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Behaviour changes following HIV diagnosis among men who have sex with men in the era of treatment as prevention: data from a prospective study

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ABSTRACT

We described the longitudinal changes in sexual behaviour and associated factors among newly diagnosed with HIV men who have sex with men participating in a prospective observational study from a London HIV clinic (2015–2018). Participants self-completed questionnaires at baseline, months 3 and 12. Information collected included socio-demographic, sexual behaviour, health, lifestyle and social support. Trends in sexual behaviours over one year following diagnosis and associated factors were assessed using generalized estimating equations with logit link. Condomless sex (CLS) dropped from 62.2% at baseline to 47.6% at month-three but increased again to 61.8% at month-12 (p -trend = 0.790). Serodiscordant-CLS increased between month-three and month-12 (from 13.1% to 35.6%, p -trend < 0.001). The prevalence of serodiscordant-CLS with high risk of transmitting to their partners at month-three was 10.7%. CLS was higher among men who reported recreational drug use (adjusted Odds Ratio (aOR) 3.03, 95%CI 1.47–6.24, p = 0.003), those with undetectable viral load (aOR 2.17, 95% CI 1.22–3.84, p = 0.008) and those who agreed with a statement “condoms are not necessary when HIV viral load is undetectable” (aOR 3.41, 95%CI 1.58–7.38, p = 0.002). MSM continued to engage in CLS after HIV diagnosis, which coincided with U = U publications and increased throughout the study.

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Sexual behaviour; HIV diagnosis; MSM; condomless sex; treatment as prevention

Introduction

Treating people with HIV (PWH) to reduce transmission of HIV is known as Treatment as Prevention (TasP) and was recommended following results from the HPTN 052 trial in 2011, which showed that treatment was efficacious in reducing HIV transmission risk to a sexual partner (Cohen et al., 2016). The first evidence that PWH who are receiving antiretroviral therapy (ART) and their viral load (VL) is suppressed to an undetectable level cannot transmit HIV in the context of sero-different same-sex male couples was published in 2016 (Rodger et al., 2016) and led to the launch of Undetectable = Untransmittable (U = U) campaign (Bavinton et al., 2018; Lancet HIV, 2017; Rodger et al., 2019). An undetectable VL (<200 copies/mL with ongoing treatment adherence) eliminates the risk of HIV transmission, even when condoms are not used and the other partner is not on pre-exposure prophylaxis (PrEP). The U = U campaign has changed the message given to PWH.

The effect of an HIV diagnosis on the subsequent sexual behaviour of men who have sex with men with

HIV (MSM-WH) in the era of TasP remains unclear. Before the risk of HIV transmission in a person with undetectable VL was demonstrated to be zero, longitudinal cohorts outside of the UK reported that MSM-WH reduced sexual risk behaviours at the time of diagnosis; however, the decreases were temporary (Heijman et al., 2012), with the rebound of condomless sex (CLS) practice with sero-discordant partners was after nine months (Colfax et al., 2002; Gorbach et al., 2006). Longitudinal studies suggest there is a complex relationship between people's perception of VL and individual decisions to engage in risky sex (Levy et al., 2017; Seng et al., 2011). After the launch of TasP, data from a French cohort showed that CLS increased over calendar time regardless of the HIV status of sexual partners; with the main reported reason for not using condoms was “being on ART or having undetectable VL”, suggesting that MSM-WH were aware of TasP (Champenois et al., 2018). In the UK, MSM accounted for more than 50% of total new HIV diagnoses in 2018 (O'Halloran et al., 2019); however, the longitudinal trends in sexual behaviour post-HIV diagnosis are less

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understood (Fox et al., 2009). Understanding the pattern of risk behaviours among MSM-WH following diagnosis is crucial to assess the potential risk of HIV spread in the community.

In this paper, we describe sexual behaviour changes among newly diagnosed MSM and associated factors in the 12 months after their HIV diagnosis.

Material and methods

Study design and participants

This prospective observational study recruited people newly diagnosed from the genito-urinary medicine (GUM)/HIV department at Guy's and St. Thomas' NHS Trust (Beck et al., 2023). Participants enrolled between February 2015 and April 2017 and were followed-up for one year. Individuals were eligible if they were over 18 years old and diagnosed with HIV-1 within the previous four months. All participants were given standard messaging about transmission and VL suppression upon diagnosis. Individuals could consent immediately or after a more extended consideration by contacting the GUM/HIV department. Consent included permission to contact general practitioner practices to provide information on the encounters with the patients for the six months before and the 12 months since the patient was diagnosed with HIV. The study protocol and amendments were reviewed and approved by the National Research Ethics Service (NRES) Committee London-Surrey Borders. Individuals self-completed a paper-based or electronic questionnaire at baseline, month-three (m3), month-six (m6) and month-12 (m12). The questionnaires collected information on socio-demographics, sexual behaviour, health and well-being, social support, lifestyle, and ART adherence.

Measures (all in the past three months unless stated otherwise)

Sexual behaviour

We considered the following measures of sexual behaviours: any sex, CLS, condomless sex with HIV seroconcordant partner(s) (CLS-C), condomless sex with at least one HIV-discordant partner (CLS-D) [assessed as dichotomously (yes; no)], and number of sexual partners (one regular partner; one casual partner; 2–4 partners; 5–10 partners; and >10 partners). Measures of any sex, CLS, and number of sexual partners were collected at baseline, m3 and m12, while CLS-C and CLS-D data were only available at m3 and m12. Since the recall period at baseline questionnaire may cover periods of

being HIV-positive and HIV-negative, questions on sero-discordant or concordant CLS at baseline are difficult to interpret. We also measured CLS-D with risk of HIV transmission (CLS-D-HIV risk) at m3 and m12, defined as CLS-D while not on ART, or with most recent (within three months) documented VL >200 copies/mL.

Other variables

Socio-demographic characteristics included age group, racial identity, country of birth, education, employment status, housing status, relationship status, difficulty to pay for the heating cost, and benefits status. Health and lifestyle factors included recreational drug use, alcohol dependency symptoms (a CAGE score of ≥ 2) (Ewing, 1984), and depressive symptoms (a Patient Health Questionnaire-9 [PHQ-9] score of ≥ 10) (Kroenke et al., 2001).

Other behavioural and HIV-related covariates included STI diagnoses, disclosure of HIV status to others than health care staff, having a partner with HIV, current-ART use, VL status, and views on HIV transmission risk (agree or not to two statements about HIV transmission: “A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load” and “If an HIV positive person's viral load is undetectable, it is not necessary to use a condom to prevent transmission of HIV”).

All variables were collected at baseline, m3 and m12 questionnaires, except for racial identity, country of birth and education which were only obtained at baseline. VLs were routinely collected and obtained from the electronic medical records of the clinic.

Statistical analysis

Analysis in this study focussed on MSM whose baseline visit was within three months of HIV diagnosis. The prevalence of measures of sexual behaviour at baseline, m3, m12 were calculated as the proportion of men who reported the sexual behaviours out of total number who completed questionnaires at each visit. Trends over one year of follow-up since baseline in the prevalence of sexual behaviour were assessed using univariable logistic regression models fitted using generalized estimating equations (GEE). We also assessed the prevalence of other HIV-related characteristics over time as follows: undetectable VL, ART use, views on HIV transmission risk, recreational drug use, and STI diagnoses.

GEE logistic models were also used to assess the associations of factors with sexual behaviours, using questionnaires from m3 and m12. For number of

partners we assessed associations with reporting 2–4, 5–10 and >10 partners. Factors were also assessed separately at m3 and m12, including factors associated with stopping CLS at m3 among those who reported CLS at baseline, using logistic regression models. Analyses were conducted unadjusted and adjusted for age, racial identity, country of birth, and education. Results are presented as odds ratios (ORs) with their 95% confidence intervals (CIs). All analyses were conducted using Stata statistical software (version 15.1). Missing values were excluded from analyses.

Results

Participants' characteristics

121 participants (112 men and nine women) enrolled in the study and completed a baseline questionnaire, of whom 96 were MSM. Six (6.2%) men were excluded because they had been diagnosed with HIV for more than three months. In total, data from 90 (93.8%) men (250 questionnaires in total) were used in the analyses. Baseline questionnaires were completed in a mean of 29 days (median 22 days) after HIV diagnosis (Table 1). At baseline, participants' mean age was 36 years, 83.3% were of White race, 42.2% were UK-born, 64.4% had a university degree, and 85.6% being employed. The majority of men (78.9%) had disclosed HIV status to others. Of the 90 men who completed a baseline questionnaire, 84 (93.3%) completed at m3, and 76 (84.4%) at m12. 73 (81.1%) men completed all three questionnaires.

Sexual behaviour following HIV diagnosis

Figure 1 presents trends in sexual behaviours according to visits. Any sex remained stable throughout the 12-month follow-up period: 85.6% (77/90) at baseline, 79.8% (67/84) at m3 and 80.3% (61/76) at m12 (p -value for linear trend from GEE model = 0.250). CLS was reported by 62.2% (56/90) of men at baseline, dropped to 47.6% (40/84) at m3, increased again to 61.8% (47/76) at m12 (p -trend = 0.790). CLS-C declined slightly, from 31.2% (25/80) at m3 to 26.3% (20/76) at m12 (p -trend = 0.524), while CLS-D increased considerably from 13.1% (11/84) at m3 to 35.6% (27/76) at m12 (p -trend < 0.001). CLS-D-HIV risk decreased from 10.7% (9/84) at m3 to 1.3% (1/76) at m12 (p -trend = 0.050).

