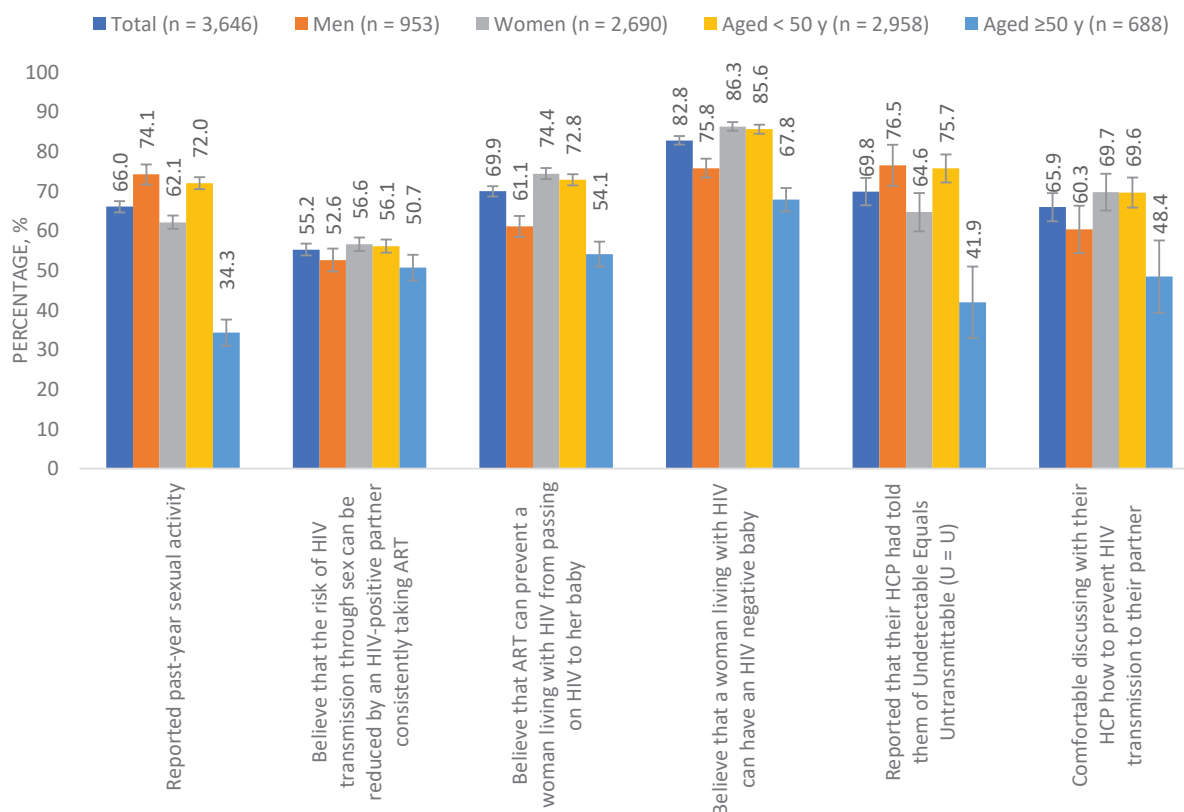
those with multiple sexual partners (64.0%), reporting past-year sex with a commercial sex worker (39.7%), engaging in anal sex (63.7%), and reporting injection drug use (58.7%). Among all individuals with a laboratory-confirmed positive HIV test, 66.0% reported past-year sexual activity and this was significantly higher among men than women (74.1% vs 62.1%), and among persons aged <50 years than ≥50 years (72.0% vs 34.3%) (all p<0.05, Figure 2).

Comparison of health-related outcomes among status-aware PLHIV, status-unaware PLHIV, and the non-HIV population

Within SABSSM-V, when HIV status was dichotomized

broadly as living with HIV versus not living with HIV, those living with HIV generally reported less favorable health outcomes as shown in Table 2, regardless of whether the dichotomization was based on self-reported or laboratory confirmed HIV status. Within a more nuanced analysis accounting for both laboratory-confirmed HIV infection and self-reported awareness of one’s status, status-unaware PLHIV reported subjective health-related outcomes that were a lot more like the non-HIV population than to status-aware PLHIV (Table 3). For example, self-rated optimal overall health was 82.5% among the non-HIV population, 84.8% among status-unaware PLHIV, and 67.5% among status-aware PLHIV.

Figure 2. Past-year sexual activity and U=U-related beliefs among adults aged ≥18 years in South Africa with a laboratory confirmed positive HIV status, South African National HIV, Behavior, And Health Survey, 2017–2018 (N= 3646)



HCP: healthcare provider. The indicators for whether participants had been told by their healthcare provider about U=U, and whether they felt comfortable discussing how to prevent HIV transmission to their partners, were assessed in the Positive Perspectives Survey, wave 2 (PP2). The sample sizes shown above are for the South African National HIV, Behavior, And Health Survey, 2017–2018. Corresponding sample sizes for PP2 for the analyzed denominators are: total (n=179), men (n=68), women (n=99), aged <50 years (n=148), and aged ≥50 years (n=31).

