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Original research

Undetectable equals untransmittable (U = U): awareness and associations with health outcomes among people living with HIV in 25 countries

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ABSTRACT

Objectives ‘Undetectable equals Untransmittable’ (U=U) is an empowering message that may enable people living with HIV (PLHIV) to reach and maintain undetectability. We estimated the percentage of PLHIV who ever discussed U=U with their main HIV care provider, and measured associations with health-related outcomes. Secondly, we evaluated whether the impact of the U=U message varied between those who heard it from their healthcare provider (HCP) vs from elsewhere.

Methods Data were from the 25-country 2019 Positive Perspectives Survey of PLHIV on treatment (n=2389). PLHIV were classified as having discussed U=U with their HCP if they indicated that their HCP had ever told them about U=U. Those who had not discussed U=U with their HCP but were nonetheless aware that ‘My HIV medication prevents me from passing on HIV to others’ were classified as being made aware of U=U from non-HCP sources. Multivariable logistic regression was used to measure associations between exposure to U=U messages and health outcomes.

Results Overall, 66.5% reported ever discussing U=U with their HCP, from 38.0% (South Korea) to 87.3% (Switzerland). Prevalence was lowest among heterosexual men (57.6%) and PLHIV in Asia (51.3%). Compared with those unaware of U=U, those reporting U=U discussions with their HCP had lower odds of suboptimal adherence (AOR=0.59, 95% CI 0.44 to 0.78) and higher odds of self-reported viral suppression (AOR=2.34, 95% CI 1.72 to 3.20), optimal sexual health (AOR=1.48, 95% CI 1.14 to 1.92) and reporting they ‘always shared’ their HIV status (AOR=2.99, 95% CI 1.42 to 6.28). While exposure to U=U information from non-HCP sources was beneficial too, the observed associations were attenuated relative to those seen with reported discussions with HCPs.

Conclusion HCP discussion of U=U with PLHIV was associated with favourable health outcomes. However, missed opportunities exist since a third of PLHIV reported not having any U=U discussion with their HCP. U=U discussions with PLHIV should be considered as a standard of care in clinical guidelines.

INTRODUCTION

Despite global targets to eliminate AIDS as a public health threat by 2030, about 14% (3.5 million) of

the 25.4 million people living with HIV (PLHIV) on treatment are virally non-suppressed.^{1 2} The evidence-based campaign, ‘Undetectable Equals Untransmittable’ (U=U),^{3–8} is an empowering discussion that may help motivate and incentivise PLHIV to reach and maintain undetectability.² The key message behind this informational campaign is that ‘for people who achieve and maintain viral suppression, there is effectively no risk of transmitting HIV to their HIV-negative sexual partners’.⁵

U=U is appealing in its simplicity, person-focus and potential downstream benefits in promoting prevention at all levels, including primary (preventing transmission to uninfected persons), secondary (ensuring regular viral load monitoring and health screenings among PLHIV) and tertiary (improving PLHIV’s quality of life). By focusing on being ‘undetectable’, an objectively measured health state, U=U provides PLHIV with an unambiguous health target that emphasises personal responsibility.^{3 4} ‘Untransmissibility’, the reward for ‘Undetectability’ may be particularly appealing for serodiscordant couples in a relationship or wishing to start a family. Besides encouraging antiretroviral therapy (ART) initiation and adherence among PLHIV, U=U could also recalibrate social norms among non-HIV populations, given that transmission risk is a major source of fear/stigma.^{9–12}

The U=U message has been incorporated into numerous public health campaigns and clinical guidelines.^{3 4 13} Discussing U=U in clinical settings is vital because patients perceive information they hear directly from their healthcare providers (HCPs) as being more believable.¹⁴ The impact of HCP counselling has been well demonstrated in other areas of public health such as smoking cessation.¹⁵ Since clinicians are likely the first professionals to whom a newly diagnosed person will turn for advice about their new health circumstance, it is essential to evaluate the extent to which HCPs share information on U=U with their patients and whether this varies by recency of diagnosis, at-risk groups for HIV transmission and by burden of disease.^{16–21}

This study therefore examined: (1) Prevalence and disparities in self-report of having had a U=U discussion with HCPs. (2) Associations between exposure to U=U information and health-related perceptions and behaviours. We further examined

whether the observed impact of exposure to U=U message was modified by the source of the information (HCP or non-HCP sources) as well as by PLHIV characteristics.

METHODS

Data source

Sample size

The 2019–2020 Positive Perspectives Study was fielded from 3 April 2019 to 31 January 2020 ($n=2389$, response rate=58.6%). It was a web-based, self-reported, cross-sectional survey of PLHIV in 25 countries: USA ($n=400$), South Africa ($n=179$), Russia ($n=150$), UK ($n=123$), Australia ($n=120$), Canada ($n=120$), France ($n=120$), Germany ($n=120$), Italy ($n=120$), Spain ($n=120$), Japan ($n=75$), Mexico ($n=63$), Portugal ($n=60$), Brazil ($n=58$), Switzerland ($n=55$), Taiwan ($n=55$), Netherlands ($n=51$), Argentina ($n=50$), Austria ($n=50$), Chile ($n=50$), China ($n=50$), Ireland ($n=50$), Belgium ($n=50$), Poland ($n=50$), and South Korea ($n=50$). Sampling was purposive and aimed at achieving adequate sample sizes within three prespecified strata: those diagnosed as HIV seropositive within the last 2 years, women and persons aged 50+ years. The rationale was to better understand the specific perceptions and attitudes of these population subgroups who may sometimes be under-represented in routine surveillance.

Survey recruitment/fielding

Participants were eligible for selection if they were aged ≥ 18 years, confirmed being HIV seropositive and were on ART. Of the 2389 participants, 1387 (58.1%) were recruited from support groups/charities for patients with HIV; 627 (26.2%) from existing panels of PLHIV; 204 (8.5%) from local operating company contacts; 108 (4.5%) from patient-to-patient referrals; and 63 (2.6%) from social media (online supplementary table 1). The survey was fielded in 20 languages.

The questionnaire, developed specifically for this primary data collection, comprised 60 questions designed to be completed in 25–30 min. It was developed, piloted and reviewed alongside an advisory panel that included PLHIV. The survey was sponsored by ViiV Healthcare and fielded independently by Ipsos Healthcare. To minimise bias in administering the survey, there was double blinding: ViiV Healthcare was not identified to participants as the study sponsor; likewise, participants' identities were not revealed to ViiV Healthcare. Participants were however told the study was being conducted 'on behalf of a pharmaceutical company'.

MEASURES

Exposure to U=U information

Conceptually, we classified participants into three categories based on exposure to U=U information: (a) Not heard of U=U. (b) Discussed U=U with their HCP. (c) Heard about U=U only from sources other than an HCP. Operationally, those who affirmed in the survey ('agree' or 'strongly agree') that 'My provider has told me about "undetectable=untransmittable"' were classified as (b) regardless of whether the discussion was patient-prompted or HCP initiated, and also regardless of whether PLHIV heard about U=U from other sources as well; those not informed of U=U by their HCP, but who nonetheless reported awareness that 'My HIV medication prevents me from passing on HIV to others' were classified as (c); all others who provided dissenting responses to the two survey questions above were classified as (a). The specific wording of the questions above are shown in online supplementary table 2. Respondents were

also asked their perceived comfort discussing with HCPs their 'concerns about the safety of others/preventing transmission'.

Self-rated health

Participants rated their sexual, physical, mental and overall health. Responses of 'Very good' or 'Good' (vs 'Neither good nor poor'/'Poor'/'Very poor') were classified as optimal.

Sharing of HIV status

Both components of social norms—descriptive (estimated prevalence) and injunctive (perceptions of acceptability)—can mediate the stigma experienced among PLHIV.²² For example, PLHIV might be unwilling to share their HIV status because they perceive very few other people within their social circle as living with HIV (descriptive norms), or because having HIV is judged by people within their social circle as being undesirable (injunctive norms).^{9 23}

We assessed whether exposure to U=U messages was associated with differential willingness to share HIV status with others. PLHIV were asked various questions to determine their perceived comfort 'with sharing (their) HIV status'; if they had 'ever hidden or disguised (their) HIV medication to avoid revealing (their) status', and perceived comfort discussing with HCPs their 'concerns about privacy and not disclosing (their) HIV status'. PLHIV further identified whom they had shared their HIV status with besides their primary HIV care providers.

Other variables

Suboptimal adherence was a report of at least one reason for missing ART for at least five times within the past month. Other assessed variables included age, gender, sexual orientation, location of PLHIV and of their primary HCP, commute time to HCP, relationship status, and duration of disease. Several other aspects of engagement with HCPs were assessed, including sharing of health information, involvement in treatment decisions/care and communication.

Analyses

Percentages were compared with χ^2 tests. Associations between receipt of U=U message and health outcomes were measured using logistic regression. The outcomes analysed were self-reported viral suppression, suboptimal adherence, self-rated health, and privacy-related perceptions and behaviours. Separate logistic regression analyses were conducted for each outcome, adjusting for gender, age, sexual orientation, geographical region, duration of disease, domicile (metropolitan or non-metropolitan), education and ethnicity. Confounding variables were identified statistically (independently associated with exposure and outcomes) as well as with directed acyclic graphs. To assess for effect modification by PLHIV characteristics ($\geq 10\%$ difference in effect measure), analyses were further stratified by age (<50 or ≥ 50 years) and gender (men or women). All statistical procedures were performed with R V.3.6.1.