The most common number of sexual partners during follow-up reported by participants was 2–4 partners (35.6%; 89/250). There were no changes in reporting one regular partner (p -trend = 0.563), one casual

partner (p -trend = 0.915), 2–4 partners (p -trend = 0.842), and 5–10 partners (p -trend = 0.935) from baseline to m12. The proportion reporting >10 partners decreased from 15.6% at baseline to 6.6% at m12 (p -trend = 0.101). We also assessed the sexual behaviour changes among the 73 men who completed all three visits, detailed explanations and figures are shown in Appendix 1.

Figure 2 shows trends in other HIV-related characteristics. At baseline, almost all men (97.8%) had a detectable VL, which decreased significantly to 48.8% (41/84) at m3, then to 7.9% (6/76, p < 0.001) at m12. STI diagnoses also decreased over time (p < 0.001), while ART use increased (p < 0.001). Recreational drug use remained stable, 67.8% at baseline and 60.2% at m12 (p = 0.103). At baseline, the majority of men (84.4%) were aware that “a person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load”, this increased over time but not statistically significant (86.9% at m3, 92.1% at m12, p = 0.319). Those who agreed with the statement “If an HIV positive person's viral load is undetectable, it is not necessary to use a condom to prevent transmission of HIV” was just under 18% at baseline, then increased significantly (27.8% at m3, 36.8% at m12, p = 0.022).

Factors associated with sexual behaviours after diagnosis

Tables 2 and 3 show the adjusted associations of factors with any sex, CLS, CLS-C, and number of partners. We did not include baseline data to focus on the associated factors in the initial period after HIV diagnosis (total questionnaires used 160). The odds of having any sex (adjusted OR (aOR) 3.03, 95%CI 1.40–6.54, p = 0.005), CLS (aOR 3.03, 95%CI 1.47–6.24, p = 0.003), CLS-C (aOR 4.56, 95%CI 1.62–12.76, p = 0.004), and reporting 5–10 partners (aOR 4.46, 95%CI 1.01–19.65, p = 0.048) was greater among men who reported recreational drug use. Undetectable VL was associated with increased odds of having CLS (aOR 2.15, 95%CI 1.22–3.84, p = 0.008) and CLS-D (aOR 4.18, 95%CI 1.61–10.84, p = 0.003). Participants who agreed to “condoms are not necessary when HIV viral load is undetectable” had an increased odds of having any sex (aOR 2.55, 95%CI 1.34–4.86, p = 0.004), CLS (aOR 3.41, 95%CI 1.58–7.38, p = 0.002), CLS-D (aOR 3.02, 95%CI 1.33–6.84, p = 0.008), reporting 5–10 partners (aOR 5.36, 95%CI 1.79–15.98, p = 0.003) and >10 partners (aOR 6.73, 95%CI 1.17–38.62, p = 0.032). Men with STI diagnoses had greater odds of reporting any sex (aOR 1.80, 95%CI 1.03–3.15, p = 0.038) and 2–4 partners

Table 1. Baseline characteristics among 90 newly diagnosed with HIV MSM participating in the Guy's and St. Thomas' Hospital observational study.

Characteristics	n	%
Total sample ^a	90	100
Demographic		
Age category, years		
< 25	7	7.8%
25–29	20	22.2%
30–34	17	18.9%
35–39	13	14.4%
40–44	16	17.8%
≥ 45	17	18.9%
Mean age (SD)	36 (9.6)	
Racial identity^b		
White	75	83.3%
Other race	15	16.7%
Country of birth		
UK	38	42.2%
Outside the UK	52	57.8%
Socio-economic and partnership status		
University education status		
Yes	58	64.4%
No	32	35.6%
Employment status^c		
Full time / part time employment	77	85.6%
Unemployed / other	13	14.4%
Housing status^d		
Homeowner	20	22.2%
Renting	65	72.2%
Other	4	4.5%
Difficulty to pay for the heating cost in winter		
Yes	15	16.7%
No or not applicable	75	83.3%
Receive benefits		
Yes	5	5.6%
No	85	94.4%
Relationship status		
Yes, living with partner	29	32.2%
Yes, not living with partner	15	17.7%
No	46	51.1%
Patient and HIV		
Have a partner with HIV		
Yes	7	7.8%
No	83	92.2%
Disclosure of HIV status to others		
Yes	71	78.9%
No	19	21.1%
Ever taken ART		
Yes	13	14.9%
No	74	85.1%
Views on HIV transmission risk		
Agree to statement: <i>A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load.</i>	76	84.4%
Agree to statement: <i>If an HIV positive person's viral load is undetectable, it is not necessary to use a condom to prevent transmission of HIV</i>	16	17.8%
HIV viral load (VL) at diagnosis		
≤ 200 copies/mL	2	2.2%
> 200 copies/mL	88	97.8%
Mean days of VL measurement since diagnosis (SD)	14 days (16.4)	
Median days of VL measurement since diagnosis (IQR)	8 days (4–18)	
Time from diagnosis to baseline completion		
≤ 14 days	26	28.9%
15–30 days	36	40.0%
31 days – 3 months	28	31.1%
Mean days from diagnosis to baseline (SD)	29 days (23.2)	
Median days from diagnosis to baseline (IQR)	22 days (14–36)	
Sexual behaviour		
STI diagnoses in the past 3 months		
Yes	43	47.8%
No	47	52.2%

(Continued)

Table 1. Continued.

Characteristics	n	%
Total sample ^a	90	100
Any sex in the past 3 months		
Yes	77	85.6%
No	13	14.4%
Condomless sex in the past 3 months		
Yes	56	62.2%
No	34	37.8%
Number of partners in the past 3 months		
0 or no sex	13	14.4%
1 – regular or long-term partner	15	16.7%
1 – casual or short-term partner	7	7.8%
2–4 partners	30	33.3%
5–10 partners	11	12.2%
> 10 partners	14	15.6%
Lifestyle, health and wellbeing		
Recreational drugs use in the past 3 months		
Yes	61	67.8%
No	29	32.2%
Depressive symptoms (PHQ-9 score ≥10)		
Yes	22	24.4%
No	68	75.6%
Mean PHQ-9 score (SD)	6.9 (6.8)	
Median PHQ-9 score (IQR)	4 (2–10)	
Alcohol dependency symptoms (CAGE score ≥2)		
Yes	7	7.8%
No	83	92.2%

^aThere were no missing data except for: housing status: 1; ever taken ART: 3 ^bOther race includes Black, Asian, Mixed, and other race group ^cUnemployed or other group includes student, retired and disabled or sick ^dOther housing status includes temporary accommodation, staying with partner, and homeless. MSM: men who have sex with men; SD: standard deviation, IQR: interquartile range; STI: sexually transmitted infection; PHQ-9: patient health questionnaire-9; CAGE: alcohol questionnaire.

(aOR 3.44, 95%CI 1.59–7.44, $p = 0.002$). The odds of having CLS (aOR 1.84, 95%CI 1.12–3.02, $p = 0.016$) and CLS-D (aOR 3.58, 95%CI 1.78–7.21, $p < 0.0001$) increased at m12 compared to m3. The odds of having CLS-D was also greater in more recent year (aOR for the year 2017/2018 versus 2015 3.85, 95%CI 1.08–13.69, global $p = 0.030$). Not having ART (aOR 2.82, 95%CI 1.10–7.22, $p = 0.031$) was associated with CLS-C. Not in a relationship (aOR 2.35, 95%CI 1.10–5.00, $p = 0.026$) was associated with reporting 2–4 partners, while receiving benefits was associated with reporting >10 partners (aOR 25.13, 95%CI 2.38–265.07, $p = 0.007$).

The unadjusted associations are shown in Appendix 2 (similar results). When factors were analysed separately for week 12 and week 48, similar results were observed (Appendix 3). We also analysed factors associated with stopping CLS at m3 among 52 men who reported CLS at baseline (Appendix 4). Of the 52, 21 (40%) men reported no CLS at m3. The only factor associated with stopping CLS was not using recreational drugs (OR 0.21, 95%CI 0.05–0.86, $p = 0.030$).

Discussion

Our data indicate that a high proportion of MSM-WH continue to have sex after diagnosis, with the majority having CLS. The prevalence of CLS tended to return to baseline levels within 12 months, and a substantial

increase in CLS-D was observed from month-three to month-12. An understanding of the reduced risk of HIV transmission due to the suppressive effect of ART was significantly associated with increased odds of reporting CLS, CLS-D and higher number of sexual partners.

Our baseline data showed that more than 80% were aware that a person with undetectable VL is less likely to transmit HIV. This might be because the study recruitment period coincided with the results from the PARTNER (first presented in 2014 and published in 2016) (Rodger et al., 2016); therefore, participants might have been informed of the effectiveness of TasP. Baseline data also showed that most men disclosed their HIV status to others. As HIV status disclosure is an important step in delivering the right care to patients, this suggests that men were confident and ready to start their treatment. Those who agreed that condoms are not necessary when viral load is suppressed were low at baseline (<20%), but this significantly increased at the end of the study, reflecting men's greater confidence in ART due to the increasing publicity around U = U (2016–2017, follow-up period of this study), which made headlines globally. As ART use and undetectable VL increased to almost 100%, men became more comfortable to have sex with sero-discordant partners in the later period, shown by the proportion who reported CLS-D at month-12 was higher (>35%) than those who reported CLS-C.