Within adjusted analyses using status-aware PLHIV as the reference category in SABSSM-V, the likelihood of optimal self-rated health was higher among both status-unaware PLHIV (APR=1.23; 95% CI: 1.15–1.32) and the non-HIV population (APR=1.21; 95% CI: 1.14–1.29). Conversely, the likelihood of reporting poor emotional wellbeing was lower among both status-unaware PLHIV and the non-HIV population than among status-aware PLHIV. Adjusted prevalence ratios were as follows: nervous (status-unaware PLHIV: AOR=0.62; 95% CI: 0.48–0.80; non-HIV: AOR=0.63; 95% CI: 0.53–0.76); hopeless (status-unaware PLHIV: AOR=0.73; 95% CI: 0.58–0.91; non-HIV: AOR=0.63; 95% CI: 0.53–0.74); depressed (status-unaware PLHIV: AOR=0.80; 95% CI: 0.66–0.97; non-HIV: AOR=0.74; 95% CI: 0.64–0.86); sad (status-unaware PLHIV: AOR=0.66; 95% CI: 0.51–0.86; non-HIV: AOR=0.70; 95% CI: 0.58–0.85); and worthless (status-unaware PLHIV: AOR=0.66; 95% CI: 0.50–0.87; non-HIV: AOR=0.62; 95% CI: 0.50–0.76). Status-unaware PLHIV and the non-HIV population were also more likely to endorse stigmatizing HIV beliefs than status-aware PLHIV, including that they would not buy food from someone with

HIV (status-unaware PLHIV: AOR=1.62; 95% CI: 1.08–2.43; non-HIV: AOR=2.12; 95% CI: 1.51–2.96); they would not buy fresh vegetables from someone with HIV (status-unaware PLHIV: AOR=1.72; 95% CI: 1.15–2.57; non-HIV: AOR=2.24; 95% CI: 1.60–3.13); and they would not provide care for a family member with AIDS (status-unaware PLHIV: AOR=3.43; 95% CI: 1.92–6.13; non-HIV: AOR=3.93; 95% CI: 2.33–6.63).

Within PP2 (all respondents being status-aware PLHIV on treatment), participants reported various unmet treatment needs related to confidentiality and stigma (Supplementary file Table 1). Only 30.2% felt comfortable sharing their HIV status, 37.4% felt that taking HIV medicines every day increased the chances of revealing their HIV status, 50.8% had ever hidden/disguised their HIV medication in the past six months, 35.2% would be stressed/anxious if someone saw their HIV medication, and 29.1% had missed ART ≥1 time within the past month because of privacy concerns. Reported reasons for withholding HIV status from others in the past included fear of the following: gossip (57.5%), being treated differently (57.0%), romantic discrimination (48.6%), losing their friends (40.2%), being excluded from

Table 2. Comparison of indicators of self-rated health, stigma, and HIV beliefs between the HIV and non-HIV populations, South Africa, South African National HIV, Behavior, And Health Survey, 2017–2018

Characteristics	HIV status as defined by laboratory tests ^a			HIV status as defined by self-report ^b		
	HIV-negative (N=13610)	HIV-positive (N=3646)	p	Reported not living with HIV (N=21483)	Reported living with HIV (N=1930)	p
Indicators of self-rated overall and physical health						
Optimal overall health ^c	81.0 (79.8–82.1)	76.7 (74.3–79.1)	0.001	83.1 (82.2–83.9)	68.1 (64.6–71.5)	<0.001
Non-HIV comorbidity ^d	21.9 (20.8–23.0)	26.7 (24.3–29.2)	0.0003	21.4 (20.5–22.2)	39.6 (35.9–43.3)	<0.001
Feelings over the past 30 days (mental health)						
Tired out for no good reason	19.5 (18.4–20.7)	22.8 (20.3–25.3)	0.0147	17.6 (16.7–18.5)	25.5 (22.2–28.9)	<0.001
Nervous	14.4 (13.4–15.4)	17.5 (15.3–19.6)	0.0079	13.2 (12.4–14.0)	21.7 (18.5–24.9)	<0.001
So nervous that nothing could calm you down	10.3 (9.4–11.2)	12.8 (10.9–14.6)	0.0124	9.7 (9.0–10.4)	15.1 (12.5–17.7)	<0.001
Hopeless	15.5 (14.4–16.6)	22.3 (19.9–24.8)	<0.001	14.3 (13.5–15.1)	25.0 (21.7–28.3)	<0.001
Restless or fidgety	13.1 (12.1–14.1)	16.0 (13.8–18.1)	0.0122	12.4 (11.7–13.2)	18.5 (15.5–21.4)	<0.001
So restless you could not sit still	11.1 (10.2–12.0)	13.9 (12.0–15.9)	0.0061	10.3 (9.6–11.0)	15.8 (13.1–18.4)	<0.001
Depressed	20.7 (19.5–21.9)	27.1 (24.5–29.7)	<0.001	19.4 (18.5–20.3)	29.7 (26.2–33.2)	<0.001
Everything was an effort	17.9 (16.7–19.0)	20.3 (17.9–22.7)	0.0683	16.2 (15.3–17.0)	24.0 (20.7–27.3)	<0.001
So sad that nothing could cheer you up	13.2 (12.2–14.2)	16.3 (14.1–18.4)	0.0082	11.7 (10.9–12.4)	19.6 (16.7–22.6)	<0.001
Worthless	10.7 (9.8–11.6)	14.7 (12.7–16.6)	0.0001	9.8 (9.1–10.5)	17.8 (14.9–20.7)	<0.001
Indicators of stigma						
Would not buy food from a shopkeeper or food seller known to have HIV	14.8 (13.9–15.8)	7.6 (6.1–9.1)	<0.001	14.5 (13.7–15.2)	6.2 (4.4–8.0)	<0.001
Would not buy fresh vegetables from a shopkeeper or vendor known to have HIV	15.3 (14.4–16.3)	7.8 (6.3–9.3)	<0.001	15.2 (14.4–16.0)	6.2 (4.5–8.0)	<0.001
Not willing to care for a family member with AIDS	8.0 (7.3–8.7)	4.3 (3.2–5.3)	<0.001	8.5 (7.9–9.1)	2.4 (1.4–3.4)	<0.001
A teacher with HIV should not be allowed to continue to teach even if they are not sick	10.0 (9.2–10.8)	5.3 (4.1–6.4)	<0.001	9.8 (9.2–10.4)	4.0 (2.7–5.4)	<0.001
It is a waste of money to train or give a promotion to someone with HIV/AIDS	14.0 (13.0–14.9)	14.0 (11.9–16.1)	0.9566	13.5 (12.7–14.3)	13.5 (10.8–16.2)	0.9853
Would want to keep the HIV-positive status of a family member a secret	64.3 (62.9–65.7)	70.9 (68.2–73.6)	<0.001	66.1 (65.1–67.2)	70.3 (66.8–73.8)	0.0325
Comfortable talking to a family member about HIV/AIDS	12.3 (11.4–13.2)	9.5 (7.9–11.2)	0.0063	12.2 (11.5–12.9)	7.9 (5.8–9.9)	0.001