RESULTS

Mean age was 41.2 (SD=12.2) years. Overall, 29.1% self-identified as women, 70.7% were aged <50 years and 73.5% had $>$ high school. Among those diagnosed with HIV prior to 2017, 60.1% (1106/1841) currently prioritised preventing transmission to a sexual partner, and 20.4% (376/1841) currently prioritised having children. Black participants made up 13.6% (275/2014) of all respondents with information on ethnicity,

Table 1 Attitudes and perceptions towards preventing HIV transmission and the percentage that reported ever discussing U=U with their healthcare provider among people living with HIV in 25 countries, Positive Perspectives Study, 2019

Characteristics	Categories	N, %	Comfortable discussing HIV transmission with HCP, %	Ever discussed U=U with HCP, %	Aware that HIV medications prevent HIV transmission, %	Either discussed U=U with HCP or reported awareness that HIV medications prevent transmission, %
Total	Overall	2389 (100.0)	59.8	66.5	74.2	87.6
Age, years	<50	1690 (70.7)	55.5	65.5	74.0	87.0
	50+	699 (29.3)	70.1	68.8	74.7	89.0
Gender	Men	1623 (67.9)	61.5	66.6	76.8	88.4
	Women	696 (29.1)	58.0	64.7	67.8	85.1
	Other	70 (2.9)	37.1	81.4	78.6	95.7
Gender/sexual orientation	Men who have sex with men	1018 (42.6)	70.3	70.5	83.2	92.7
	Men who have sex with women	479 (20.1)	42.8	57.6	63.0	78.7
	Women who have sex with men	481 (20.1)	59.3	64.2	69.9	85.7
	Women who have sex with women	62 (2.6)	45.2	61.3	54.8	74.2
	Other/indeterminate	349 (14.6)	55.6	70.8	72.8	90.0
Overall health	Suboptimal	1012 (42.4)	50.5	61.4	69.1	83.8
	Optimal	1377 (57.6)	66.6	70.2	78.0	90.4
Physical health	Suboptimal	953 (39.9)	50.2	59.8	67.1	83.0
	Optimal	1436 (60.1)	66.2	70.9	79.0	90.7
Mental health	Suboptimal	1013 (42.4)	50.9	58.8	68.3	81.9
	Optimal	1376 (57.6)	66.3	72.1	78.6	91.8
Sexual health	Suboptimal	1227 (51.4)	55.7	63.0	70.9	85.8
	Optimal	1162 (48.6)	64.1	70.1	77.7	89.5
Geographical Region*	Northern America	520 (21.8)	53.8	67.3	64.2	84.8
	Europe	1119 (46.8)	61.1	68.4	78.8	90.5
	Latin America	221 (9.3)	59.7	60.6	71.9	84.6
	Asia	230 (9.6)	50.4	51.3	64.3	78.7
	Australia	120 (5.0)	81.7	80.0	90.8	97.5
	South Africa	179 (7.5)	65.9	69.8	78.8	86.0
Housing status	Own	722 (30.2)	61.1	65.7	73.1	88.4
	Rent	916 (38.3)	63.3	68.1	77.5	89.2
	Other	751 (31.4)	54.2	65.2	71.2	85.0
HCP location	Metropolitan	1583 (66.3)	64.8	69.0	79.7	90.9
	Non-metropolitan	806 (33.7)	49.9	61.5	63.4	81.1
PLHIV location	Metropolitan	1335 (55.9)	63.4	67.9	80.0	90.7
	Non-metropolitan	1054 (44.1)	55.1	64.6	66.9	83.7
Commute to HCP	<30 min	869 (36.4)	65.5	71.9	78.3	91.4
	30–59 min	1027 (43.0)	58.1	65.5	71.0	85.0
	60+ min/unknown	493 (20.6)	53.1	58.8	73.8	86.4
Employment status	Employed	1653 (69.2)	60.0	65.8	73.7	87.6
	Non-employed	736 (30.8)	59.4	68.1	75.3	87.6
Education	≤High school	532 (22.3)	59.0	72.6	72.0	88.5
	>High school	1756 (73.5)	61.4	63.7	74.7	87.0
	Refused to answer	101 (4.2)	35.6	83.2	78.2	93.1
Ethnicity	White	1393 (58.3)	61.7	67.1	74.3	88.4
	Black	275 (11.5)	60.0	69.8	70.9	84.0
	Other	346 (14.5)	59.0	63.9	74.0	86.7
	Unknown/missing	375 (15.7)	53.3	64.0	76.5	88.3
Preventing HIV transmission was a treatment goal when starting treatment	No	1216 (50.9)	57.6	61.8	69.4	84.7
	Yes	1173 (49.1)	62.1	71.3	79.2	90.6
Self-reported viral load	Not suppressed/unknown	619 (25.9)	48.5	59.6	54.3	79.2
	Suppressed	1770 (74.1)	63.7	68.9	81.2	90.6
HIV diagnosis year	2017–2019	548 (22.9)	55.5	67.3	67.9	88.5
	2010–2016	913 (38.2)	54.2	66.2	73.1	85.0
	Pre-2010	928 (38.8)	67.8	66.3	79.1	89.7

* Geographical regions were: Northern America (U.S. and Canada); Europe (Austria, Belgium, France, Germany, Italy, the Netherlands, Poland, Portugal, Ireland, Russia, Spain, Switzerland, and the UK); Latin America (Argentina, Brazil, Chile, and Mexico), and Asia (China, Japan, South Korea, and Taiwan); South Africa and Australia were analyzed separately.

HCP, healthcare provider; PLHIV, people living with HIV; U=U, undetectable equals untransmittable.

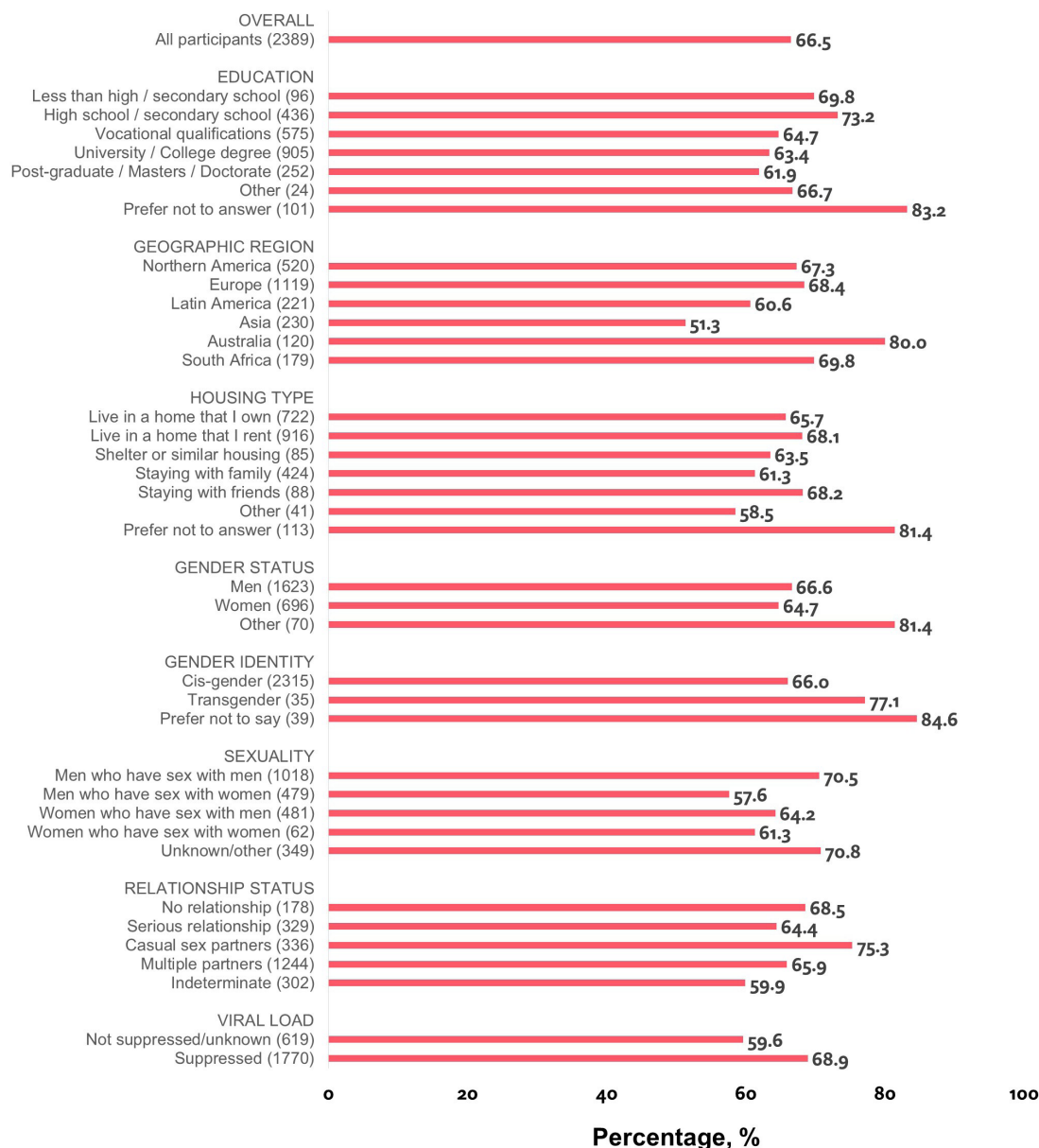


Figure 1 Percentage of people living with HIV who reported being told by their healthcare provider of 'Undetectable=Untransmittable', by selected characteristics, Positive Perspectives Study, 2019 (n=2389). Note: relationship status was assessed indirectly using a series of survey questions that asked participants with whom they had shared their HIV status. Those not in the relationship of interest selected 'not applicable'. Separate assessments were done for partner/spouse/significant other (indicated here as 'serious relationship') versus other sexual partners (indicated here as 'casual sex partners'). Those identifying they were in both relationships were classified as having multiple partners whereas those selecting 'not applicable' to both were classified as not being in any relationship. Because of skip patterns in the survey, data on relationship status could not be assessed for 302 individuals. The sum of men who have sex with men and men who have sex with women does not equal the total number of men because of individuals with missing/indeterminate information for sexual orientation; the same applies for women.

ranging from 0% in Asia to 84.1% (137/163) in South Africa. Other characteristics are in [table 1](#).

Percentage of PLHIV reporting past U=U discussions with HCPs

Overall, 66.5% (1588/2389) reported ever discussing U=U with their HCP ([table 1](#)). PLHIV who considered prevention of HIV transmission to a partner as an important treatment goal when they started ART reported significantly higher prevalence than those less concerned at ART initiation (71.3% [836/1173] vs 61.8% [752/1216], $p < 0.001$). Notably, there was no significant difference in discussing U=U with HCPs by either year of HIV diagnosis ($p = 0.886$) or age ($p = 0.119$).