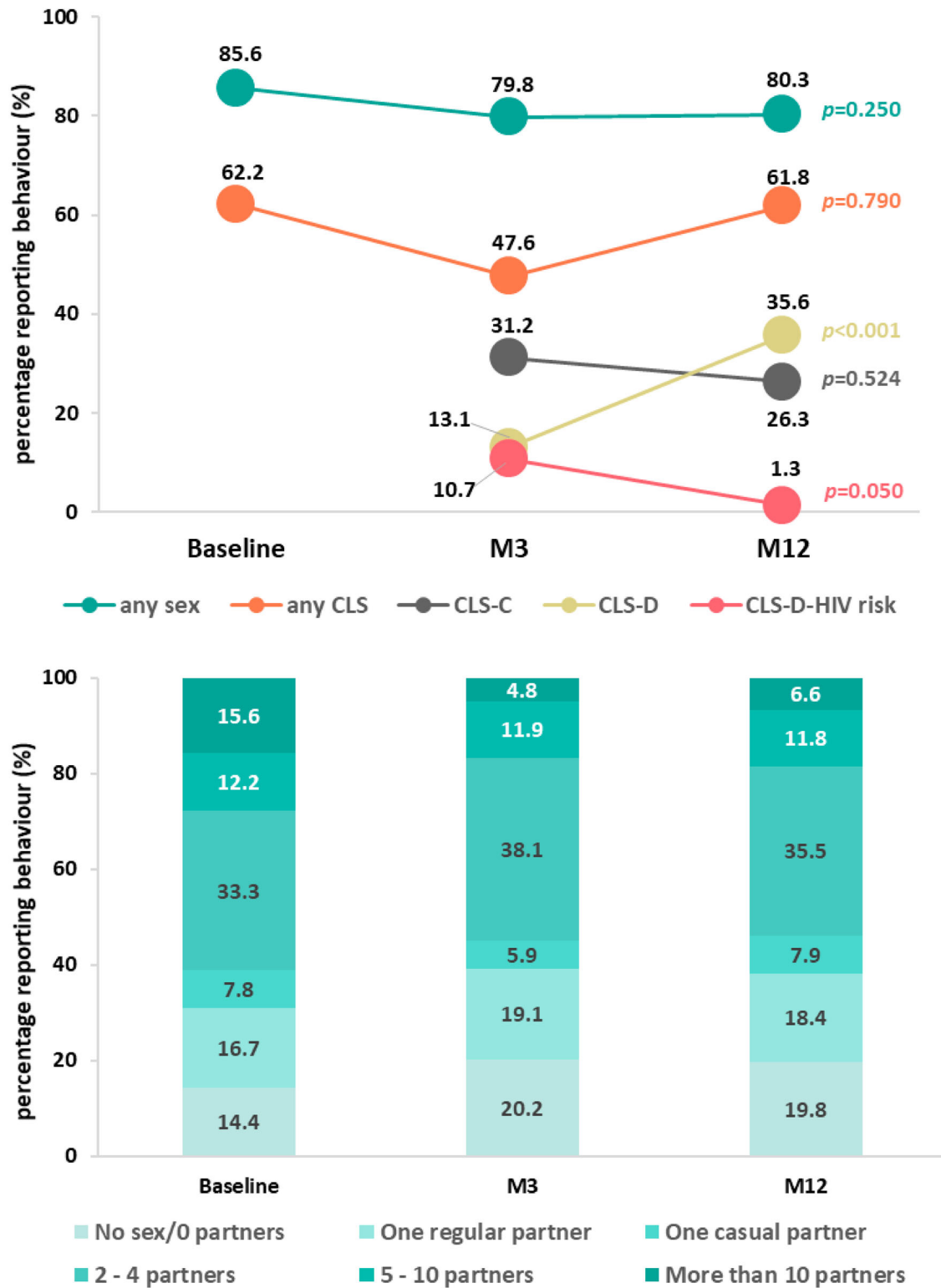


Figure 1. Prevalence of any sex, condomless sex, seroconcordant condomless sex, serodiscordant condomless sex and number of sexual partners over time. Top figure: Trends over one-year follow-up period in any sex, CLS, CLS-C, CLS-D and the prevalence of CLS-D-HIV risk, sample sizes at baseline: 90 men, week 12: 84 men, week 48: 76 men; CLS-C and CLS-D data were not available at baseline, three missing questionnaires on CLS-C. Prevalence of sexual behaviours in the past three months at baseline corresponds to three months pre-diagnosis – diagnosis day; Bottom figure: Trends over one-year follow-up period in number of sexual partners, sample sizes at baseline: 90 men, week 12: 84 men, week 48: 76 men, no missing questionnaires. Prevalence of sexual behaviours in the past three months at baseline corresponds to three months pre-diagnosis – diagnosis.

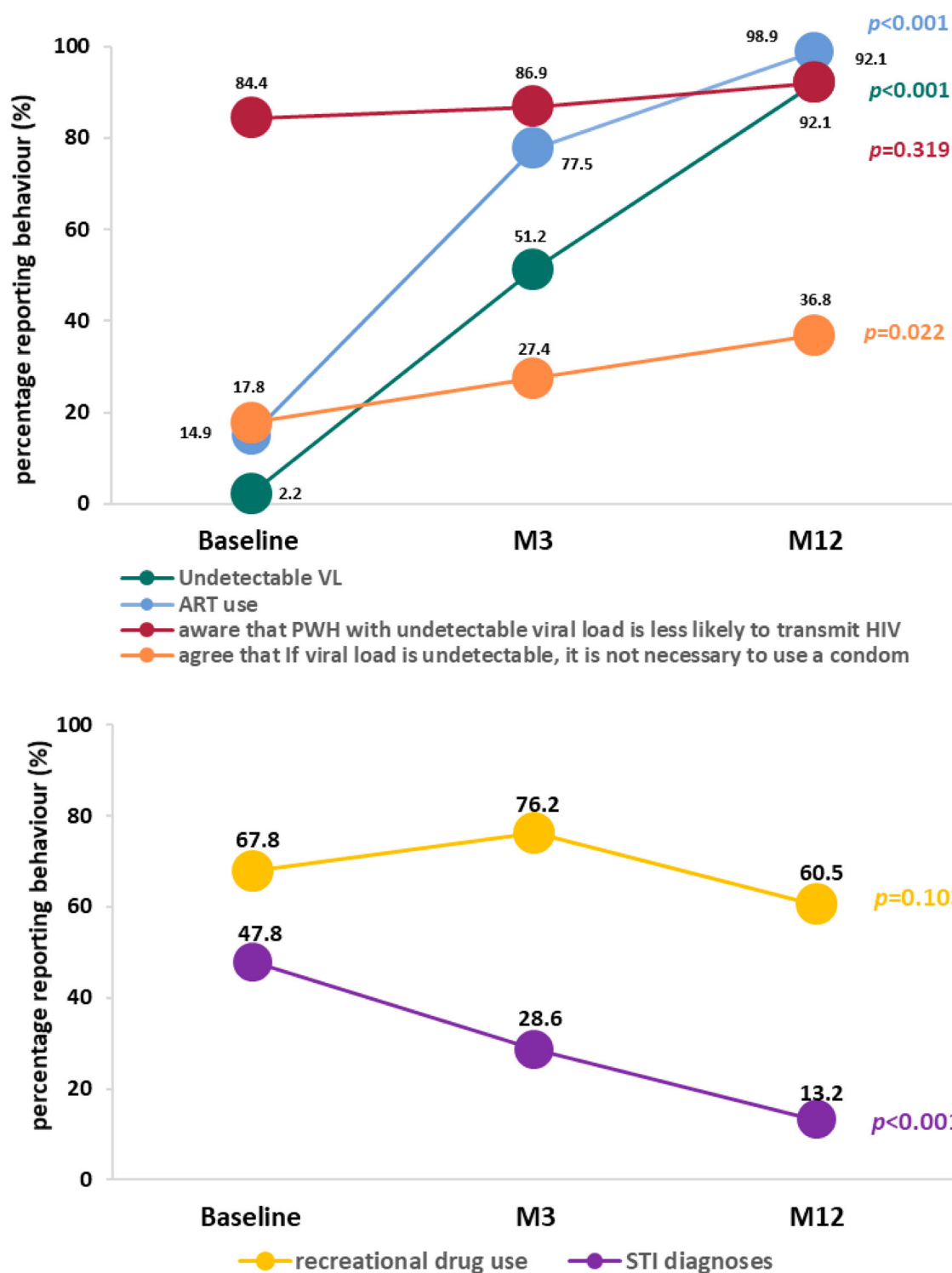


Figure 2. Prevalence of other HIV-related characteristics over time. Top figure: Trends over one-year follow-up period in undetectable VL, ART use and views on HIV transmission risk, sample sizes at baseline: 90 men, week 12: 84 men, week 48: 76 men; no missing questionnaires. Prevalence the past three months at baseline corresponds to three months pre-diagnosis – diagnosis day; Bottom figure: Trends over one-year follow-up period in STI diagnoses and recreational drug use, sample sizes at baseline: 90 men, week 12: 84 men, week 48: 76 men, no missing questionnaires. Prevalence in the past three months at baseline corresponds to three months pre-diagnosis – diagnosis.