Continued

Table 2. Continued

Characteristics	HIV status as defined by laboratory tests ^a			HIV status as defined by self-report ^b		
	HIV-negative (N=13610)	HIV-positive (N=3646)	p	Reported not living with HIV (N=21483)	Reported living with HIV (N=1930)	p
A person would be foolish to marry a person who is living with HIV/AIDS	20.8 (19.7–21.9)	19.2 (16.9–21.5)	0.2254	21.2 (20.3–22.1)	18.8 (15.7–21.9)	0.1641
A pupil with HIV should not be allowed to continue to go to school even if they are not sick	11.0 (10.2–11.9)	8.1 (6.6–9.7)	0.0032	10.9 (10.2–11.6)	7.4 (5.4–9.4)	0.0045
Children living with HIV should not be able to attend school with children who are HIV-negative	10.3 (9.5–11.1)	7.5 (6.0–8.9)	0.0022	10.4 (9.8–11.1)	6.0 (4.2–7.8)	0.0002
A person can get HIV by sharing food with someone who is living with HIV	12.2 (11.3–13.1)	14.1 (12.2–16.0)	0.0677	12.7 (12.0–13.4)	14.1 (11.6–16.6)	0.286
U=U beliefs						
The risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV	51.5 (50.1–53.0)	55.2 (52.3–58.2)	0.0274	52.9 (51.7–54.1)	55.6 (51.8–59.4)	0.1915
Antiretroviral drugs/ treatment (ART) are a treatment for HIV infection and can keep people healthy for a long time	75.8 (74.6–76.9)	84.5 (82.6–86.5)	<0.001	81.3 (80.4–82.2)	92.6 (90.7–94.4)	<0.001
Drugs, medicine, pills, or ART can prevent a pregnant woman living with HIV from passing on HIV to her baby (i.e. vertical transmission)	58.7 (57.3–60.1)	69.9 (67.4–72.4)	<0.001	63.2 (62.1–64.3)	76.8 (73.6–79.9)	<0.001
Without treatment, HIV can be transmitted from a mother to her unborn baby	72.2 (70.9–73.6)	75.4 (72.9–77.9)	0.0307	72.7 (71.7–73.8)	75.2 (71.9–78.5)	0.1708
A woman living with HIV can still have an HIV-negative baby	74.3 (73.0–75.5)	82.8 (80.6–84.9)	<0.001	74.9 (73.9–75.8)	84.6 (81.9–87.3)	<0.001

Data are given as mean percentage and range. ^a Of the 26875 adults aged ≥18 years who completed the questions, 64.3% (n=17256) provided a blood sample for laboratory confirmation of HIV status. ^b Self-reported HIV status was defined based on one of the following holding true: 1) respondents indicated they were previously tested for HIV and reported the result of their last test as 'Positive'; and 2) respondents answered 'Yes' when asked 'Do you currently have any of the following illnesses? – HIV'. ^c Respondents were classified as having optimal overall health if they answered 'Excellent' or 'Good' to the question: 'In general, would you say that your health is excellent, good, fair, or poor?' ^d Comorbidities ever diagnosed, included hypertension, diabetes, tuberculosis, cancer, and heart disease.

activities (38.0%), losing their jobs (17.9%), or even being physically attacked (17.3%). Despite these challenges, 44.7% overall were not comfortable discussing privacy concerns with their main HIV healthcare provider, and 23.1% had not told their general care (i.e. non-HIV) provider about their HIV status. One-fifth of participants endorsed negative beliefs about their future living with HIV, including sentiments they

would die prematurely from HIV (20.1%), and that because of HIV, they no longer planned for their old age (19.0%). The daily dosing schedule presented additional challenges and was perceived by some as cueing internalized stigma. For example, 50.8% felt that taking HIV medicines every day reminded them of their HIV. In addition, 22.3% felt their daily dosing schedule was stressful, 20.1% felt it limited their life,

Table 3. Comparison of indicators of self-rated health, perceived stigma, and HIV beliefs between the non-HIV population as well as between PLHIV aware vs not aware of their HIV status, South African National HIV, Behavior, And Health Survey, 2017–2018