Subgroups reporting high percentages for having discussed U=U with their HCP included people of black origins (69.8%, 192/275), those identifying as transgender (77.1%, 27/35), with casual sex partners (75.3%, 253/336), reporting viral suppression (68.9%, 1219/1770) and with \leq high school (72.6%, 386/532) ([table 1](#), [figure 1](#)). Prevalence by gender was 66.6% (1081/1623) for men, 64.7% (450/696) for women and 81.4% (57/70) for self-reported 'Other' gender ($p = 0.018$). Striking differences were observed when separating estimates for men who have sex with men (70.5%, 718/1018) versus men who have sex with women (57.6%, 276/479) ($p < 0.001$). Place-based differences were also noted; prevalence was highest among those whose HCP practised in a metropolitan area (69.0%, 1092/1583) and whose commute

Education

to their HCP was <30min (71.9%, 625/869). Country-specific prevalence ranged from Switzerland (87.3%, 48/55) to South Korea (38.0%, 19/50) (online supplementary figure 1).

Discussions with HCPs about U=U were correlated with other indicators of HCP engagement. Compared with those not reporting any U=U discussions with their HCP, those reporting a past discussion also reported significantly higher estimates for the following indicators: 'I am given enough information to be involved in making choices about my HIV treatment' (72.0% [1144/1588] vs 43.8% [351/801]), 'My provider seeks my views about treatment before prescribing' (72.4% [1150/1588] vs 43.7% [350/801]), 'My provider asks me if I have any concerns about the HIV medication I am currently taking' (74.5% [1183/1588] vs 46.6% [373/801]), 'My provider asks me frequently about any side effects I might be experiencing with my HIV treatment' (72.8% [1156/1588] vs 43.6% [349/801]),

'My provider tells me about new HIV treatment options that become available' (69.3% [1101/1588] vs 39.0% [312/801]) and 'I feel I understand enough about my HIV treatment' (79.0% [1254/1588] vs 56.8% [455/801]) (all $p<0.001$).

Differences in health outcomes with HCP versus non-HCP U=U exposure

Stronger associations with health outcomes were noted when PLHIV discussed U=U with their HCP, than when exposed from non-HCP sources (tables 2 and 3). Prevalence of various health-related outcomes was as follows among the three categories of PLHIV reporting being unaware of U=U, being made aware of U=U from non-HCP sources and being engaged in a past U=U discussion with their HCP, respectively: self-reported viral suppression (56.4% [167/296], 76.0% [384/505] and

Table 2 Bivariate analyses of prevalence of health outcomes by source of information about U = U, Positive Perspectives Study, 2019 (n=2389)

Domain	Characteristic	Overall (n=2389)	Completely unaware of U=U (n=296)	Aware of U=U from non-HCP sources (n=505)	Informed by HCP of U=U (n=1588)	P value
Health indicators	Viral suppression	74.1	56.4	76.0	76.8	<0.001
	Optimal overall health	57.6	44.6	55.0	60.9	<0.001
	Optimal mental health	57.6	38.2	53.7	62.5	<0.001
	Optimal physical health	60.1	45.3	56.2	64.1	<0.001
	Optimal sexual health	48.6	41.2	44.6	51.3	0.001
Attitudes and behaviours towards sharing HIV status	Comfortable sharing HIV status	29.8	19.6	26.5	32.7	<0.001
	Would be anxious or stressed if others were to see their HIV medication	45.8	51.0	50.3	43.3	0.004
	Ever hid or disguised their HIV medication within the past 6 months	57.9	67.2	61.4	55.0	<0.001
	Comfortable discussing ART-related privacy concerns with HCP	52.0	34.8	45.5	57.2	<0.001
	Comfortable discussing with HCP concerns about the safety of others/preventing transmission	59.8	36.1	55.2	65.6	<0.001
	Have always shared HIV status	6.8	2.7	5.5	8.0	0.002
	Missed ART dose for 5+ times in past month because of privacy concerns	4.3	8.8	5.5	3.0	<0.001
People shared HIV status with	Shared HIV status with nobody besides primary HIV care provider	12.6	20.9	11.7	11.4	<0.001
	'Most of the people in my life'	29.1	20.1	31.6	29.9	0.002
	Close friends	71.1	56.4	73.9	72.9	<0.001
	Parents, siblings and children	68.1	60.2	67.4	69.8	0.006
	Co-workers	33.9	27.5	39.0	33.4	0.007
	Wider family/circle of friends	46.7	34.8	46.3	48.9	0.001
	Current family doctor not providing HIV care	68.0	55.5	67.0	70.6	<0.001
	Sexual partners	61.1	50.9	62.0	62.5	0.005
	Other HCPs not providing HIV care	60.5	48.4	62.8	62.0	<0.001
Reason for not sharing HIV status	Partner/spouse/significant other	75.8	69.3	75.8	77.2	0.025
	They would see or treat me different	58.6	47.6	62.0	59.6	0.0001
	They might then disclose my HIV status to others	51.8	48.3	54.7	51.6	0.210
	I might be excluded from activities	38.1	40.2	39.2	37.4	0.565
	Being denied access to healthcare services	18.1	18.2	24.0	16.2	<0.001
	Being denied access to financial benefits	17.7	20.3	17.8	17.1	0.427
	Might affect my friendships	45.8	43.9	47.7	45.6	0.549
	I might lose my job	33.9	34.5	37.6	32.6	0.115
	Might affect my romantic or sexual relationships	37.3	27.0	39.2	38.7	0.001
	My physical safety/potential violence	20.1	22.6	22.8	18.7	0.068
	Criminal prosecution	10.1	10.5	10.5	9.9	0.899

The p-values shown are derived from global tests (Chi-square statistics) assessing whether at least two groups are significantly different. ART, antiretroviral therapy; HCP, healthcare provider; U=U, undetectable equals untransmittable.

Table 3 Binary logistic regression analyses for the relationship between awareness of U=U and health outcomes among the entire study population, Positive Perspectives Study, 2019 (n=2389)

Outcomes	Categories of predictor variable	Crude analyses		Adjusted analyses*	
		OR (95% CI)	P value	OR (95% CI)	P value
Self-reported viral suppression	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	2.45 (1.80 to 3.33)	<0.001	2.10 (1.45 to 3.02)	<0.001
	Informed by HCP	2.55 (1.97 to 3.30)	<0.001	2.34 (1.72 to 3.20)	<0.001
Suboptimal adherence	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	0.74 (0.54 to 0.99)	0.049	0.94 (0.68 to 1.30)	0.699
	Informed by HCP	0.46 (0.35 to 0.60)	<0.001	0.59 (0.44 to 0.78)	<0.001
Optimal overall health	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.52 (1.14 to 2.03)	0.004	1.51 (1.12 to 2.03)	0.007
	Informed by HCP	1.93 (1.51 to 2.49)	<0.001	1.94 (1.49 to 2.51)	<0.001
Optimal mental health	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.88 (1.40 to 2.51)	<0.001	1.79 (1.32 to 2.43)	<0.001
	Informed by HCP	2.70 (2.09 to 3.48)	<0.001	2.50 (1.91 to 3.26)	<0.001
Optimal physical health	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.55 (1.16 to 2.07)	0.003	1.44 (1.07 to 1.94)	0.018
	Informed by HCP	2.16 (1.68 to 2.77)	<0.001	1.95 (1.50 to 2.54)	<0.001
Optimal sexual health	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.15 (0.86 to 1.53)	0.358	1.13 (0.83 to 1.53)	0.441
	Informed by HCP	1.50 (1.17 to 1.93)	0.001	1.48 (1.14 to 1.92)	0.004
Comfortable sharing HIV status	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.48 (1.05 to 2.10)	0.027	1.58 (1.10 to 2.26)	0.013
	Informed by HCP	1.99 (1.47 to 2.70)	<0.001	2.15 (1.57 to 2.95)	<0.001
Always share HIV status	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	2.11 (0.95 to 4.70)	0.067	2.10 (0.93 to 4.77)	0.075
	Informed by HCP	3.13 (1.51 to 6.46)	0.002	2.99 (1.42 to 6.28)	0.004
Shared HIV status with others besides HIV care provider	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	2.00 (1.36 to 2.96)	<0.001	1.67 (1.11 to 2.52)	0.014
	Informed by HCP	2.06 (1.50 to 2.84)	<0.001	1.74 (1.24 to 2.45)	0.001
Ever disguised/hid HIV medicines in past 6 months	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	0.77 (0.57 to 1.05)	0.098	0.87 (0.63 to 1.21)	0.417
	Informed by HCP	0.60 (0.46 to 0.78)	<0.001	0.65 (0.49 to 0.86)	0.003
Comfortable discussing privacy issues with HCP	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	1.57 (1.17 to 2.11)	0.003	1.41 (1.04 to 1.91)	0.029
	Informed by HCP	2.51 (1.94 to 3.25)	<0.001	2.50 (1.91 to 3.28)	<0.001
Comfortable discussing concerns about transmission with HCP	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	2.18 (1.62 to 2.93)	<0.001	1.93 (1.42 to 2.62)	<0.001
	Informed by HCP	3.37 (2.60 to 4.37)	<0.001	3.27 (2.49 to 4.29)	<0.001
Missed ART for ≥5 times in past month because of privacy concerns	Completely unaware of U=U	1.00 (referent)		1.00 (referent)	
	Aware from non-HCP sources	0.61 (0.35 to 1.06)	0.080	0.83 (0.47 to 1.48)	0.533
	Informed by HCP	0.32 (0.20 to 0.53)	<0.001	0.41 (0.25 to 0.69)	0.001

*Adjusted for ethnicity, region, age, sexual orientation, diagnosis year, domicile and education.

ART, antiretroviral therapy; HCP, healthcare provider; U=U, undetectable equals untransmittable.

76.8% [1219/1588]), optimal overall health (44.6% [132/296], 55.0% [278/505] and 60.9% [967/1588]), optimal sexual health (41.2% [122/296], 44.6% [225/505] and 51.3% [815/1588]), never shared their HIV status with anyone besides their primary HIV care providers (20.9% [62/296], 11.7% [59/505] and 11.4% [181/1588]), perceived comfort discussing concerns regarding HIV transmission with HCP (36.1% [107/296], 55.2% [279/505] and 65.6% [1042/1588]) and suboptimal adherence (35.8% [106/296], 29.1% [147/505] and 20.3% [322/1588]) (all $p < 0.05$, table 2).