The proportion of men having CLS-D-HIV risk at month-three was almost 11% in this study. As sero-discrepant CLS without viral suppression remains a risk

factor for HIV transmission; HIV providers should continue to support and counsel men at the time of diagnosis about the risk of HIV transmission before being

Table 2. Adjusted associations of factors with any sex, condomless sex, seroconcordant condomless sex, and serodiscordant condomless sex among 90 newly diagnosed with HIV MSM participating in the Guy's and St. Thomas' Hospital observational study (n = 160 observations from month 3 and month 12).^a

Characteristics	Any sex ^b		condomless sex ^b		CLS-C ^c		CLS-D ^d	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Age					156 obs			
< 25	ref	0.692	ref	0.775	refv	0.272	ref	0.611
25–29	0.33 (0.02–6.91)		0.30 (0.04–2.02)		0.38 (0.08–1.82)		0.58 (0.12–2.74)	
30–34	0.59 (0.03–13.18)		0.40 (0.05–2.97)		0.73 (0.14–3.88)		0.44 (0.07–2.79)	
35–39	0.33 (0.01–7.92)		0.37 (0.05–2.73)		0.27 (0.05–1.51)		1.21 (0.25–5.77)	
40–44	0.39 (0.01–10.22)		0.31 (0.04–2.62)		0.67 (0.11–3.85)		0.30 (0.04–2.17)	
≥ 45	0.38 (0.02–8.89)		0.38 (0.05–3.08)		0.25 (0.05–1.36)		1.09 (0.23–5.21)	
Racial identity					156 obs			
White	ref	0.535	ref	0.831	ref	0.241	ref	0.102
Other race	1.54 (0.39–6.07)		1.11 (0.42–2.90)		0.51 (0.17–1.56)		2.39 (0.84–6.83)	
Country of birth								
UK	ref	0.773	ref	0.952	ref	0.849	ref	0.853
Outside the UK	1.16 (0.42–3.24)		0.98 (0.45–2.09)		1.09 (0.45–2.62)		0.93 (0.42–2.06)	
University education status								
Yes	ref		ref	0.652	ref	0.764	ref	0.735
No	0.77 (0.29–2.06)	0.611	0.82 (0.35–1.92)		0.87 (0.36–2.11)		0.84 (0.31–2.28)	
Employment status								
Full time / part time employment	ref	0.543	ref	0.669	ref	0.369	ref	0.574
Unemployed / other	1.42 (0.46–4.39)		1.24 (0.46–3.33)		1.56 (0.59–4.12)		0.70 (0.21–2.39)	
Housing status								
Homeowner	ref	0.687	ref	0.959	ref	0.212	ref	0.265
Renting	0.52 (0.16–1.61)		0.61 (0.24–1.56)		0.45 (0.13–1.49)		1.07 (0.27–4.22)	
Other	1.02 (0.18–5.82)		1.38 (0.29–6.45)		0.27 (0.03–2.76)		4.56 (0.55–37.79)	
Difficulty to pay for heating cost								
Yes	ref	0.322	ref	0.687	ref	0.375	ref	0.671
No	1.52 (0.66–3.49)		1.17 (0.55–2.49)		1.62 (0.56–4.75)		0.81 (0.30–2.18)	
Receive benefits								
Yes	ref	0.431	ref 1.06 (0.23–4.94)	0.941	ref	0.900	ref	0.510
No	1.86 (0.39–8.65)				0.86 (0.09–8.19)		2.31 (0.19–27.79)	
In relationship status								
No	ref 1.69 (0.65–4.35)	0.255	ref	0.930	ref	0.260	ref	0.109
Yes, living with partner	1.46 (0.62–3.45)		0.96 (0.43–2.13)		1.64 (0.71–3.79)	0.77 (0.26–2.22)	0.52 (0.24–1.13)	
Yes, not living with partner			1.00 (0.41–2.48)				0.92 (0.35–2.46)	
Have a partner with HIV		-						
No	1 (success perfectly)		ref	0.066	ref	0.108	ref	0.730
Yes			4.19 (0.91– 19.35)		2.75 (0.80–9.44)		1.25 (0.35–4.53)	
Disclosure of HIV status to others								
Yes	ref	0.143	ref	0.189	ref	0.699	ref	0.157
No	0.54 (0.23–1.23)		0.53 (0.21–1.36)		0.83 (0.32–2.13)		0.45 (0.15–1.36)	
Currently on ART								
Yeys	ref	0.574	ref	0.906	ref	0.031	1	-
No	1.70 (0.26–10.91)		1.06 (0.38–2.95)		2.82 (1.10–7.22)			
Detectable viral load								
Yes	ref	0.757	ref	0.008	ref	0.843	ref	0.003
No	1.10 (0.60–2.01)		2.17 (1.22–3.84)		0.94 (0.49–1.80)		4.18 (1.61–10.84)	
		0.005		0.003		0.004		0.626

Recreational drug use in the past 3 months								
No	ref		ref		ref		ref	
Yes	3.03 (1.40–6.54)		3.03 (1.47–6.24)		4.56 (1.62–12.76)		1.22 (0.54–2.74)	
STI diagnoses in the past 3 months								
No	ref	0.038	ref	0.715	ref	0.638	ref	0.938
Yes	1.80 (1.03–3.15)		1.15 (0.53–2.52)		1.21 (0.54–2.69)		1.04 (0.39–2.71)	
Depressive symptoms (PHQ-9 score ≥ 10)								
No	ref	0.738	ref	0.200	ref	0.115	ref	0.628
Yes	1.32 (0.26–6.85)		0.47 (0.15–1.49)		0.30 (0.07–1.34)		0.72 (0.18–2.77)	
Alcohol dependency symptoms (CAGE score ≥ 2)								
No	ref	0.918	ref	0.650	ref	0.930	ref	0.793
Yes	0.92 (0.19–4.42)		1.35 (0.37–4.95)		1.06 (0.29–3.89)		1.17 (0.36–3.86)	
Views on HIV transmission risk								
Agree to statement: A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load								
No	ref	0.643	ref	0.384	ref	0.842	ref	0.354
Yes	0.85 (0.42–1.72)		1.63 (0.54–4.92)		0.87 (0.23–3.36)		2.39 (0.38–15.05)	
Agree to statement: If an HIV positive person's viral load is undetectable, it is not necessary to use a condom								
No	ref	0.004	ref	0.002	ref	0.369	ref	0.008
Yes	2.55 (1.34–4.86)		3.41 (1.58–7.38)		1.42 (0.66–3.07)		3.02 (1.33–6.84)	
Visit								
3 months	ref	0.696	ref	0.016	ref	0.603	ref	<0.001
12 months	1.11 (0.65–1.92)		1.84 (1.12–3.02)		0.85 (0.46–1.56)		3.58 (1.78–7.21)	
Calendar Year								
2015	ref	0.683	ref	0.607	ref	0.127	ref	0.030
2016	0.62 (0.27–1.40)		1.22 (0.68–2.19)		0.91 (0.44–1.87)		2.11 (0.69–6.40)	
2017 / 2018	0.81 (0.29–2.21)		1.24 (0.56–2.80)		0.45 (0.15–1.30)		3.85 (1.08–13.69)	

^aOR adjusted for age, racial identity, country of birth, and education. ^bTotal complete observations for any sex and CLS: 160; housing status: 154 observations; difficulty to pay for heating and ever taken ART: 156 observations. No missing data for the other variables in the table. ^cTotal complete observations for CLS-C: 156; housing status: 150 observations; difficulty to pay for heating and ever taken ART: 152 observations. ^dTotal complete observations for CLS-D: 160; housing status: 154 observations; difficulty to pay for heating and ever taken ART: 156 observations. MSM: men who have sex with men; aOR: adjusted odds ratio; CI: confidence interval; CLS: condomless sex; STI: sexually transmitted infection; PHQ-9: patient health questionnaire-9; CAGE: alcohol questionnaire.

Table 3. Adjusted associations of factors with number of sex partners among 90 newly diagnosed men who have sex with men in the St. Thomas observational study (n = 160 observations from month 3 and month 12).^a

Characteristics	2–4 partners ^b		5–10 partners ^b		>10 partners [†]	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Age						
< 25	ref	0.167	ref	0.262	ref	0.566
25–29	3.21 (0.62–16.71)		0.11 (0.01–1.26)		0.31 (0.04–2.24)	
30–34	3.31 (0.59–18.66)		0.06 (0.01–0.70)		0.86 (0.08–9.33)	
35–39	3.36 (0.65–17.33)		0.57 (0.09–3.59)		0.82 (0.09–6.76)	
40–44	6.48 (1.25–33.45)		0.24 (0.03–1.74)		empty	
≥ 45	4.30 (0.79–23.38)		0.15 (0.02–1.09)		empty	
Racial identity						
White	ref	0.122	ref	0.101	ref	0.796
Other race	1.19 (0.95–1.49)		0.17 (0.02–1.42)		1.22 (0.26–5.69)	
Country of birth						
UK	ref	0.107	ref	0.118	ref	0.999
Outside the UK	1.99 (0.86–4.62)		2.43 (0.79–7.45)		1.00 (0.19–5.21)	
University education status						
Yes	ref	0.383	ref	0.884	ref	0.282
No	0.71 (0.32–1.54)		0.92 (0.30–2.80)		0.25 (0.02–3.08)	
Employment status						
Full time / part time employment	ref	0.105	ref	0.876	ref	0.574
Unemployed / other	0.43 (0.16–1.19)		1.13 (0.24–5.41)		1.76 (0.24–12.53)	
Housing status						
Homeowner	ref	0.785	ref	0.789	ref	0.486
Renting	1.20 (0.46–3.09)		0.73 (0.15–3.55)		0.29 (0.01–6.13)	
Other	0.58 (0.12–2.79)		0.87 (0.10–7.54)		2.67 (0.11–64.95)	
Difficulty to pay for heating cost						
Yes	ref	0.189	ref	0.788	ref	0.749
No	1.99 (0.71–5.56)		1.19 (0.32–4.48)		0.75 (0.13–4.39)	
Receive benefits						
No	1	-	1	-	ref	0.007
Yes					25.13 (2.38–265.07)	
In relationship status						
Yes, living with partner	ref	0.026	ref	0.996	ref	0.195
Yes, not living with partner	1.49 (0.51–4.33)		0.37 (0.04–3.67)		1.04 (0.06–17.76)	
No	2.35 (1.10–5.00)		0.96 (0.31–2.93)		2.87 (0.55–14.93)	
Have a partner with HIV		0.394				
No	ref		1	-	1	-
Yes	1.67 (0.51–5.44)					
Disclosure of HIV status to others						
Yes	ref	0.574	ref	0.599	ref	0.210
No	1.27 (0.55–2.96)		0.68 (0.17–2.81)		2.83 (0.55–14.39)	
Currently on ART						
Yes	ref	0.718	ref	0.230	1	-
No	0.81 (0.27–2.46)		0.34 (0.06–1.97)			
Detectable viral load						
Yes	ref	0.286	ref	0.627	ref	0.759
No	1.47 (0.72–3.02)		1.27 (0.48–3.40)		1.28 (0.26–6.28)	
Recreational drug use in the past 3 months						
No	ref	0.200	ref	0.048	ref	0.262
Yes	1.75 (0.74–4.09)		4.46 (1.01–19.65)		3.51 (0.39–31.57)	