Health-related outcome	Exposure categories ^a	Prevalence	Prevalence ratios
		%	APR (95% CI)
Optimal overall health	Not living with HIV	82.5 (81.6–83.4)	1.21 (1.14–1.29)
	Tested positive but unaware of status	84.8 (81.9–87.6)	1.23 (1.15–1.32)
	Tested positive and aware of status ®	67.5 (63.5–71.4)	1
Non-HIV comorbidity	Not living with HIV	20.6 (19.8–21.5)	0.57 (0.51–0.65)
	Tested positive but unaware of status	20.5 (17.3–23.7)	0.68 (0.57–0.82)
	Tested positive and aware of status ®	37.0 (32.9–41.1)	1
Tired out for no good reason in the past 30 days	Not living with HIV	17.7 (16.8–18.6)	0.71 (0.61–0.83)
	Tested positive but unaware of status	18.7 (15.5–21.8)	0.74 (0.59–0.92)
	Tested positive and aware of status ®	27.2 (23.4–31.0)	1
Nervous in the past 30 days	Not living with HIV	13.3 (12.5–14.1)	0.63 (0.53–0.76)
	Tested positive but unaware of status	13.6 (11.1–16.2)	0.62 (0.48–0.80)
	Tested positive and aware of status ®	22.5 (18.8–26.1)	1
So nervous that nothing could calm you down in the past 30 days	Not living with HIV	9.7 (9.0–10.4)	0.73 (0.59–0.91)
	Tested positive but unaware of status	10.9 (8.6–13.1)	0.75 (0.56–1.00)
	Tested positive and aware of status ®	15.0 (12.0–18.0)	1
Felt hopeless in the past 30 days	Not living with HIV	14.2 (13.3–15.0)	0.63 (0.53–0.74)
	Tested positive but unaware of status	18.3 (15.2–21.4)	0.73 (0.58–0.91)
	Tested positive and aware of status ®	26.3 (22.5–30.1)	1
Restless or fidgety in the past 30 days	Not living with HIV	12.5 (11.7–13.3)	0.69 (0.56–0.84)
	Tested positive but unaware of status	13.9 (11.2–16.6)	0.76 (0.58–1.00)
	Tested positive and aware of status ®	18.6 (15.2–22.0)	1
So restless you could not sit still in the past 30 days	Not living with HIV	10.3 (9.6–11.0)	0.75 (0.60–0.93)
	Tested positive but unaware of status	12.5 (9.9–15.1)	0.84 (0.63–1.12)
	Tested positive and aware of status ®	15.6 (12.6–18.6)	1
Depressed in the past 30 days	Not living with HIV	19.3 (18.4–20.3)	0.74 (0.64–0.86)
	Tested positive but unaware of status	23.2 (19.8–26.5)	0.80 (0.66–0.97)
	Tested positive and aware of status ®	30.7 (26.7–34.6)	1
Everything was an effort in the past 30 days	Not living with HIV	16.2 (15.3–17.1)	0.73 (0.62–0.86)
	Tested positive but unaware of status	16.6 (13.5–19.7)	0.69 (0.55–0.88)
	Tested positive and aware of status ®	25.1 (21.3–28.9)	1
So sad that nothing could cheer you up in the past 30 days	Not living with HIV	11.8 (11.1–12.6)	0.70 (0.58–0.85)
	Tested positive but unaware of status	12.7 (10.1–15.4)	0.66 (0.51–0.86)
	Tested positive and aware of status ®	20.3 (16.9–23.8)	1
Felt worthless in the past 30 days	Not living with HIV	9.8 (9.1–10.5)	0.62 (0.50–0.76)
	Tested positive but unaware of status	11.5 (9.2–13.9)	0.66 (0.50–0.87)
	Tested positive and aware of status ®	18.0 (14.7–21.3)	1
Would not buy food from a shopkeeper or food seller known to have HIV	Not living with HIV	14.8 (14.0–15.6)	2.12 (1.51–2.96)
	Tested positive but unaware of status	9.2 (7.0–11.4)	1.62 (1.08–2.43)
	Tested positive and aware of status ®	5.8 (3.9–7.7)	1

Continued

Table 3. Continued

Health-related outcome	Exposure categories ^a	Prevalence	Prevalence ratios
		%	APR (95% CI)
Would not buy fresh vegetables from a shopkeeper or vendor known to have HIV	Not living with HIV	15.6 (14.7–16.4)	2.24 (1.60–3.13)
	Tested positive but unaware of status	9.7 (7.4–11.9)	1.72 (1.15–2.57)
	Tested positive and aware of status ®	5.7 (3.8–7.6)	1
Not willing to care for a family member with AIDS	Not living with HIV	8.6 (8.0–9.2)	3.93 (2.33–6.63)
	Tested positive but unaware of status	6.5 (4.7–8.2)	3.43 (1.92–6.13)
	Tested positive and aware of status ®	1.8 (0.9–2.7)	1
A teacher with HIV should not be allowed to continue to teach even if they are not sick	Not living with HIV	10.0 (9.4–10.7)	2.21 (1.50–3.25)
	Tested positive but unaware of status	6.5 (4.8–8.2)	1.68 (1.06–2.65)
	Tested positive and aware of status ®	3.9 (2.4–5.3)	1
It is a waste of money to train or give a promotion to someone with HIV/AIDS	Not living with HIV	13.4 (12.6–14.2)	0.94 (0.74–1.19)
	Tested positive but unaware of status	13.8 (11.0–16.6)	0.97 (0.72–1.31)
	Tested positive and aware of status ®	14.3 (11.1–17.5)	1
Would want to keep the HIV-positive status of a family member a secret	Not living with HIV	65.6 (64.5–66.7)	1.00 (0.94–1.06)
	Tested positive but unaware of status	72.9 (69.3–76.6)	1.05 (0.98–1.14)
	Tested positive and aware of status ®	69.0 (64.9–73.0)	1
Comfortable talking to a family member about HIV/AIDS	Not living with HIV	12.3 (11.5–13.0)	1.43 (1.05–1.95)
	Tested positive but unaware of status	11.1 (8.7–13.4)	1.36 (0.94–1.97)
	Tested positive and aware of status ®	7.8 (5.4–10.1)	1
A person would be foolish to marry a person who is living with HIV/AIDS	Not living with HIV	21.2 (20.3–22.2)	0.94 (0.77–1.14)
	Tested positive but unaware of status	19.8 (16.6–22.9)	1.02 (0.80–1.30)
	Tested positive and aware of status ®	19.0 (15.4–22.6)	1
A pupil with HIV should not be allowed to continue to go to school even if they are not sick	Not living with HIV	11.0 (10.3–11.6)	1.47 (1.06–2.03)
	Tested positive but unaware of status	9.5 (7.2–11.7)	1.40 (0.95–2.08)
	Tested positive and aware of status ®	6.8 (4.7–9.0)	1
Children living with HIV should not be able to attend school with children who are HIV negative	Not living with HIV	10.5 (9.8–11.1)	1.59 (1.12–2.27)
	Tested positive but unaware of status	9.2 (7.1–11.4)	1.66 (1.10–2.52)
	Tested positive and aware of status ®	5.6 (3.7–7.5)	1
A person can get HIV by sharing food with someone who is living with HIV	Not living with HIV	12.6 (11.9–13.3)	0.84 (0.68–1.05)
	Tested positive but unaware of status	13.6 (11.0–16.2)	0.91 (0.69–1.20)
	Tested positive and aware of status ®	14.8 (11.9–17.8)	1