Results remained consistent within multivariable analyses (table 3). Those who reported discussing U=U with their HCP had more favourable outcomes compared with those unaware

of U=U, for: suboptimal adherence (adjusted OR (AOR)=0.59, 95% CI 0.44 to 0.78); optimal sexual health (AOR=1.48, 95% CI 1.14 to 1.92) and reporting they 'always shared' their HIV status (AOR=2.99, 95% CI 1.42 to 6.28). For several positive outcomes, when compared with those unaware of U=U, significantly higher odds were seen among both those made aware of U=U from non-HCP sources, as well as those reporting a past U=U discussion with their HCP although stronger associations were noted for the latter. These outcomes included: viral suppression (AOR=2.10 and 2.34, non-HCP and HCP, respectively); optimal overall health (AOR=1.51 and 1.94, respectively); optimal mental health (AOR=1.79 and 2.50, respectively); comfortable sharing HIV status with others (AOR=1.58 and

2.15, respectively); ever shared HIV status with people other than their primary HIV HCPs (AOR=1.67 and 1.74, respectively); comfortable discussing ART-related privacy concerns with HCP (AOR=1.41 and 2.50, respectively) and comfortable discussing with HCPs their concerns regarding HIV transmission (AOR=1.93 and 3.27, respectively) (all $p < 0.05$).

Differences in health outcomes by subgroups exposed to the U=U message

Within four mutually exclusive strata of age and gender, ≥ 50 -year-old men reported the highest prevalence of sharing their HIV status with family, friends or co-workers; conversely, < 50 -year-old women were least likely to share their HIV status among their social contacts (online supplementary figure 2).

The observed strength of association between exposure to the U=U message and health outcomes varied by age and gender. For example, compared with those unaware of U=U, discussing U=U with an HCP was significantly associated with higher odds of optimal sexual health among < 50 -year-olds (AOR=1.79; 95% CI 1.33 to 2.42), but non-significant among ≥ 50 -year-olds within adjusted analyses. Conversely, discussing U=U with an HCP was associated with over five times higher odds of sharing HIV status with other people among ≥ 50 -year-olds (AOR=5.58; 95% CI 2.59 to 12.03) whereas a more attenuated association was observed among < 50 -year-olds (AOR=1.60, 95% CI 1.10 to 2.33) (online supplementary table 3).

DISCUSSION

Overall, 66.5% of PLHIV in our study had discussed U=U with their HCP. We saw no significant difference between PLHIV diagnosed prior to 2017 vs 2017 or later in being told of U=U by their HCP²⁴. Indeed, almost a decade before the launch of the U=U campaign,²⁴ the Swiss Federal Commission for HIV/AIDS first endorsed a similar message of undetectable equals uninfected in 2008.^{25 26} The global U=U campaign has however allowed for universal endorsement of this message. A possible explanation for the non-significant finding by time of diagnosis is that patient education about U=U may be occurring at multiple periods throughout the course of treatment other than just at time of diagnosis, thus explaining the similar rates of ever receiving U=U information from an HCP regardless of when diagnosed. We also observed that people of lower educational status were more likely to report receiving information on U=U from their HCP, possibly reflecting lack of other sources. Proactively discussing U=U at different points, including at the time of diagnosis, initiating ART and during routine follow-up consultations can empower PLHIV.²⁷ Even brief counselling of 2–3 min has been shown to be effective with other behavioural interventions such as smoking cessation counselling.²⁸

Information provided by HCPs may be deemed more credible than other media which may explain our observation of stronger associations with positive health outcomes among those who had the opportunity to discuss U=U with an HCP versus those who accessed similar information from non-HCP sources. PLHIV who were concerned about transmitting HIV reported significantly higher prevalence of receiving information on U=U from their HCP, suggesting patient-initiated discussions. At the same time, however, PLHIV who reported having U=U discussion with their HCPs also were more likely to be engaged by their HCPs on other fronts, including discussing new treatment options as well as their management plan before prescribing treatment, suggesting a stronger patient/doctor relationship. Patients that are actively engaged with their HCP may proactively invite these topics of

discussion compared with patients less engaged; however, the onus of these discussions should not be placed on the patient. HCP initiation of these sensitive topics in patients that have difficulty engaging may also help empower patients. Our findings indicate that directly addressing sexual health and U=U is associated with significantly better health outcomes.

PLHIV face many emotional/psychological challenges, including self-stigma, which may impact their ability, desire or comfort level with sharing their emotional concerns with HCPs. Creating an enabling, non-judgmental and stigma-free environment where PLHIV feel encouraged to discuss personal challenges is critical. Independent of duration of diagnosis, exposure to U=U message was associated with higher odds of better social interactions among older adults but higher odds of optimal sexual health among younger ones, suggesting differences in perceived priorities and life experiences. Tailored communication regarding the benefits of U=U among PLHIV could improve acceptability of the U=U message.

Previous research has identified some degree of misunderstanding, confusion and even suspicion among those informed of 'U=U'; inconsistent HCP practices in relation to U=U have also been reported previously.^{29 30} A survey of 270 members of the British HIV Association found variations in timing of delivery and the substance of the message itself. For example, varying terminologies were reported to describe the risk of HIV transmission such as 'zero risk/no risk', 'next to zero', 'negligible' or 'extremely low'. This can be confusing as 'negligible' is often interpreted as still a non-zero risk.^{27 29} HCPs should use clear, unambiguous language to convey U=U, while reinforcing to patients that the U=U message is not about discouraging condom use or responsible sexual behaviour; rather, it is about providing assurance about their sometimes unexpressed fear of infecting others—a key cause of stigma, shame and poor psychological well-being.^{9 23} Recommending U=U discussions as a standard in clinical guidelines can help the uniformity of information dissemination, endorse the U=U message internationally, and help improve HIV care beyond viral load end points.

Opportunities exist to enhance dissemination of this key information considering that a third of PLHIV were not informed by their provider. Implementation research and training is needed to better understand how to optimise delivery of the U=U message in clinical settings. Research is also needed on the effectiveness of U=U counselling when delivered by a variety of healthcare professionals. Understanding the unique challenges to delivering (among HCPs) or believing (among PLHIV) the U=U message can inform public health practice, programmes and policies.

Strengths and limitations

The strengths of this study include the use of a standardised protocol in 25 countries and a large sample size which increases precision of estimates. Nonetheless, limitations exist. The non-probabilistic sampling and web-based survey administration may limit generalisability while the self-reported measures may be subject to misreporting and other measurement errors. For example, there could be underestimation of the percentage informed about U=U in clinical settings because of poor recall, or if PLHIV were informed by someone other than their primary HIV care provider. We could not explore non-HCP sources of U=U information in great detail because of limited information. Misclassification of U=U exposure status could also arise from dichotomisation of the Likert-type scale, but the effect of this misclassification is likely to be conservatively towards the null (ie, individuals with some exposure classified as being non-exposed). Finally, only associations can be drawn because of the cross-sectional design.

Key messages

- ▶ A third of people living with HIV (PLHIV) in this international study reported not having had discussions with their healthcare provider (HCP) about 'Undetectable equals Untransmittable' ('U=U').
- ▶ PLHIV who reported discussing with their HCP about U=U had more favourable health outcomes than those not informed of U=U; for example, they had 41% lower odds of reporting suboptimal adherence and 48% higher odds of optimal sexual health.
- ▶ While U=U-related information accessed from non-HCP sources was beneficial as well, the observed associations were attenuated relative to those seen with actually discussing U=U with HCPs.
- ▶ U=U discussions between HCPs and patients should be considered in standard of care guidelines to help improve health-related outcomes of PLHIV and benefit public health.

CONCLUSIONS

Overall, only 66.5% of all PLHIV reported having discussed U=U with their HCP and disparities by region and other characteristics were observed. Discussing U=U with an HCP was significantly associated with favourable health outcomes, including greater adherence, better viral control, optimal health (including sexual health), greater willingness to share HIV status with others, and increased comfort discussing with HCP concerns about HIV transmission and privacy. Increased dissemination of the U=U message in clinical settings can benefit public health.

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Online supplementary table 1. Respondent recruitment source/channel, overall and by country, Positive Perspectives Study, 2019

Country	Panel/ community members	HIV patient support groups/ charities	Local Operating Company contacts	Patient- to- patient referrals	Social media	Languages	Total participants	Total days of recruitment	End date
	<i>Recruitment sources</i>								
USA	132	254	0	8	6	English	400	115	28-Jul
Canada	17	62	1	30	10	English, Canadian French	120	83	23-Jul
Mexico	11	49	0	0	3	Latin American Spanish	63	75	06-Aug
Argentina	4	39	0	1	6	Latin American Spanish	50	56	18-Jul
Brazil	17	39	0	1	1	Brazilian Portuguese	58	87	06-Aug
Chile	13	35	0	0	2	Latin American Spanish	50	56	18-Jul
United Kingdom	67	51	0	4	1	English	123	112	23-Jul
Ireland	8	16	0	26	0	English	50	104	24-Jul
France	26	2	90	2	0	French	120	63	25-Jun
Germany	48	61	0	10	1	German	120	66	30-Jun
Italy	30	85	0	4	1	Italian	120	76	16-Jul
Spain	20	21	70	9	0	Spanish	120	64	26-Jun
Portugal	2	53	3	2	0	Portuguese	60	69	27-Jul
Netherlands	3	13	34	1	0	Dutch	51	90	24-Jul
Belgium	8	33	0	6	3	French, Flemish	50	76	07-Aug
Austria	16	34	0	0	0	German	50	74	15-Aug
Switzerland	0	50	5	0	0	French, German	55	84	15-Aug
Poland	2	44	0	4	0	Polish	50	82	13-Aug
Russia	81	66	1	0	2	Russian	150	120	29-Jan
South Africa	44	114	0	0	21	English, Afrikaans, Zulu, Sotho	179	85	31-Jan
Japan	6	69	0	0	0	Japanese	75	56	25-Jul
South Korea	0	50	0	0	0	Korean	50	49	18-Jul
Taiwan	1	48	0	0	6	Traditional Chinese	55	62	31-Jul
China	15	35	0	0	0	Simplified Chinese	50	33	28-Jun
Australia	56	64	0	0	0	English	120	115	16-Aug
Overall	627	1387	204	108	63	20 languages	2389		31-Jan 2020