STI diagnosis in the past 3 months						
No	ref	0.002	ref	0.898	ref	0.655
Yes	3.44 (1.59–7.44)		1.08 (0.32–3.59)		0.69 (0.14–3.48)	
Depressive symptoms (PHQ-9 score ≥ 10)						
No	ref	0.424	ref	0.878	ref	0.952
Yes	0.60 (0.17–2.10)		0.88 (0.17–4.57)		0.93 (0.09–9.82)	
Alcohol dependency symptoms (CAGE score ≥ 2)						
No	ref	0.279	ref	0.413	ref	0.298
Yes	0.50 (0.14–1.75)		0.42 (0.06–3.29)		3.05 (0.37–25.04)	
Views on HIV transmission risk						
Agree to statement: A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load						
No	ref	0.655	1	-	ref	0.143
Yes	1.27 (0.44–3.67)				0.27 (0.05–1.55)	
Agree to statement: If an HIV positive person's viral load is undetectable, it is not necessary to use a condom						
No	ref	0.939	ref	5.36 (1.79–15.98)	ref	0.032
Yes	1.03 (0.48–2.22)			0.003	6.73 (1.17–38.62)	
Visit						
3 months	ref	0.598	ref	0.870	ref	0.603
12 months	0.84 (0.45–1.59)		1.08 (0.44–2.61)		1.40 (0.39–5.03)	
Calendar Year						
2015	ref	0.972	ref	0.478	ref	0.821
2016	1.01 (0.44–2.32)		0.63 (0.17–2.27)		1.02 (0.24–4.24)	
2017 / 2018	0.72 (0.27–1.90)		1.81 (0.46–7.08)		1.23 (0.20–7.61)	

^aOR adjusted for age, racial identity, country of birth, and education. ^bTotal complete observations for any sex and CLS; 160; housing status; 154 observations; difficulty to pay for heating and ever taken ART: 156 observations. No missing data for the other variables in the table. aOR: adjusted odds ratio, CI confidence interval, CLS condomless sex, STI sexually transmitted infection, PHQ-9 patient health questionnaire-9, CAGE alcohol questionnaire.

virally suppressed and how long it takes (Crepaz et al., 2020). Furthermore, safer sex through condom use interventions, irrespective of the VL levels or whether the other partner uses PrEP, should never be neglected to prevent STIs. Shortly after diagnosis, a sizeable proportion (>30%) of MSM-WH in this study reported CLS-C as compared to CLS-D (13%), which may suggest actual or perceived serosorting. While encouraging, this does not eliminate the risk of other STIs among these men (Wiley et al., 2000).

Evidence suggests that internalized HIV-related stigma among PWH is associated with HIV-transmission-related risk behaviours, including CLS (Overstreet et al., 2013). Similarly, minority stress among MSM also represents a plausible explanation for sexual health disparities and outcomes (Hatzenbuehler, 2009). MSM-WH are exposed to both sexual minority and HIV-stigma-related stressors that can lead to the development of emotion dysregulation over time; including depression, anxiety, sexual compulsivity, and HIV transmission risk behaviour (Rendina et al., 2017). The provision of information on U = U will hopefully encourage people to get tested, link to care, get onto treatment, appreciate that they cannot pass on HIV once virally suppressed, and contribute to ending stigma. Many PWH now have less sex-related anxiety because of U = U, which means they do not worry about passing on HIV, even when they do not use condoms. CLS, CLS-C, and CLS-D are not regarded as risk behaviours if people remain undetectable.

Consistent with previous findings in the UK, recreational drug use was associated with CLS and higher number of sexual partners (Daskalopoulou et al., 2014; Melendez-Torres et al., 2016; Pufall et al., 2018). Health promotion interventions that discuss the effects of drug use on sexual decision-making and can link MSM-WH to drug treatments when needed will be helpful to address the issues.

The strengths of this study are its longitudinal nature, high retention rate, and relatively few missing data. Regarding the study limitations, the relatively small number of participants in this study means that results should be interpreted carefully, as power is limited to assess associations. The findings may not be generalizable to all MSM in the UK, as data were collected in a single site in London. The eligibility criteria of being diagnosed within three months of baseline may cause the sample in this study to represent only those men who regularly access care. Sexual behaviour data were self-reported, which can be subject to recall and social desirability bias; however, this was minimized by the survey being completed confidentially. Because there is a gap in risk behaviour data (month-three to month-6), it is unknown

when MSM returned to baseline levels of risk behaviour. Furthermore, questions at baseline referred to “past three months” rather than “since diagnosis”, which has made the data hard to interpret as it referred to a period that was only partly before diagnosis. Therefore, in this analysis, factors were assessed for associations at month-three and 12. Finally, participants’ data on the type of STIs, recreational drugs (i.e., chemsex, injection drugs) and whether sero-discordant partners were on PrEP are not available; this needs to be better characterized in further studies. Our CLS-D-HIV risk measure may include those who were engaging in sexual activity with partners who were on PrEP, which is not regarded as a risky behaviour for HIV transmission, as PrEP is an effective method for HIV prevention.

Despite limitations, our study provides evidence that MSM-WH continued to have sex over time, with many of them doing so without the use of a condom. Strong associations were found between CLS and undetectable VL, an understanding that condoms are unnecessary when VL is undetectable and recreational drug use. Greater awareness of U = U has improved the lives of MSM-WH; they can have relationships without the fear of transmitting HIV, experience a normal romantic life take into account prevention strategies and positively contribute to the community. Still, for those starting ART, the message to use condoms until undetectable needs to be reinforced. If a condom is correctly used during sex, the chances of contracting HIV and other STIs will be lower.

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Appendices

Appendix 1

Changes in sexual behaviour among men with complete data (Figures A1 and A2)

For this analysis, data from the same individuals who completed all three visits were used ($n = 73$ men). Longitudinal changes were presented as the proportion who reported and did not report sexual behaviours among those who reported sexual behaviours in the previous visit, and the same was done among those who did not report sexual behaviours in the previous visit.

Among the 73 men, the general tendency for reporting any sex and CLS was that levels of sexual behaviour fell from baseline to m3, and tended to increase again by one year (Figure A1(A) and A1(B) – Appendix 1). There was a slight decrease in the frequency of CLS-C from m3 to m12 and an increase in the frequency of CLS-D. The tendency to report one regular partner, one casual partner, 2-4 partners, and 5-10 partners was stable; however, men tended to reduce reporting >10 partners after HIV diagnosis.

Figure A1(A) shows that 87.7% of men (64/73) reported any sex at baseline; 69.9% (51/73) continued to report any sex at week 12, while 17.8% (13/73) stopped reporting any sex. Among the nine men who did not report any sex at baseline (12.3% of 73), five men (6.8% of 73) started reporting

any sex at week 12, while four men continued to not report any sex at week 12 (5.5% of 73). The total prevalence of reporting any sex among 73 men at week 12 was 76.7% (56 men). At week 48, 51 of 56 men who reported any sex at week 12 continued to report any sex at week 48 (69.9%, or 51 from a total of 73 men at baseline), and four men (4/73, 5.5%) stopped reporting it. Among the 17 men of 73 men who did not report any sex at week 12 (23.3%), seven men (7/73, 9.6%) reported any sex at week 48, while ten men of the 73 (13.7%) continued not to report any sex. The total prevalence of reporting any sex among 73 men at week 48 was 79.5%. 45 of 73 men (61.6%) reported CLS at baseline, of whom 28 of 73 (38.4%) continued to report CLS in week 12, while 17 men (23.3%) stopped reporting CLS. Among 28 men who did not report CLS at baseline (38.4%), five men (6.8%) started reporting CLS in week 12, while 23 men continued not to report CLS in week 12 (31.5%). From the total 33 of 73 men (45.2%) who reported CLS in week 12, 28 men (38.4%) continued to report CLS in week 48, and five men (6.8%) stopped reporting it. Among the 40 men of 73 men who did not report CLS in week 12 (54.8%), 17 men (23.3%) reported CLS in week 48, while 23 men (31.5%) continued not to report CLS. The total prevalence of CLS among the 73 men in week 48 was 61.6% (Figure A1(B)).

For the analysis of CLS-C, we only used data from 70 men (three missing responses). Of 70, 20 men reported CLS-C in week 12 (28.6%), and of these 20, ten men (14.3%) continued to report CLS-C in week 48, while ten men (14.3%) did not report CLS-C. 50 men out of 70 (71.4%) did not report CLS-C in week 12; of these, eight men (11.4%) reported CLS-C in week 48, and 42 men (60.1%) continued not to report CLS-C. The total reported CLS-C in week 48 was 25.7% (Figure A1(C)).