Prevalence data are given as mean percentage and range. APR: adjusted prevalence ratios. Analyses controlled for age, gender, geographical location, and race. ® Reference categories. ^a Based on agreement between laboratory-confirmed and self-reported HIV status, participants aged ≥18 years were classified into 3 groups: negative laboratory test and negative self-report (i.e. not living with HIV, n=23371); positive laboratory test and negative self-report (i.e. status-unaware PLHIV, n=1912); and positive laboratory test and positive self-report (i.e. status-aware PLHIV, n=1496). We excluded n=96 adults with a negative laboratory test and positive self-report as potential misclassification cases.

and 47.5% were worried about missing an ART dose. Other concerns were about possible weight gain/ altered body shape from ART (64.8%), having to take more and more medicines with age (62.6%), long-term negative impacts of treatment (68.2%), and potential drug-drug interactions (48.0%). Overall, 44.1% felt there was room for improving their HIV medications, 40.8% had ever switched ART at least once – most commonly to reduce the number of pills taken

daily – and 27.9% overall would prefer not having to take HIV medicines every day. Other treatment-related challenges and experiences are summarized in Supplementary file Table 1.

Subgroup differences were observed among PP2 participants in some of the perceptions indicative of internalized stigma. Older adults aged ≥50 years were more likely to report that they no longer planned for their old age because of HIV than participants aged <50 years

Table 4. Adjusted prevalence ratios with corresponding 95% confidence intervals for the associations between awareness of U=U principles and personal experiences with PLHIV and stigma attitudes among the HIV and non-HIV populations aged ≥18 years in South Africa, South African National HIV, Behavior, And Health Survey, 2017–2018

	Would not buy food from a shopkeeper or food seller known to have HIV	Would not buy fresh vegetables from a shopkeeper or vendor known to have HIV	Not willing to care for a family member with AIDS	A teacher with HIV should not be allowed to continue to teach even if they are not sick	It is a waste of money to train or give a promotion to someone with HIV/AIDS	Would want to keep the HIV-positive status of a family member a secret	Comfortable talking to a family member about HIV/AIDS	A person would be foolish to marry a person who is living with HIV/AIDS	A pupil with HIV should not be allowed to continue to go to school even if they are not sick	Children living with HIV should not be able to attend school with children who are HIV negative
Among people living with HIV (self-reported, N=1930)										
The risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV										
Yes vs No	1.03 (0.59–1.81)	0.82 (0.47–1.44)	0.38 (0.16–0.92)	0.75 (0.38–1.48)	1.07 (0.70–1.64)	1.14 (1.03–1.27)	0.74 (0.44–1.25)	0.82 (0.59–1.14)	0.58 (0.33–1.00)	0.71 (0.39–1.29)
Drugs, medicine, pills, or ARVs can prevent a pregnant woman living with HIV from passing on HIV to her baby										
Yes vs No	0.46 (0.26–0.81)	0.46 (0.26–0.81)	0.46 (0.26–0.81)	0.45 (0.23–0.90)	0.71 (0.45–1.10)	1.10 (0.97–1.25)	0.67 (0.38–1.18)	0.80 (0.56–1.14)	0.47 (0.27–0.80)	0.23 (0.13–0.42)
A woman living with HIV can have an HIV-negative baby										
Yes vs No	0.38 (0.21–0.70)	0.36 (0.20–0.63)	0.37 (0.16–0.86)	0.51 (0.24–1.09)	0.64 (0.39–1.04)	1.05 (0.91–1.22)	0.72 (0.41–1.27)	0.76 (0.51–1.12)	0.46 (0.25–0.84)	0.28 (0.14–0.54)
Among the non-HIV population (self-reported, N=21483)										
The risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV										
Yes vs No	0.66 (0.60–0.74)	0.66 (0.60–0.74)	0.51 (0.44–0.59)	0.50 (0.43–0.57)	1.01 (0.90–1.13)	1.17 (1.13–1.21)	0.49 (0.43–0.55)	1.01 (0.92–1.10)	0.49 (0.43–0.56)	0.46 (0.40–0.53)
Drugs, medicine, pills, or ART can prevent a pregnant woman living with HIV from passing on HIV to her baby (i.e. vertical transmission)										
Yes vs No	0.42 (0.38–0.47)	0.45 (0.41–0.51)	0.33 (0.28–0.39)	0.30 (0.26–0.35)	0.69 (0.61–0.78)	1.14 (1.10–1.18)	0.37 (0.33–0.42)	0.77 (0.71–0.84)	0.31 (0.27–0.35)	0.29 (0.25–0.33)
A woman living with HIV can still have an HIV-negative baby										
Yes vs No	0.38 (0.34–0.43)	0.41 (0.36–0.45)	0.26 (0.22–0.30)	0.26 (0.22–0.30)	0.73 (0.65–0.82)	1.17 (1.11–1.22)	0.31 (0.28–0.35)	0.80 (0.73–0.88)	0.27 (0.24–0.31)	0.26 (0.23–0.30)
A person can get HIV by sharing food with someone who is living with HIV										
Yes vs No	1.32 (1.16–1.50)	1.33 (1.18–1.51)	1.11 (0.91–1.35)	1.38 (1.17–1.63)	2.06 (1.82–2.33)	1.06 (1.02–1.11)	1.10 (0.94–1.29)	1.72 (1.56–1.89)	1.46 (1.25–1.71)	1.61 (1.38–1.88)
Attended a training workshop on HIV/AIDS in the past 12 months										
Yes vs No	0.62 (0.46–0.84)	0.77 (0.59–1.01)	0.44 (0.29–0.67)	0.53 (0.36–0.76)	0.90 (0.70–1.17)	1.04 (0.97–1.10)	0.53 (0.38–0.75)	0.61 (0.49–0.77)	0.63 (0.44–0.89)	0.63 (0.44–0.89)
Attended a community meeting about HIV/AIDS in the past 12 months										
Yes vs No	0.63 (0.45–0.88)	0.70 (0.52–0.96)	0.48 (0.29–0.79)	0.71 (0.49–1.05)	0.93 (0.71–1.21)	1.00 (0.93–1.08)	0.68 (0.48–0.97)	0.71 (0.55–0.91)	0.92 (0.66–1.28)	0.65 (0.43–0.98)