Description

Panel/community members (convenience sampling):	Ipsos recruitment partner (Opinion Health) specializes in recruiting, sourcing, and operating on-going panels/ communities of people who live with different chronic diseases. The ongoing panels/ communities include people living with HIV. These 'existing' panelists were supplemented by new panelists recruited during the survey
HIV patient support groups/ charities (targeted sampling):	Non-governmental organizations (NGOs), Patient Associations, Patient Advocacy Groups, Patient Support Groups or HIV Charities organized at local, national, or international level.
Local Operating Company (LOC) (targeted sampling):	In these cases, the recruitment resulted from contacts provided by the Sponsor company's Local Operating Company within the country, or where the questionnaire link was deployed directly by the LOC to contacts. These contacts were primarily NGOs/ Patient Advocacy Groups (but these numbers are not included in the figures for the above category).
Patient-to-patient referrals (snow-ball sampling):	Qualified participants to the study would also be asked to refer someone they may know with HIV, or if they are part of a support group if they can disseminate this among their members. In the recruitment partner's wider online panels/communities, members may have someone in their family or know of someone with HIV. If so, they may be asked to send study information and link to get in touch directly.
Social media (Volunteer sampling):	An 'advertisement' placed in the Facebook feeds of potential respondents. The advertisement related to generic recruitment of PLHIV to Opinion Health panels, not specifically to the PP2 study. These figures are separate to the 'Panel/community members' category above. Standard FB targeting tools available to all FB users were used (basic parameters available, such as region, age, and areas of interest).

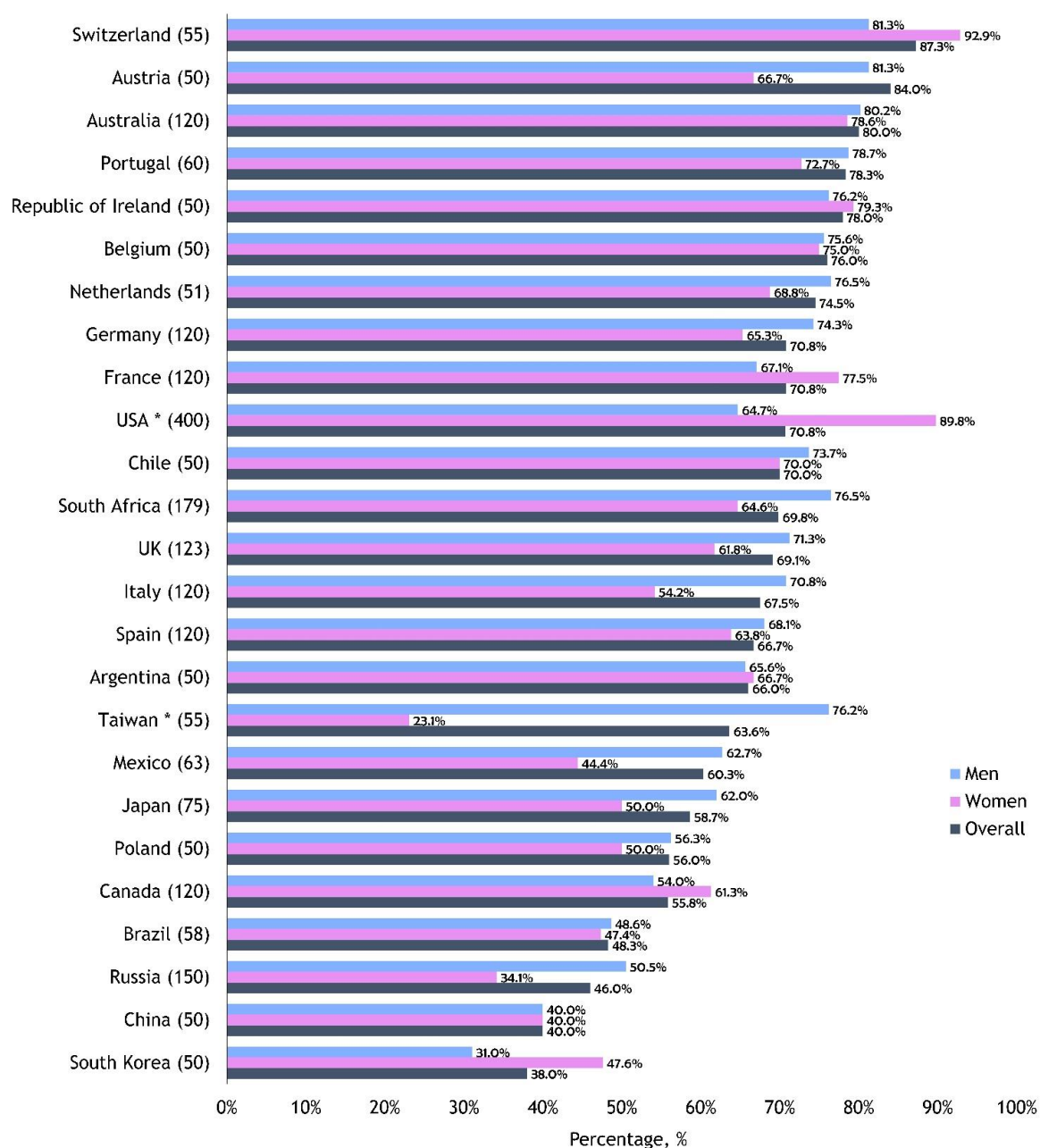
Online supplemental table 2. Wording of survey questions for key variables within the study, Positive Perspectives Study, 2019

Variable type	Construct	Question wording	Categorical response options (responses highlighted were treated as affirmative answers, where applicable)	Recoding of variable
Exposure variable	Ever told of U = U by healthcare provider (HCP)	My provider has told me about “undetectable = untransmutable” (U=U)	① Strongly disagree ② Disagree ③ Neither agree nor disagree ④ Agree ⑤ Strongly agree	Strongly agree or Agree = 1; all other responses = 0
	Awareness of treatment as prevention	My HIV medication prevents me from passing on HIV to others	① Strongly disagree ② Disagree ③ Neither agree nor disagree ④ Agree ⑤ Strongly agree	Strongly agree or agree = 1; all other responses = 0
Selected outcome variables	Self-reported viral load	What is your most recent viral load?	① ‘Undetectable’ or ‘Suppressed’ ② ‘Detectable’ or ‘Unsuppressed’ ③ I don’t know ④ Prefer not to say	‘Undetectable’ or ‘Suppressed’ = 1; all other responses = 0
	Preamble for self-rated health			
	Self-rated health (assessed separately for physical, mental, sexual, and overall domains)	How would you describe your [physical / mental / sexual / overall] health over the past 4 weeks? <i>Physical health refers to the physical condition of your body, specifically the absence of any illness or injury and being free from aches or pains in any part of your body.</i> <i>Mental health refers to your state of well-being in which you realise</i>	① Very Poor ② Poor ③ Neither Good nor Poor ④ Good ⑤ Very Good	Good or Very good = 1; all other responses = 0

		<p><i>your own potential, can cope with the normal stresses of life, can function productively and fruitfully, and are able to contribute to your community.</i></p> <p><i>Sexual health refers to your sexual well-being, the quality of your sexual relations, your sex drive (libido), as well as your reproductive health and any (non-HIV) sexually transmitted infections.</i></p>		
	Reasons for not sharing HIV status	<p>For what reasons, if any, have you not shared your HIV status with someone in the past?</p> <p>1 It has not been necessary/relevant to my daily interactions with people</p> <p>2 I was worried that they would see or treat me differently</p> <p>3 I was worried that they might then disclose my HIV status to others</p> <p>4 I was worried that I might be excluded from activities</p> <p>5 I was worried about being denied access to health care services</p> <p>6 I was worried about being denied access to financial benefits/support</p> <p>7 I was worried it might affect my friendships</p> <p>8 I was worried I might lose my job</p> <p>9 I was worried it might affect my romantic or sexual relationships</p> <p>10 I was worried about my physical safety/potential violence</p> <p>11 I was worried about criminal prosecution</p> <p>98 Other, please specify</p> <p>00 None – I have always shared my HIV status</p>	Pls, select all that apply	Reason selected = 1; not selected = 0.
	Hiding of HIV medication	In the past 6 months, have you ever hidden or disguised your HIV medication to avoid revealing your status?	<p>① Yes</p> <p>② No</p>	Yes = 1; No = 0