An increase at week 48 was seen in the within-individual frequency of CLS-D. Of 73, ten men (13.7%) reported CLS-D in week 12, of whom seven men (9.6%) continued to report CLS-D in week 48, three men (4.1%) stopped reporting this behaviour. 63 men out of 73 (86.3%) did not report CLS-D; of these, 19 men (26.0%) reported CLS-D in week 48, 44 men (60.3%) continued not to report CLS-D. The total prevalence of CLS-D in week 48 was 35.6% (Figure A1(D)).

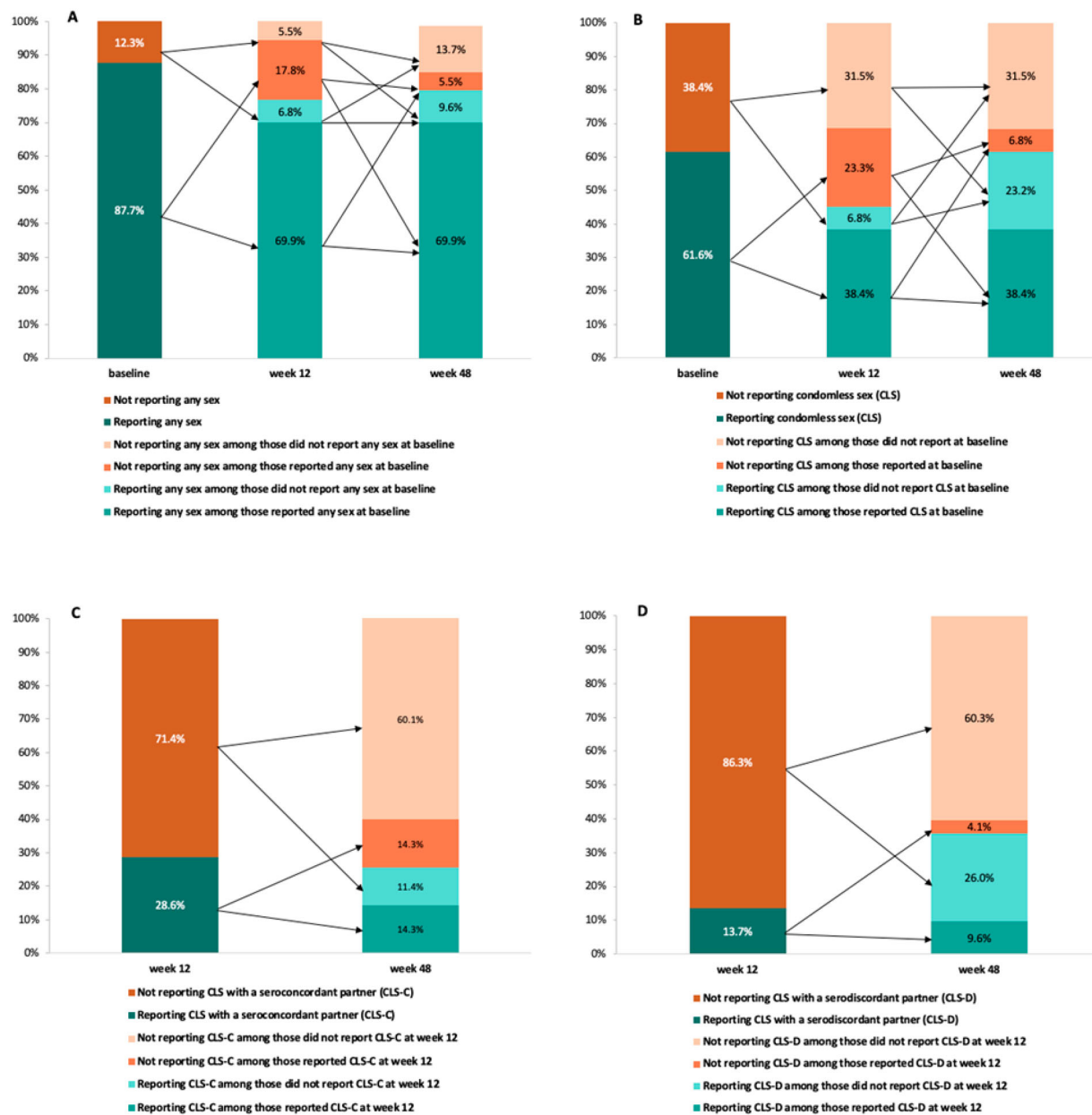


Figure A1. Changes in the frequency of any sex (panel A), condomless sex (panel B), seroconcordant condomless sex (panel C) and serodiscordant condomless sex (panel D) over time. Total number questionnaires for panel A and B: 219, panel C and panel D: 146 from 73 men who completed all three visits.

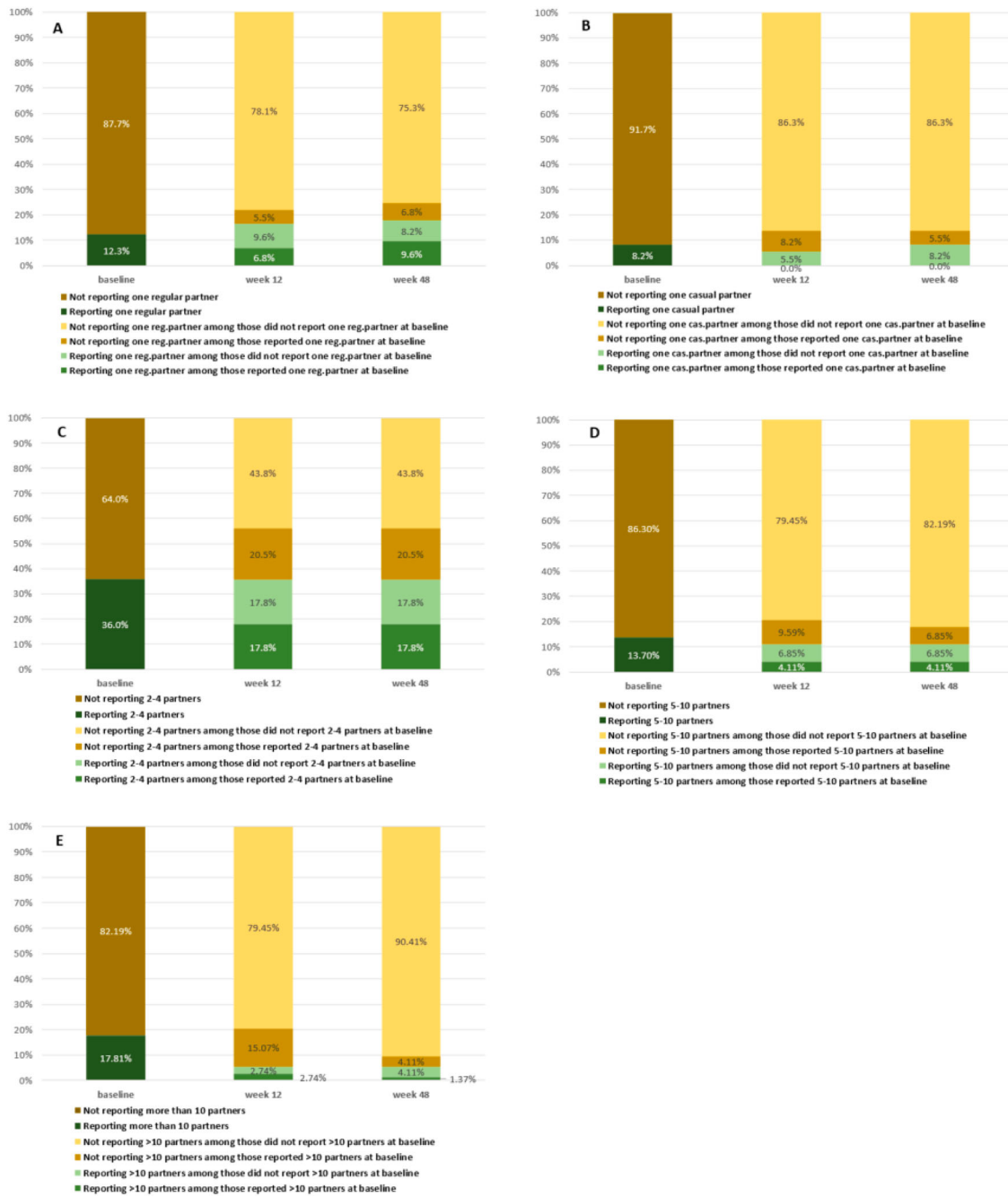


Figure A2. Changes in the frequency of reporting (A) one regular partner, (B) one casual partner, (C) 2–5 partners, (D) 5–10 partners, and (E) more than 10 partners over time. No missing questionnaires.