Continued

Table 4. Continued

	Would not buy food from a shopkeeper or food seller known to have HIV	Would not buy fresh vegetables from a shopkeeper or vendor known to have HIV	Not willing to care for a family member with AIDS	A teacher with HIV should not be allowed to continue to teach even if they are not sick	It is a waste of money to train or give a promotion to someone with HIV/AIDS	Would want to keep the HIV-positive status of a family member a secret	Comfortable talking to a family member about HIV/AIDS	A person would be foolish to marry a person who is living with HIV/AIDS	A pupil with HIV should not be allowed to continue to go to school even if they are not sick	Children living with HIV should not be able to attend school with children who are HIV negative
Attended play or dialogue or educational event on HIV/AIDS in the past 12 months										
Yes vs No	0.54 (0.37-0.80)	0.57 (0.38-0.84)	0.57 (0.35-0.94)	0.62 (0.39-0.99)	1.12 (0.84-1.49)	1.08 (1.01-1.16)	0.68 (0.46-0.99)	0.78 (0.60-1.01)	0.73 (0.49-1.09)	0.55 (0.35-0.87)
Attended a clinic discussion on HIV in the past 12 months										
Yes vs No	0.73 (0.60-0.90)	0.77 (0.63-0.94)	0.40 (0.27-0.60)	0.52 (0.39-0.70)	0.82 (0.68-1.01)	1.03 (0.98-1.08)	0.64 (0.51-0.80)	0.69 (0.58-0.82)	0.70 (0.55-0.91)	0.56 (0.42-0.74)
Know someone who is on ART										
Yes vs No	0.61 (0.52-0.71)	0.66 (0.57-0.77)	0.48 (0.39-0.60)	0.53 (0.44-0.65)	0.71 (0.61-0.82)	1.07 (1.03-1.11)	0.56 (0.48-0.66)	0.77 (0.69-0.86)	0.47 (0.39-0.56)	0.45 (0.37-0.55)
Been told by someone you know that they are HIV-positive										
Yes vs No	0.51 (0.44-0.60)	0.56 (0.49-0.65)	0.49 (0.40-0.61)	0.46 (0.38-0.56)	0.73 (0.63-0.84)	1.06 (1.02-1.10)	0.60 (0.51-0.70)	0.77 (0.69-0.86)	0.48 (0.40-0.58)	0.42 (0.34-0.51)

APR: adjusted prevalence ratios. Analyses controlled for age, gender, geographical location, and race

(25.8% vs 17.6%). Despite perceiving room for improving their medication to a greater extent (almost 10 percentage points higher, 51.6% vs 42.6%), older adults were less likely (≥ 10 percentage points lower) than participants aged < 50 years to be concerned about some more forward, long-term effects of ART, or to even feel comfortable discussing those issues with their HIV care provider. For example, compared to participants aged < 50 years, older adults were less likely to be concerned about the impact of ART on their overall health and wellbeing (38.7% vs 60.8%), and of running out of treatment options in the future (45.2% vs 56.1%). Gender differences were also observed in treatment experiences, anticipated stigma, as well as a willingness to open up to HCPs about treatment challenges or share HIV status with others. Males reported higher prevalence than females (≥ 10 percentage points higher) for an experience of side effects (48.5% vs 35.4%), perception daily ART dosing was a constant reminder of HIV in their life (58.8% vs 47.5%), difficulty swallowing pills (47.1% vs 29.3%), concern about how ART might impact their health and wellbeing (67.6% vs 50.5%), and concern about the risk of drug-drug interactions (57.4% vs 42.4%). Optimal mental health among males was conversely markedly lower than females (57.4% vs 77.8%). Males, nonetheless, reported lower prevalence than females (≥ 10 percentage points lower) forever switching their ART (30.9% vs 47.5%), comfort sharing their HIV status with others (20.6% vs 35.4%) or comfort discussing with HCPs a range of issues relevant to their wellbeing, including the impact of ART on their day-to-day life (52.9% vs 67.7%), their emotional wellbeing (54.4% vs 66.7%), side effects (51.5% vs 65.7%), and the long-term impacts of ART (47.1% vs 58.6%). The most common reason for switching ART, among females who switched, was quality-of-life reasons (to reduce the number of pills they needed to take daily, 36.2%), whereas the most common reason among males was a medical indication (viral resistance, 38.1%).