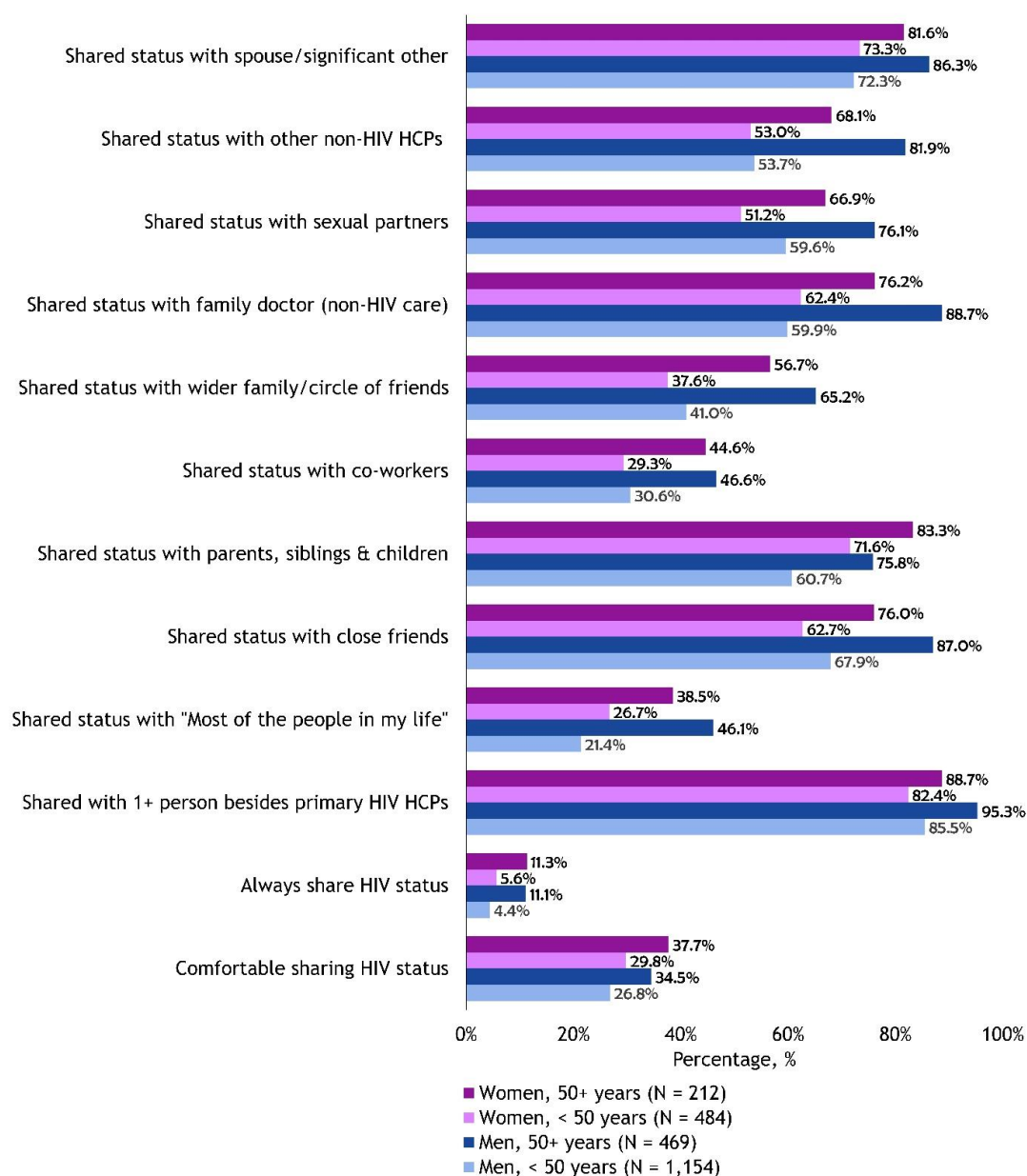
	Have not shared HIV status with other people besides HIV care providers	"Other than your HIV care providers, does anyone else know that you are living with HIV?"	<p>①Yes</p> <p>②No</p> <p>③I don't know</p>	No = 1 (i.e., very certain of having never shared HIV status); all other responses = 0 (i.e., definitely or possibly have shared HIV status with others)
	Extent of sharing of HIV status (among those who indicated someone other than their HCP knows they are living with HIV)	<p>Other than your HIV healthcare providers, who knows about your HIV status?</p> <p>1 My partner/spouse/significant other</p> <p>2 One or more of my sexual partners</p> <p>3 One or more members of my *close family (excluding partner/spouse) *by close family we mean parents, siblings & children only</p> <p>4 One or more of my close friends</p> <p>5 One or more of my wider family/circle of friends</p> <p>6 My current family doctor/GP (if not one of your HIV care providers)</p> <p>7 One or more other healthcare professionals (that are not one of your HIV care providers)</p> <p>8 One or more of my co-workers</p> <p>9 Most of the people in my life</p>	<p>①Yes</p> <p>②No</p> <p>③Not applicable</p>	<p>Yes = 1; No=0; Not applicable excluded.</p> <p>Exclusion of those not in the relationship of interest (i.e., 'not applicable') was to ensure the correct denominator was analyzed (e.g., sharing of status with sexual partners was analyzed only among those with sexual partners).</p>

Online supplementary figure 1. Percentage of people living with HIV in 25 countries who reported having discussed U=U with their healthcare provider, overall and by gender, Positive Perspectives Study, 2019 (N = 2389)



Note: Asterisks (*) indicate statistically significant country-specific gender differences using χ^2 tests at $p < 0.05$.

Online supplementary figure 2. Percentage of people living with HIV in 25 countries who reported sharing their HIV status, within four mutually exclusive strata of age and gender, Positive Perspectives Study, 2019



Note: All results were statistically significant using χ^2 tests, meaning that for each outcome assessed, at least two of the groups differed significantly at $p < 0.05$. Total sample size across the four strata does not add up to 2389 because of 70 respondents who identified with a gender other than 'man' or 'woman'

Online supplementary table 3. Binary logistic regression analyses for the relationship between awareness of U = U and health outcomes within respective strata of gender and age, Positive Perspectives Study, 2019

Outcomes	Categories of predictor variable	GENDER STRATA		AGE STRATA	
		AMONG MEN (N=1623)	AMONG WOMEN (N=696)	AMONG < 50 y (N=1690)	AMONG ≥50 y (N=699)
Self-reported viral suppression	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	2.68 (1.73-4.16)	1.56 (0.87-2.78)	2.35 (1.62-3.42)	3.93 (1.53-10.07)
	Informed by HCP	3.17 (2.18-4.62)	1.81 (1.11-2.95)	2.94 (2.13-4.05)	2.52 (1.22-5.21)
Suboptimal adherence	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.05 (0.7-1.58)	0.6 (0.35-1.02)	0.78 (0.54-1.12)	0.93 (0.47-1.85)
	Informed by HCP	0.65 (0.45-0.93)	0.41 (0.26-0.65)	0.49 (0.36-0.67)	0.58 (0.32-1.07)
Optimal overall health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.81 (1.26-2.60)	1.17 (0.7-1.96)	1.42 (1.01-1.99)	1.89 (1.07-3.36)
	Informed by HCP	2.22 (1.62-3.04)	1.68 (1.08-2.61)	2.09 (1.56-2.81)	1.84 (1.12-3.04)
Optimal mental health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.97 (1.36-2.86)	1.59 (0.95-2.65)	1.61 (1.14-2.28)	2.47 (1.38-4.41)
	Informed by HCP	2.95 (2.12-4.10)	2.09 (1.35-3.25)	2.57 (1.90-3.48)	2.98 (1.79-4.94)
Optimal physical health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.79 (1.25-2.57)	1.09 (0.66-1.83)	1.60 (1.13-2.25)	1.23 (0.70-2.16)
	Informed by HCP	2.46 (1.79-3.38)	1.49 (0.96-2.31)	2.70 (2.00-3.64)	1.21 (0.74-1.98)
Optimal sexual health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.14 (0.79-1.64)	1.15 (0.68-1.92)	1.21 (0.85-1.7)	0.88 (0.49-1.57)
	Informed by HCP	1.57 (1.14-2.16)	1.26 (0.81-1.95)	1.79 (1.33-2.42)	0.95 (0.57-1.57)
Comfortable sharing HIV status	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.59 (1.03-2.44)	1.19 (0.63-2.26)	1.29 (0.86-1.95)	2.24 (1.11-4.53)
	Informed by HCP	1.82 (1.24-2.67)	2.44 (1.42-4.19)	1.71 (1.19-2.44)	3.13 (1.66-5.92)
Always share HIV status	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.93 (0.7-5.3)	1.82 (0.47-7.11)	1.98 (0.63-6.19)	2.09 (0.66-6.57)
	Informed by HCP	2.75 (1.09-6.93)	2.97 (0.89-9.91)	3.60 (1.29-10.02)	2.52 (0.88-7.19)
Shared HIV status with others besides HIV care provider	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.73 (1.03-2.91)	1.81 (0.94-3.49)	1.68 (1.07-2.64)	2.33 (0.97-5.61)
	Informed by HCP	1.74 (1.13-2.68)	2.2 (1.28-3.8)	1.60 (1.10-2.33)	5.58 (2.59-12.03)
Ever disguised/hid HIV medicines in past 6 months	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.06 (0.71-1.57)	0.56 (0.32-0.98)	0.82 (0.56-1.21)	0.90 (0.50-1.61)
	Informed by HCP	0.65 (0.46-0.92)	0.55 (0.34-0.89)	0.60 (0.43-0.84)	0.68 (0.41-1.13)
Comfortable	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)

discussing privacy issues with HCP	Aware from non-HCP sources	1.31 (0.91-1.89)	2.07 (1.20-3.56)	1.51 (1.06-2.16)	1.40 (0.79-2.48)
	Informed by HCP	2.34 (1.69-3.23)	3.04 (1.89-4.88)	2.37 (1.74-3.24)	2.80 (1.69-4.62)
Comfortable discussing concerns about transmission with HCP	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.77 (1.23-2.56)	2.89 (1.68-4.96)	1.99 (1.40-2.83)	2.28 (1.28-4.07)
	Informed by HCP	3.07 (2.22-4.24)	4.26 (2.66-6.83)	3.19 (2.34-4.35)	3.73 (2.25-6.19)
Missed ART for ≥ 5 times in past month because of privacy concerns	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	0.83 (0.38-1.85)	0.66 (0.29-1.5)	0.71 (0.38-1.35)	0.51 (0.15-1.75)
	Informed by HCP	0.53 (0.26-1.07)	0.23 (0.10-0.50)	0.44 (0.25-0.76)	0.14 (0.04-0.48)

Note: U=U means undetectable equals untransmittable, HCP=healthcare provider, ART=antiretroviral therapy.