Appendix 2. Unadjusted associations of factors with any sex, condomless sex, seroconcordant condomless sex, and serodiscordant condomless sex among 90 newly diagnosed HIV MSM participating in the Guy's and St. Thomas' Hospital observational study (n = 160 observations from week 12 and week 48).^a

Characteristics	Any sex ^b		Condomless sex ^c		CLS-C ^d		CLS-D ^e	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Age		0.604						
< 25	ref		ref	0.786	ref	0.266	ref	0.513
25–29	0.35 (0.01–10.16)		0.31 (0.05–1.95)		0.31 (0.06–1.49)		0.83 (0.19–3.64)	
30–34	0.58 (0.18–18.71)		0.41 (0.06–2.95)		0.64 (0.13–3.23)		0.56 (0.09–3.18)	
35–39	0.30 (0.01–9.76)		0.37 (0.05–2.60)		0.25 (0.05–1.34)		1.38 (0.29–6.60)	
40–44	0.38 (0.01–13.44)		0.32 (0.04–2.51)		0.66 (0.12–3.52)		0.31 (0.04–2.45)	
≥ 45	0.35 (0.01–11.34)		0.39 (0.05–2.89)		0.25 (0.05–1.32)		1.15 (0.24–5.54)	
Racial identity								
White	ref	0.316	ref	0.904	ref	0.274	ref	0.132
Other race	1.99 (0.52–7.74)		1.06 (0.43–2.58)		0.55 (0.18–1.61)		2.10 (0.80–5.51)	
Country of birth								
UK	ref	0.620	ref	0.993	ref	0.707	ref	0.733
Outside the UK	1.20 (0.49–3.28)		0.99 (0.48–2.08)		1.17 (0.51–2.66)		0.87 (0.38–1.95)	
University degree								
Yes	ref	0.485	ref	0.709	ref	0.973	ref	0.559
No	0.71 (0.27–1.86)		0.86 (0.39–1.89)		0.98 (0.42–2.30)		0.76 (0.30–1.90)	
Employment								
Full time / part time employment	ref	0.632	ref	0.711	ref	0.563	ref	0.676
Unemployed / other	1.31 (0.43–3.96)		1.20 (0.46–3.16)		1.33 (0.50–3.54)		0.78 (0.24–2.52)	
Housing status								
Own house	ref	0.369	ref	0.277	ref	0.508	ref	0.125
Renting	0.67 (0.24–1.92)		0.66 (0.29–1.51)		0.60 (0.23–1.61)		1.01 (0.32–3.13)	
Other	1.36 (0.30–6.06)		1.55 (0.39–6.13)		0.42 (0.07–2.38)		4.25 (0.83–21.84)	
Difficulty to pay for heating cost								
Yes	ref	0.272	ref	0.661	ref	0.385	ref	0.755
No	1.56 (0.70–3.45)		1.18 (0.56–2.52)		1.59 (0.55–4.59)		0.86 (0.32–2.27)	
Receive benefits								
Yes	ref	0.268	ref	0.839	ref	0.904	ref	0.509
No	2.35 (0.52–10.71)		1.16 (0.27–5.06)		1.14 (0.14–9.37)		2.26 (0.20–25.35)	
In relationship status								
No	Ref	0.488	ref	0.997	ref	0.272	ref	0.315
Yes, living with partner	1.66 (0.64–4.31)		0.97 (0.44–2.13)		1.59 (0.71–3.56)		0.55 (0.24–1.24)	
Yes, not living with partner	1.44 (0.66–3.09)		1.00 (0.41–2.48)		0.70 (0.24–2.03)		1.02 (0.38–2.73)	
Have a partner with HIV								
No	ref		ref	0.069	ref	0.095	ref	0.872
Yes	1 (success perfectly)		4.05 (0.89–18.36)		2.91 (0.83–10.22)		1.13 (0.26–4.79)	
Disclosure of HIV status to others								
Yes	ref	0.167	ref	0.186	ref	0.626	ref	0.225
No	0.57 (0.25–1.27)		0.53 (0.21–1.35)		0.80 (0.33–1.95)		0.49 (0.16–1.54)	
Currently on ART								
Yes	ref	0.611	ref	0.930	ref	0.021	1	-
No	1.59 (0.26–9.54)		1.04 (0.39–2.83)		2.85 (1.17–6.91)			
Detectable viral load								
Yes	ref	0.575	ref	0.006	ref	0.903	ref	0.003
No	1.17 (0.67–2.07)		2.19 (1.25–3.83)		0.96 (0.51–1.80)		4.19 (1.62–10.84)	
Recreational drug use (past 3 months)		0.004		0.002		0.004		0.631

(Continued)

Appendix 2. Continued.

Characteristics	Any sex ^b		Condomless sex ^c		CLS-C ^d		CLS-D ^e	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
No	ref		ref		ref		ref	
Yes	2.90 (1.39–6.05)		3.04 (1.48–6.22)		4.29 (1.59–11.62)		1.21 (0.55–2.67)	
STI diagnosis (past 3 months)								
No	ref	0.050	ref	0.707	ref	0.565	ref	0.921
Yes	1.82 (1.00–3.30)		1.16 (0.53–2.53)		1.26 (0.57–2.77)		0.95 (0.39–2.35)	
Depressive symptoms (PHQ-9 score ≥10)								
No	ref	0.778	ref	0.182	ref	0.114	ref	0.623
Yes	1.26 (0.25–6.45)		0.47 (0.15–1.43)		0.30 (0.07–1.33)		0.73 (0.22–2.50)	
Alcohol dependency symptoms (CAGE score ≥2)								
No	ref	0.717	ref	0.742	ref	0.985	ref	0.960
Yes	0.76 (0.18–3.28)		1.22 (0.37–4.06)		0.99 (0.29–3.41)		1.03 (0.35–3.05)	
Views on HIV transmission risk								
Agree to statement: A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner than someone with a high viral load	ref	0.637	ref	0.370	ref	0.806	ref	0.307
	0.85 (0.43–1.67)		1.63 (0.56–4.79)		0.85 (0.24–3.05)		2.45 (0.44–13.66)	
	ref	0.004	ref	0.002	ref	0.458	ref	0.006
	2.43 (1.33–4.47)		3.33 (1.56–7.10)		1.32 (0.63–2.78)		2.99 (1.36–6.56)	
No								
Yes								
Agree to statement: If an HIV positive person's viral load is undetectable, it is not necessary to use a condom								
No								
Yes								
Visit								
12 weeks	ref	0.694	ref	0.017	ref	0.524	ref	<0.001
48 weeks	1.11 (0.65–1.91)		1.83 (1.12–2.99)		0.82 (0.45–1.49)		3.59 (1.80–7.17)	
Calendar Year								
2015	ref	0.403	ref	0.808	ref	0.192	ref	0.050
2016	0.62 (0.27–1.41)		1.20 (0.68–2.14)		0.89 (0.44–1.79)		2.11 (0.71–6.31)	
2017 / 2018	0.82 (0.30–2.22)		1.22 (0.55–2.72)		0.42 (0.15–1.15)		4.13 (1.21–14.08)	

^aRacial identity, country of birth, education, ever taken ART were fixed variables derived from baseline questionnaires; all other variables were time-updated variables in week 12 and 48.

^bTotal complete observations for any sex and CLS: 160; housing status: 154 observations; difficulty to pay for heating and ever taken ART: 156 observations. No missing data for the other variables in the table.

^cTotal complete observations for CLS-C: 156; housing status: 150 observations; difficulty to pay for heating and ever taken ART: 152 observations.

^dTotal complete observations for CLS-D: 160; housing status: 154 observations; difficulty to pay for heating and ever taken ART: 156 observations.

Appendix 3. Factors associated with CLS, CLS-C and CLS-D at week 12 and week 48 among 90 newly diagnosed HIV MSM participating in the Guy's and St. Thomas' observational study.^a