U=U beliefs and stigma perceptions among PLHIV and the non-HIV population

Within PP2, 69.8% of South African PLHIV on ART indicated their HCP had discussed with them U=U (Supplementary Table 1). Older adults faced a 'double whammy' with regard to communication about issues related to HIV transmission within PP2 (Figure 2). Not only were people aged ≥ 50 years less comfortable than those aged < 50 years to discuss with their HCPs concerns about preventing HIV transmission to their partners (48.4% vs 69.6%), but they were also less likely to be told about U=U by their HCPs (41.9% vs 75.7%). Female participants in PP2 were similarly less likely than their male counterparts to be told about U=U by their HCP (64.6% vs 76.5%).

In SABSSM-V, only just over half (55.6%) of those self-reporting they were living with HIV believed that the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat

HIV, and this did not differ significantly from individuals reporting not living with HIV (52.9%, $p=0.1915$). Compared to those reporting not living with HIV, a significantly higher percentage of those self-reporting they were living with HIV, however, believed that ART could prevent vertical HIV transmission (76.8% vs 63.2%, $p<0.001$) and that a woman living with HIV could still give birth to an HIV-negative baby (84.6% vs 74.9%, $p<0.001$) (Table 2). Similar results were seen when analyzed among those with objectively confirmed (i.e. laboratory) positive HIV-status as shown in Figure 2.

U=U belief among those reporting that they were living with HIV in SABSSM-V was associated with less likelihood of internalizing stigma and greater likelihood of sharing their HIV status with their sexual partners. For example, the likelihood of endorsing the discriminatory idea that children living with HIV should not be able to attend school with children who are HIV-negative was significantly lower among PLHIV believing than not believing that ART can prevent vertical transmission (APR=0.23; 95% CI: 0.13–0.42), and that a woman living with HIV could still give birth to an HIV-negative child (APR=0.28; 95% CI: 0.14–0.54). PLHIV believing that ART can prevent vertical transmission were also more likely to share their HIV status with their sexual partners than those not believing (APR=1.18; 95% CI: 1.01–1.38, data not shown). U=U belief among PLHIV was also associated with less fearfulness of those with AIDS. The likelihood of refusing to care for a family member with AIDS was lower among those believing that 'the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV' (APR=0.38; 95% CI: 0.16–0.92), those believing ART can prevent vertical transmission (APR=0.46; 95% CI: 0.26–0.81), and those believing a woman living with HIV could still give birth to an HIV-negative baby (APR=0.37; 95% CI: 0.16–0.86) (Table 4).

Among the non-HIV population in SABSSM-V, U=U belief was also inversely associated with stigma sentiments directed at PLHIV (Table 4). Conversely, wrong information about how HIV is transmitted engendered stigma. For example, those who believed HIV could be transmitted by sharing food were more likely than those without this belief to report they would not buy food from a food seller with HIV (APR=1.32; 95% CI: 1.16–1.50), not get fresh vegetables from someone with HIV (APR=1.33; 95% CI: 1.18–1.51), to disapprove of PLHIV teaching in schools (APR=1.38; 95% CI: 1.17–1.63), or of children with HIV attending the same school as children without HIV (APR=1.61; 95% CI: 1.38–1.88), to perceive that promoting or training PLHIV was a waste of money (APR=2.06; 95% CI: 1.82–2.33), or to state that it would be foolish to marry someone with HIV (APR=1.72; 95% CI: 1.56–1.89). Two behaviors that protected against stigma among the non-HIV population were past social interactions with PLHIV and actively learning about HIV. As shown in Table 4, those reporting that they knew someone living with HIV, or that someone living with HIV had shared

their HIV status with them, were significantly less likely than those without those experiences, to report HIV stigmatizing sentiments. Similarly, non-HIV individuals who had learned more about HIV in different settings, including workshops, educational events, clinic discussions, or in a community setting, reported less likelihood than those without the respective educational experiences, of reporting HIV stigma sentiments directed at PLHIV.

DISCUSSION

PLHIV aware of their HIV status had poorer self-rated health and reported higher perceived stigma than the non-HIV population. While status-unaware PLHIV showed more favorable subjective measures of emotional wellbeing, similar to levels seen among the non-HIV population, 'blissful ignorance' is not a long-term or sustainable solution to stigma. PLHIV who delay knowing or accepting their HIV status may eventually develop very high pretreatment viral loads, a state that predicts poor health outcomes such as the emergence of drug resistance, treatment failure, and disease progression²⁵. This could ultimately reinforce internal stigma because such individuals may never know the benefits of an undetectable viral load. Enhanced and sustained efforts are therefore needed to eliminate HIV stigma in all forms using evidence-based strategies that recalibrate social norms in the society²⁶.