Online supplementary table 1. Respondent recruitment source/channel, overall and by country, Positive Perspectives Study, 2019

Country	Panel/ community members	HIV patient support groups/ charities	Local Operating Company contacts	Patient- to- patient referrals	Social media	Languages	Total participants	Total days of recruitment	End date
	<i>Recruitment sources</i>								
USA	132	254	0	8	6	English	400	115	28-Jul
Canada	17	62	1	30	10	English, Canadian French	120	83	23-Jul
Mexico	11	49	0	0	3	Latin American Spanish	63	75	06-Aug
Argentina	4	39	0	1	6	Latin American Spanish	50	56	18-Jul
Brazil	17	39	0	1	1	Brazilian Portuguese	58	87	06-Aug
Chile	13	35	0	0	2	Latin American Spanish	50	56	18-Jul
United Kingdom	67	51	0	4	1	English	123	112	23-Jul
Ireland	8	16	0	26	0	English	50	104	24-Jul
France	26	2	90	2	0	French	120	63	25-Jun
Germany	48	61	0	10	1	German	120	66	30-Jun
Italy	30	85	0	4	1	Italian	120	76	16-Jul
Spain	20	21	70	9	0	Spanish	120	64	26-Jun
Portugal	2	53	3	2	0	Portuguese	60	69	27-Jul
Netherlands	3	13	34	1	0	Dutch	51	90	24-Jul
Belgium	8	33	0	6	3	French, Flemish	50	76	07-Aug
Austria	16	34	0	0	0	German	50	74	15-Aug
Switzerland	0	50	5	0	0	French, German	55	84	15-Aug
Poland	2	44	0	4	0	Polish	50	82	13-Aug
Russia	81	66	1	0	2	Russian	150	120	29-Jan
South Africa	44	114	0	0	21	English, Afrikaans, Zulu, Sotho	179	85	31-Jan
Japan	6	69	0	0	0	Japanese	75	56	25-Jul
South Korea	0	50	0	0	0	Korean	50	49	18-Jul
Taiwan	1	48	0	0	6	Traditional Chinese	55	62	31-Jul
China	15	35	0	0	0	Simplified Chinese	50	33	28-Jun
Australia	56	64	0	0	0	English	120	115	16-Aug
Overall	627	1387	204	108	63	20 languages	2389		31-Jan 2020

Description

Panel/community members (convenience sampling):	Ipsos recruitment partner (Opinion Health) specializes in recruiting, sourcing, and operating on-going panels/ communities of people who live with different chronic diseases. The ongoing panels/ communities include people living with HIV. These 'existing' panelists were supplemented by new panelists recruited during the survey
HIV patient support groups/ charities (targeted sampling):	Non-governmental organizations (NGOs), Patient Associations, Patient Advocacy Groups, Patient Support Groups or HIV Charities organized at local, national, or international level.
Local Operating Company (LOC) (targeted sampling):	In these cases, the recruitment resulted from contacts provided by the Sponsor company's Local Operating Company within the country, or where the questionnaire link was deployed directly by the LOC to contacts. These contacts were primarily NGOs/ Patient Advocacy Groups (but these numbers are not included in the figures for the above category).
Patient-to-patient referrals (snow-ball sampling):	Qualified participants to the study would also be asked to refer someone they may know with HIV, or if they are part of a support group if they can disseminate this among their members. In the recruitment partner's wider online panels/communities, members may have someone in their family or know of someone with HIV. If so, they may be asked to send study information and link to get in touch directly.
Social media (Volunteer sampling):	An 'advertisement' placed in the Facebook feeds of potential respondents. The advertisement related to generic recruitment of PLHIV to Opinion Health panels, not specifically to the PP2 study. These figures are separate to the 'Panel/community members' category above. Standard FB targeting tools available to all FB users were used (basic parameters available, such as region, age, and areas of interest).

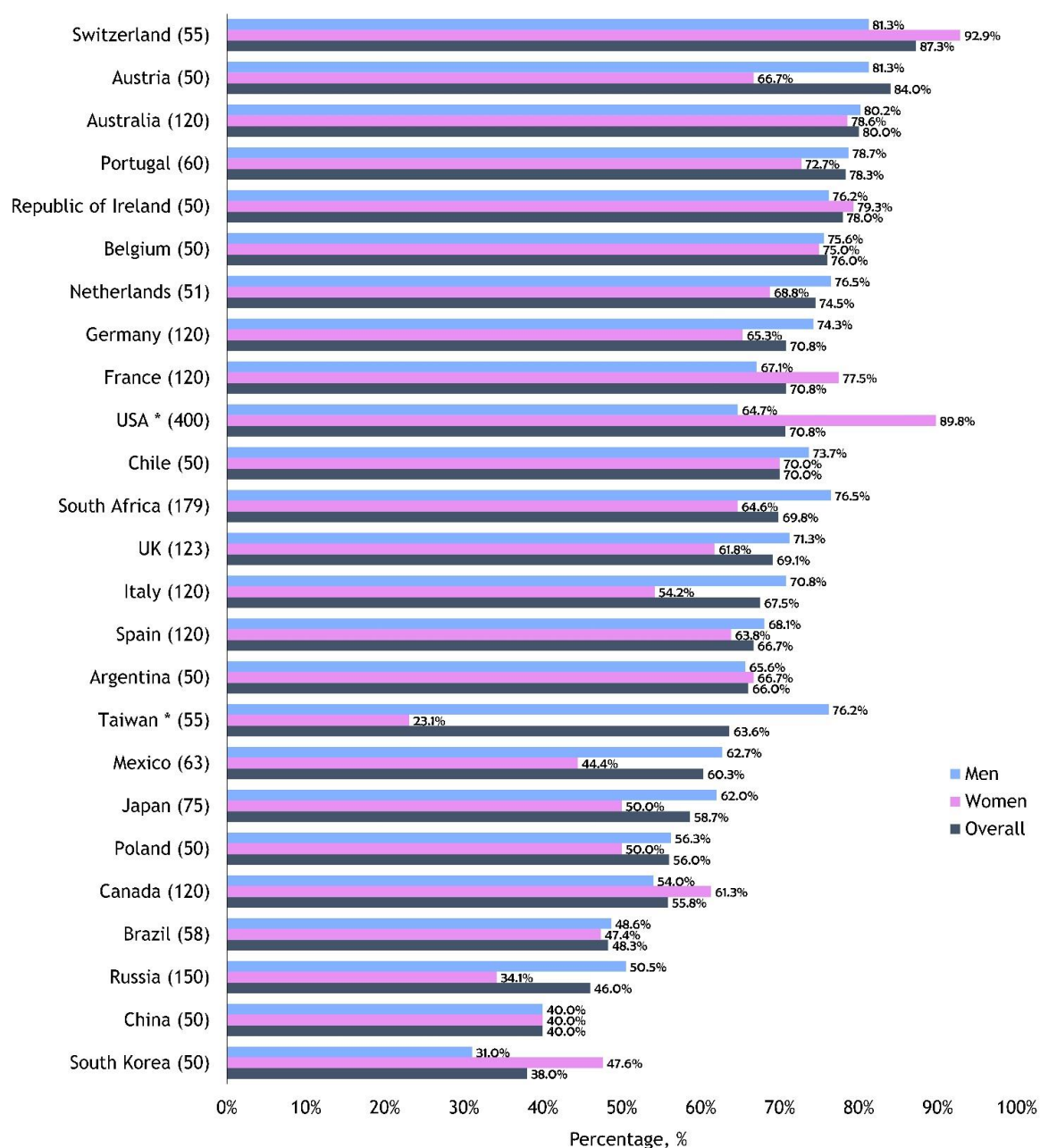
Online supplemental table 2. Wording of survey questions for key variables within the study, Positive Perspectives Study, 2019

Variable type	Construct	Question wording	Categorical response options (responses highlighted were treated as affirmative answers, where applicable)	Recoding of variable
Exposure variable	Ever told of U = U by healthcare provider (HCP)	My provider has told me about “undetectable = untransmutable” (U=U)	① Strongly disagree ② Disagree ③ Neither agree nor disagree ④ Agree ⑤ Strongly agree	Strongly agree or Agree = 1; all other responses = 0
	Awareness of treatment as prevention	My HIV medication prevents me from passing on HIV to others	① Strongly disagree ② Disagree ③ Neither agree nor disagree ④ Agree ⑤ Strongly agree	Strongly agree or agree = 1; all other responses = 0
Selected outcome variables	Self-reported viral load	What is your most recent viral load?	① ‘Undetectable’ or ‘Suppressed’ ② ‘Detectable’ or ‘Unsuppressed’ ③ I don’t know ④ Prefer not to say	‘Undetectable’ or ‘Suppressed’ = 1; all other responses = 0
	Preamble for self-rated health			
	Self-rated health (assessed separately for physical, mental, sexual, and overall domains)	How would you describe your [physical / mental / sexual / overall] health over the past 4 weeks? <i>Physical health refers to the physical condition of your body, specifically the absence of any illness or injury and being free from aches or pains in any part of your body.</i> <i>Mental health refers to your state of well-being in which you realise</i>	① Very Poor ② Poor ③ Neither Good nor Poor ④ Good ⑤ Very Good	Good or Very good = 1; all other responses = 0

		<p><i>your own potential, can cope with the normal stresses of life, can function productively and fruitfully, and are able to contribute to your community.</i></p> <p><i>Sexual health refers to your sexual well-being, the quality of your sexual relations, your sex drive (libido), as well as your reproductive health and any (non-HIV) sexually transmitted infections.</i></p>		
	Reasons for not sharing HIV status	<p>For what reasons, if any, have you not shared your HIV status with someone in the past?</p> <p>1 It has not been necessary/relevant to my daily interactions with people</p> <p>2 I was worried that they would see or treat me differently</p> <p>3 I was worried that they might then disclose my HIV status to others</p> <p>4 I was worried that I might be excluded from activities</p> <p>5 I was worried about being denied access to health care services</p> <p>6 I was worried about being denied access to financial benefits/support</p> <p>7 I was worried it might affect my friendships</p> <p>8 I was worried I might lose my job</p> <p>9 I was worried it might affect my romantic or sexual relationships</p> <p>10 I was worried about my physical safety/potential violence</p> <p>11 I was worried about criminal prosecution</p> <p>98 Other, please specify</p> <p>00 None – I have always shared my HIV status</p>	Pls, select all that apply	Reason selected = 1; not selected = 0.
	Hiding of HIV medication	In the past 6 months, have you ever hidden or disguised your HIV medication to avoid revealing your status?	<p>① Yes</p> <p>② No</p>	Yes = 1; No = 0