Characteristics	CLS at week 12 ^b		CLS at week 48 ^c		CLS-C at week 12 ^d		CLS-C at week 48 ^e		CLS-D at week 12 ^f		CLS-D at week 48 ^g	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Age												
< 25	ref	0.552	ref	0.691	ref	0.386	ref	0.699	ref	0.893	ref	0.237
25–29	0.35 (0.05–2.49)		0.44 (0.04–5.09)		0.23 (0.03–1.79)		0.40 (0.02–7.63)		1.07 (0.01–13.02)		0.40 (0.02–7.63)	
30–34	0.44 (0.06–3.15)		0.80 (0.21–3.06)		0.70 (0.11–4.59)		0.43 (0.02–9.56)		0.31 (0.02–6.07)		0.67 (0.03–14.3)	
35–39	0.22 (0.03–1.77)		1.40 (0.26–7.67)		0.30 (0.04–2.37)		0.17 (0.01–3.97)		0.42 (0.02–8.19)		1.33 (0.07–26.4)	
40–44	0.90 (0.12–6.86)		1.50 (0.32–7.06)		0.86 (0.12–6.02)		0.62 (0.03–12.65)		0.83 (0.06–11.59)		0.08 (0.01–2.66)	
≥ 45	0.44 (0.06–3.15)		0.52 (0.11–2.30)		0.25 (0.03–1.95)		0.23 (0.01–4.94)		1.07 (0.09–13.02)		0.78 (0.04–15.0)	
Racial identity												
White	ref	0.518	ref	0.526	ref	0.116	ref	0.894	ref	0.100	ref	0.444
Other race	0.69 (0.22–2.15)		1.47 (0.45–4.79)		0.28 (0.06–1.37)		0.92 (0.26–3.28)		3.22 (0.79–12.98)		1.55 (0.50–4.82)	
Country of birth												
UK	ref	0.599	ref	0.646	ref	0.625	ref	1.00	ref	0.767	ref	0.659
Outside the UK	1.27 (0.52–3.05)		0.80 (0.31–2.06)		1.28 (0.48–3.41)		0.98 (0.35–2.77)		1.22 (0.32–4.58)		0.81 (0.31–2.09)	
Education												
University	ref	0.217	ref	0.086	ref	0.629	ref	0.597	ref	0.140	ref	0.352
In between secondary level and university	2.58 (0.88–7.53)		0.37 (0.12–1.15)		1.69 (0.57–4.98)		0.78 (0.20–2.65)		2.72 (0.72–10.28)		0.44 (0.12–1.55)	
Secondary or high school	1.11 (0.27–4.64)		0.25 (0.05–1.19)		1.01 (0.17–5.87)		0.34 (0.04–3.07)		1.00 ~		0.48 (0.09–2.62)	
Employment												
Full time / part time employment	ref	0.859	ref	0.753	ref	0.696	ref	0.615	ref	0.604	ref	0.884
Unemployed / other	1.11 (0.33–3.82)		1.27 (0.29–5.57)		1.30 (0.34–4.98)		1.47 (0.33–6.59)		0.56 (0.06–4.92)		0.89 (0.20–3.95)	
Housing status												
Own house	ref	0.698	ref	0.533	ref	0.776	ref	0.727	ref	0.742	ref	0.661
Renting	0.64 (0.23–1.79)		0.64 (0.19–2.19)		0.68 (0.23–2.07)		0.59 (0.16–2.13)		0.76 (0.17–3.31)		1.00 (0.29–3.45)	
Other	0.82 (0.09–7.11)		1.50 (0.22–10.45)		0.57 (0.05–6.71)		0.67 (0.09–4.64)		1.89 (0.14–25.18)		2.0 (0.34–11.69)	
Difficulty to pay for heating cost												
Yes	ref	0.883	ref	0.323	ref	0.474	ref	0.477	ref	0.333	ref	0.744
No	0.92 (0.29–2.91)		1.79 (0.56–5.73)		1.67 (0.41–6.73)		1.65 (0.41–6.69)		0.48 (0.11–2.11)		1.22 (0.37–4.08)	
Receive benefits												
Yes	ref	0.728	ref	0.862	ref	0.784	ref	0.781	ref		ref	0.936
No	1.39 (0.22–8.88)		0.80 (0.07–9.43)		1.38 (0.13–14.2)		0.70 (0.06–8.34)		1.00		1.10 (0.09–13.0)	
In relationship status												
No	ref	0.979	ref	0.933	Ref	0.201	ref	0.718	ref	0.193	ref	0.845
Yes, living with partner	0.97 (0.37–2.51)		0.87 (0.31–2.43)		2.46 (0.86–7.01)		1.04 (0.34–3.14)		0.14 (0.02–1.18)		0.84 (0.29–2.39)	
Yes, not living with partner	1.10 (0.32–3.76)		0.79 (0.21–3.03)		1.07 (0.24–4.89)		0.52 (0.09–2.83)		0.67 (0.12–3.63)		1.26 (0.33–4.84)	
Have a partner with HIV												
No	ref	0.030	ref	0.730	ref	0.060	ref		ref	0.402	ref	0.671
Yes	10.75 (1.26–91.50)		0.61 (0.03–10.31)		4.33 (0.94–20.03)		1.00		2.09 (0.37–11.81)		1.85 (0.11–31.32)	
Disclosure of HIV status to others												
Yes	ref	0.336	ref	0.473	ref	0.813	ref	0.929	ref	0.482	ref	0.518
No	0.56 (0.17–1.84)		0.58 (0.13–2.56)		0.85 (0.24–3.07)		0.93 (0.17–5.07)		0.46 (0.05–3.98)		0.57 (0.11–3.09)	
Currently on ART												
Yes	ref	0.625	1	-	ref	0.079	1	-	1	-	1	-
No	1.30 (0.45–3.82)				2.76 (0.89–8.59)							
Detectable viral load												
Yes	ref	0.321	ref	0.141	ref	0.434	ref	0.778	ref	0.611	ref	0.105
No	1.61 (0.63–4.17)		2.80 (0.71–11.05)		1.5 (0.54–4.14)		0.81 (0.19–3.52)		1.41 (0.37–5.39)		5.85 (0.69–49.63)	
Recreational drug use in the past 3 months												
No	ref	0.008	ref	0.002	ref	0.021	ref	0.046	ref	0.642	ref	0.198
Yes	5.14 (1.53–17.23)		4.77 (1.75–13.01)		11.67 (1.44–94.52)		3.47 (1.02–11.78)		1.47 (0.29–7.53)		1.93 (0.71–5.29)	

(Continued)

Appendix 3. Continued.

Characteristics	CLS at week 12 ^b		CLS at week 48 ^c		CLS-C at week 12 ^d		CLS-C at week 48 ^e		CLS-D at week 12 ^f		CLS-D at week 48 ^g	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
STI diagnosis in the past 3 months												
No	ref		ref		ref		ref		ref		ref	
Yes	2.33 (0.88–6.21)	0.090	1.52 (0.35–6.46)	0.573	1.38 (0.48–3.91)	0.547	1.23 (0.28–5.37)	0.778	2.37 (0.64–8.73)	0.195	1.24 (0.32–4.91)	0.753
Depressive symptoms (PHQ-9 score ≥10)												
No	ref		ref		ref		ref		ref		ref	
Yes	0.43 (0.12–1.54)	0.197	0.45 (0.11–1.84)	0.264	0.39 (0.08–1.96)	0.253	0.31 (0.04–2.74)	0.296	0.51 (0.06–4.40)	0.539	0.89 (0.20–3.95)	0.884
Alcohol dependency symptoms (CAGE score >2)												
No	ref		ref		ref		ref		ref		ref	
Yes	0.81 (0.17–3.90)	0.794	1.27 (0.29–5.57)	0.753	1.11 (0.19–6.56)	0.909	0.78 (0.15–4.14)	0.768	1.00		1.53 (0.37–6.31)	0.556
Views on HIV transmission risk												
Agree to statement: A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner												
No	ref		ref		ref		ref		ref		ref	
Yes	1.10 (0.31–3.97)	0.878	1.69 (0.31–9.10)	0.540	0.49 (0.13–1.80)	0.283	1.86 (0.20–17.24)	0.583	1.00	0.479	1.11 (0.19–6.57)	0.908
Agree to statement: If an HIV positive person's viral load is undetectable, it is not necessary to use a condom												
No	ref		ref		ref		ref		ref		ref	
Yes	2.70 (0.99–7.37)	0.053	6.52 (1.95–21.83)	0.002	1.69 (0.58–4.88)	0.335	ref1.20 (0.42–3.45)	0.735	1.62 (0.42–6.22)		4.48 (1.63–12.35)	0.004

^aRacial identity, country of birth, education, and ever taken ART were derived from baseline questionnaires; all other variables were time-updated variables at week 12 and week 48; multivariable models adjusted for age, racial identity, country of birth, and education did not change the associations.

^bhousing status: 83 observations; difficulty to pay for heating: 83 observations; ever taken ART: 82 observations; other variables no missing questionnaires.

^chousing status: 71 observations; difficulty to pay for heating: 73 observations; ever taken ART: 74 observations; other variables no missing questionnaires.

^dhousing status and difficulty to pay for heating: 79 observations and ever taken ART: 78 observations; other variables no missing questionnaires

^e housing status: 71 observations; difficulty to pay for heating: 73 observations and ever taken ART: 74 observations; other variables no missing questionnaires

^fhousing status and difficulty to pay for heating: 83 observations; received benefits: 79 observations; ever taken ART: 82 observations; CAGE score: 77 observations; other variables no missing questionnaires

^ghousing status: 71 observations; difficulty to pay for heating: 73 observations; ever taken ART: 74 observations; other variables no missing questionnaires

~ omitted due to collinearity

Appendix 4.

Factors associated with stopping CLS at week 12 among 52 men who reported condomless sex at baseline in the Guy's and St. Thomas' Hospital observational study^a.

Characteristics	Stopping any condomless sex at week 12 ^b	
	OR (95% CI)	p-value
Age		
< 25	ref	0.555
25–29	1.00 (0.18–5.45)	
30–34	0.80 (0.14–4.61)	
35–39	1.50 (0.25–8.98)	
40–44	0.17 (0.01–1.95)	
≥ 45	1 (empty observations) ~	
Racial identity		
White	ref	0.259
Other race	2.33 (0.54–10.16)	
Country of birth		
UK	ref	0.090
Outside the UK	3.11 (0.84–11.55)	
Education		
University	ref	0.326
In between secondary level and university	0.33 (0.08–1.41)	
Secondary or high school	0.80 (0.11–5.53)	
Employment		
Full time / part time employment	ref	0.688
Unemployed / other	1.35 (0.31–5.85)	
Housing status		
Own house	ref	0.523
Renting	2.28 (0.52–9.98)	
Other	3.00 (0.13–66.25)	
Difficulty to pay for heating cost		
Yes	ref	0.570
No	1.67 (0.29–9.70)	
Receive benefits		
Yes	ref	0.331
No	0.29 (0.02–3.51)	
In relationship status		
No	ref	0.696
Yes, living with partner	1.56 (0.43–5.67)	
Yes, not living with partner	1.78 (0.39–8.02)	
Have a partner with HIV		
No	ref	0.098
Yes	0.16 (0.02–1.40)	
Disclosure of HIV status to others		
Yes	ref	0.941
No	1.07 (0.16–7.19)	
Currently on ART		
Yes	ref	0.316
No	0.38 (0.06–2.53)	
Recreational drug use in the past 3 months		
No	ref	0.030
Yes	0.21 (0.05–0.86)	
STI diagnosis in the past 3 months		
No	ref	0.746
Yes	0.82 (0.24–2.75)	
Depressive symptoms (PHQ-9 score ≥10)		
No	ref	0.150
Yes	2.33 (0.73–7.40)	
Alcohol dependency symptoms (CAGE score >2)		
No	ref	
Yes	1.00~	
Views on HIV transmission risk		
Agree to statement: <i>A person on HIV treatment who has an undetectable viral load is less likely to transmit HIV to a sexual partner</i>	ref	0.544
No	0.59 (0.10–3.29)	0.482
Yes	ref	
Agree to statement: <i>If an HIV positive person's viral load is undetectable, it is not necessary to use a condom to prevent transmission of HIV</i>	0.64 (0.18–2.24)	
No		
Yes		

^aRacial identity, country of birth, education, and ever taken ART were derived from baseline questionnaires: all other variables were time-updated in week 12.

^bhousing status: 51 observations; CAGE score: 49 observations.

~ omitted due to collinearity