Addressing stigma requires an all-hands-on-deck approach from all stakeholders, including PLHIV, healthcare providers, the non-HIV population, grassroots organizations, as well as governmental and non-governmental agencies²⁶. The role of PLHIV is supported by our study finding that individuals without HIV who reported that someone living with HIV had shared their HIV status with them were less likely to endorse negative, stigmatizing sentiments about PLHIV. The burden of reducing stigma should, however, not fall first and foremost to the victims of stigma but should start with other parties – HCPs, policy makers, and the public, with the inclusion of PLHIV in the discussions around what can be done to support them to feel safe enough to disclose. We observed that individuals without HIV who reported having a discussion with a clinician about HIV were less likely to endorse negative stereotypes about PLHIV, underscoring the role that general care providers also play in eliminating stigma. Our findings, however, suggest much room for improvement in HCP involvement given that nearly 1 in 3 PLHIV in our study reported not being told about U=U by their HCPs, especially females (despite their higher HIV seroprevalence), and older adults aged ≥ 50 years (despite a third of them reporting past-year sexual activity in our study). With evidence that ART increases life expectancy comparable to that seen in the general population²⁷, and against the backdrop of our finding that 1 in 4 older PLHIV did not expect a normal life expectancy, it is imperative for providers to educate older PLHIV about U=U and how the benefits of being 'Undetectable' go beyond

being 'Untransmissible' to living a longer, healthier life. To accelerate progress towards the 2030 target of eradicating AIDS as a public health threat^{28,29}, it is important to incorporate the U=U message into HIV policies, guidelines, and service delivery within the South African context.

ART-related challenges were associated with internalized stigma within the PP2 sample; many of the challenges with daily oral ART were higher among men than women, as was suboptimal mental health – also associated with stigma. Men were less comfortable disclosing their status to others or opening up to their HCPs about their treatment challenges. For example, despite having a higher prevalence of side effects, males reported a lower prevalence for perceived comfort discussing side effects and several other concerns about their emotional wellbeing with HCPs compared to females. This might suggest an underlying 'macho' factor, especially when taken together with other observations such as males being the group with the lowest prevalence of switching ART for 'mere convenience' (to reduce number of pills swallowed daily) but reporting the highest prevalence of those switching for 'intractable' challenges (viral failure). The high switching on account of viral failure among males could also be that they may be kept on failing regimens longer, which could deny them the benefit of U=U, ultimately reinforcing internal stigma. Individuals identifying with some 'other genders' neither male nor female were generally less likely to have many of the concerns around daily oral dosing and were more likely to change ART for side effects or ART simplification, and to be satisfied with their care (including current medications) than other groups/overall. This may possibly be because such individuals may be accessing ART through specialized services catering for other genders and sensitized to them.

Expanding the flexibility of treatment options may be helpful in mitigating internalized stigma among those who feel that daily HIV dosing is a constant reminder of HIV in their lives, as reported by over half of South African participants in PP2³⁰. The most common reason overall for switching ART in our study was to reduce the number of pills taken, underscoring the extent to which dosing flexibility and quality of life play a role in treatment choices among PLHIV. Considering the quality of life factors beyond viral suppression and seeking the viewpoint of PLHIV when planning treatment can help address unmet needs and improve health-related quality of life as espoused in the fourth 90 targets^{19,31}.

Strengths and limitations

This study's strengths include the use of a very large sample and laboratory confirmation of HIV status which enhance the internal and external validity of this study. Nonetheless, there are some limitations. First, the sampling frame of SABSSM-V excluded groups that may have a different risk of HIV, including patients admitted in hospitals, military personnel living in barracks, incarcerated individuals, and

homeless people. In addition, SABSSM-V did not assess knowledge of other routes of HIV transmission to a child other than during pregnancy, including during childbirth and breastfeeding. Also, while not a limitation, it should be noted that the construct of 'awareness' of HIV status as defined in our article is not synonymous with every diagnosis of HIV status. While only 45.0% of those with a positive laboratory test indicated awareness of their HIV status based on self-report alone, this number doubled when factoring in both self-report and the presence of ART analytes in the blood stream²⁴. The underestimation of diagnosis by self-reports has little relevance to our study though, because our aim was not to estimate the percentage of PLHIV diagnosed but rather to measure the impact that embracing one's diagnosis has on indicators of stigma and overall wellbeing. Limitations exist to the PP2 study as well; the survey was web-based and may have oversampled individuals of higher socio-economic status. Also, some subgroups in PP2 (e.g. people identifying with some 'other gender') had very small sample sizes which may have led to imprecise estimates.

CONCLUSIONS

Just over half (55.6%) of individuals reporting they were living with HIV were aware that 'the risk of HIV transmission through sex can be reduced by an HIV-positive partner consistently taking drugs that treat HIV'. PLHIV were more familiar with the fact that ART can prevent vertical transmission (76.8%) and that a woman living with HIV can still give birth to an HIV-negative baby (84.6%). Awareness of U=U was associated with significantly less perceived stigma among both PLHIV and the non-HIV population. Given that 1 in 3 of South African PLHIV on treatment reported having not been told of U=U by their HCP, enhanced and sustained efforts are needed to incorporate the U=U message into HIV policies, guidelines, and service delivery in South Africa.

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CONFLICTS OF INTEREST

The authors have each completed and submitted an ICMJE form for Disclosure of Potential Conflicts of Interest. The authors declare that they have no competing interests, financial or otherwise, related to the current work. The authors declare that they are employees of ViiV Healthcare.

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ETHICAL APPROVAL AND INFORMED CONSENT

Analyzed data from the 2017–2018 South African National HIV

Prevalence, Incidence, Behavior and Communication Survey were de-identified data. An ethical review of the 2019 Positive Perspective Study in South Africa was provided by the Sefako Makgatho Research Ethics Committee (Approval number: SMUREC/M/223/2019). Participation in the survey was deemed informed consent.

DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

PROVENANCE AND PEER REVIEW

Not commissioned; externally peer review.