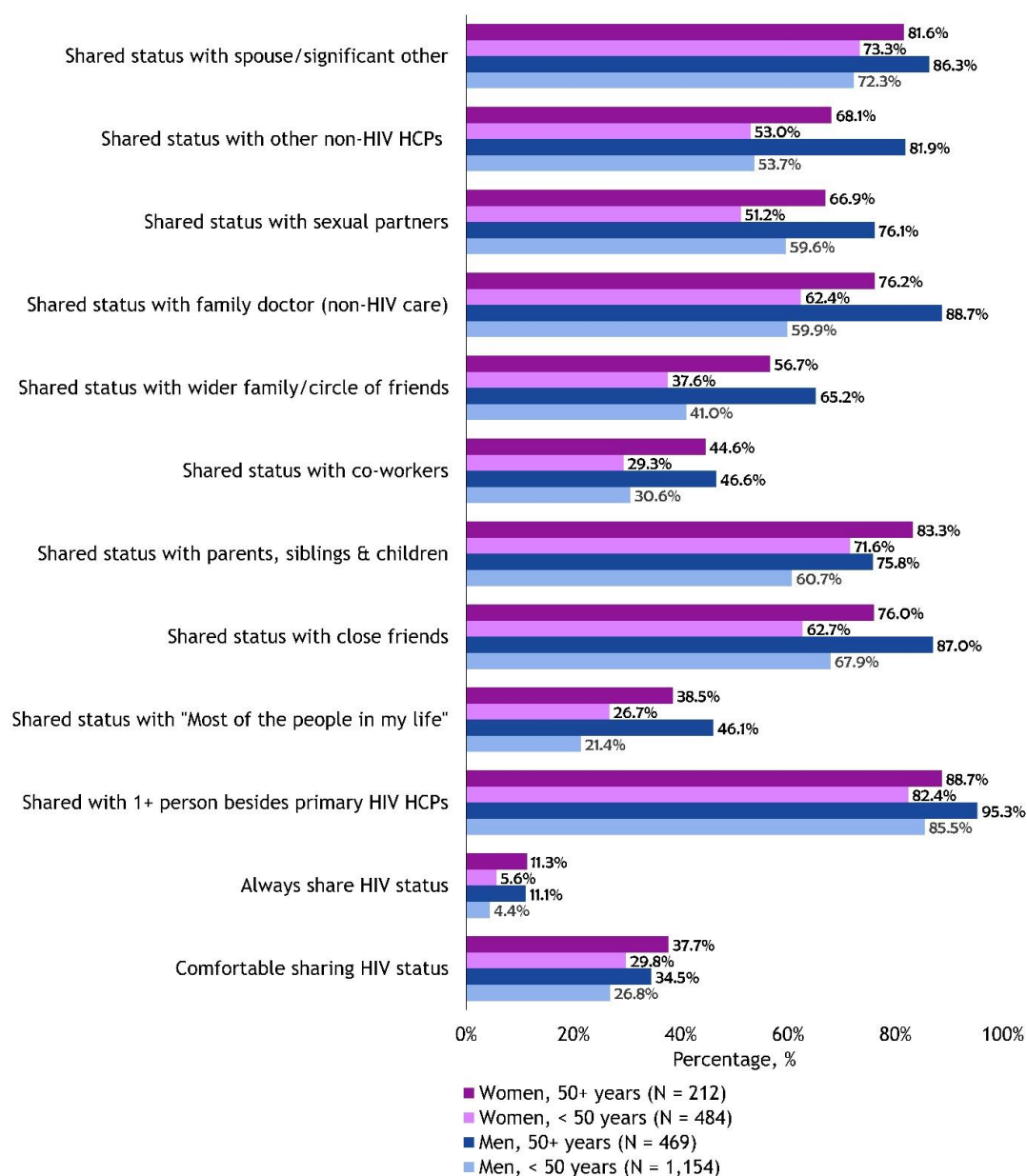
	Have not shared HIV status with other people besides HIV care providers	"Other than your HIV care providers, does anyone else know that you are living with HIV?"	①Yes ②No ③I don't know	No = 1 (i.e., very certain of having never shared HIV status); all other responses = 0 (i.e., definitely or possibly have shared HIV status with others)
	Extent of sharing of HIV status (among those who indicated someone other than their HCP knows they are living with HIV)	Other than your HIV healthcare providers, who knows about your HIV status? 1 My partner/spouse/significant other 2 One or more of my sexual partners 3 One or more members of my *close family (excluding partner/spouse) *by close family we mean parents, siblings & children only 4 One or more of my close friends 5 One or more of my wider family/circle of friends 6 My current family doctor/GP (if not one of your HIV care providers) 7 One or more other healthcare professionals (that are not one of your HIV care providers) 8 One or more of my co-workers 9 Most of the people in my life	①Yes ②No ③Not applicable	Yes = 1; No=0; Not applicable excluded. Exclusion of those not in the relationship of interest (i.e., 'not applicable') was to ensure the correct denominator was analyzed (e.g., sharing of status with sexual partners was analyzed only among those with sexual partners).

Online supplementary figure 1. Percentage of people living with HIV in 25 countries who reported having discussed U=U with their healthcare provider, overall and by gender, Positive Perspectives Study, 2019 (N = 2389)



Note: Asterisks (*) indicate statistically significant country-specific gender differences using χ^2 tests at $p < 0.05$.

Online supplementary figure 2. Percentage of people living with HIV in 25 countries who reported sharing their HIV status, within four mutually exclusive strata of age and gender, Positive Perspectives Study, 2019



Note: All results were statistically significant using χ^2 tests, meaning that for each outcome assessed, at least two of the groups differed significantly at $p < 0.05$. Total sample size across the four strata does not add up to 2389 because of 70 respondents who identified with a gender other than 'man' or 'woman'

Online supplementary table 3. Binary logistic regression analyses for the relationship between awareness of U = U and health outcomes within respective strata of gender and age, Positive Perspectives Study, 2019

Outcomes	Categories of predictor variable	GENDER STRATA		AGE STRATA	
		AMONG MEN (N=1623)	AMONG WOMEN (N=696)	AMONG < 50 y (N=1690)	AMONG ≥50 y (N=699)
Self-reported viral suppression	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	2.68 (1.73-4.16)	1.56 (0.87-2.78)	2.35 (1.62-3.42)	3.93 (1.53-10.07)
	Informed by HCP	3.17 (2.18-4.62)	1.81 (1.11-2.95)	2.94 (2.13-4.05)	2.52 (1.22-5.21)
Suboptimal adherence	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.05 (0.7-1.58)	0.6 (0.35-1.02)	0.78 (0.54-1.12)	0.93 (0.47-1.85)
	Informed by HCP	0.65 (0.45-0.93)	0.41 (0.26-0.65)	0.49 (0.36-0.67)	0.58 (0.32-1.07)
Optimal overall health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.81 (1.26-2.60)	1.17 (0.7-1.96)	1.42 (1.01-1.99)	1.89 (1.07-3.36)
	Informed by HCP	2.22 (1.62-3.04)	1.68 (1.08-2.61)	2.09 (1.56-2.81)	1.84 (1.12-3.04)
Optimal mental health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.97 (1.36-2.86)	1.59 (0.95-2.65)	1.61 (1.14-2.28)	2.47 (1.38-4.41)
	Informed by HCP	2.95 (2.12-4.10)	2.09 (1.35-3.25)	2.57 (1.90-3.48)	2.98 (1.79-4.94)
Optimal physical health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.79 (1.25-2.57)	1.09 (0.66-1.83)	1.60 (1.13-2.25)	1.23 (0.70-2.16)
	Informed by HCP	2.46 (1.79-3.38)	1.49 (0.96-2.31)	2.70 (2.00-3.64)	1.21 (0.74-1.98)
Optimal sexual health	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.14 (0.79-1.64)	1.15 (0.68-1.92)	1.21 (0.85-1.7)	0.88 (0.49-1.57)
	Informed by HCP	1.57 (1.14-2.16)	1.26 (0.81-1.95)	1.79 (1.33-2.42)	0.95 (0.57-1.57)
Comfortable sharing HIV status	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.59 (1.03-2.44)	1.19 (0.63-2.26)	1.29 (0.86-1.95)	2.24 (1.11-4.53)
	Informed by HCP	1.82 (1.24-2.67)	2.44 (1.42-4.19)	1.71 (1.19-2.44)	3.13 (1.66-5.92)
Always share HIV status	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.93 (0.7-5.3)	1.82 (0.47-7.11)	1.98 (0.63-6.19)	2.09 (0.66-6.57)
	Informed by HCP	2.75 (1.09-6.93)	2.97 (0.89-9.91)	3.60 (1.29-10.02)	2.52 (0.88-7.19)
Shared HIV status with others besides HIV care provider	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.73 (1.03-2.91)	1.81 (0.94-3.49)	1.68 (1.07-2.64)	2.33 (0.97-5.61)
	Informed by HCP	1.74 (1.13-2.68)	2.2 (1.28-3.8)	1.60 (1.10-2.33)	5.58 (2.59-12.03)
Ever disguised/hid HIV medicines in past 6 months	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.06 (0.71-1.57)	0.56 (0.32-0.98)	0.82 (0.56-1.21)	0.90 (0.50-1.61)
	Informed by HCP	0.65 (0.46-0.92)	0.55 (0.34-0.89)	0.60 (0.43-0.84)	0.68 (0.41-1.13)
Comfortable	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)

discussing privacy issues with HCP	Aware from non-HCP sources	1.31 (0.91-1.89)	2.07 (1.20-3.56)	1.51 (1.06-2.16)	1.40 (0.79-2.48)
	Informed by HCP	2.34 (1.69-3.23)	3.04 (1.89-4.88)	2.37 (1.74-3.24)	2.80 (1.69-4.62)
Comfortable discussing concerns about transmission with HCP	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	1.77 (1.23-2.56)	2.89 (1.68-4.96)	1.99 (1.40-2.83)	2.28 (1.28-4.07)
	Informed by HCP	3.07 (2.22-4.24)	4.26 (2.66-6.83)	3.19 (2.34-4.35)	3.73 (2.25-6.19)
Missed ART for ≥ 5 times in past month because of privacy concerns	Completely unaware of U = U	1.00 (referent)	1.00 (referent)	1.00 (referent)	1.00 (referent)
	Aware from non-HCP sources	0.83 (0.38-1.85)	0.66 (0.29-1.5)	0.71 (0.38-1.35)	0.51 (0.15-1.75)
	Informed by HCP	0.53 (0.26-1.07)	0.23 (0.10-0.50)	0.44 (0.25-0.76)	0.14 (0.04-0.48)

Note: U=U means undetectable equals untransmittable, HCP=healthcare provider, ART=antiretroviral therapy.