

Using behavioural insights to increase HIV self-sampling kit returns: a randomized controlled text message trial to improve England's HIV self-sampling service

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Objectives

The aim of the study was to determine whether behaviourally informed short message service (SMS) primer and reminder messages could increase the return rate of HIV self-sampling kits ordered online.

Methods

The study was a 2 × 2 factorial design randomized control trial. A total of 9585 individuals who ordered a self-sampling kit from www.freetesting.hiv different SMS combinations: 1) standard reminders sent days 3 and 7 after dispatch (control); 2) primer sent 1 day after dispatch plus standard reminders; 3) behavioural insights (BI) reminders (no primer); or 4) primer plus BI reminders. The analysis was restricted to individuals who received all messages ($n = 8999$). We used logistic regression to investigate independent effects of the primer and BI reminders and their interaction. We explored the impact of sociodemographic characteristics on kit return as a secondary analysis.

Results

Those who received the primer and BI reminders had a return rate 4% higher than that of those who received the standard messages. We found strong evidence of a positive effect of the BI reminders (odds ratio 1.13; 95% confidence interval 1.04–1.23; $P = 0.003$) but no evidence for an effect of the primer, or for an interaction between the two interventions. Odds of kit return increased with age, with those aged ≥ 65 years being almost 2.5 times more likely to return the kit than those aged 25–34 years. Men who have sex with men were 1.5–4.5 times more likely to return the kit compared with other sexual behaviour and gender identity groups. Non-African black clients were 25% less likely to return the kit compared with other ethnicities.

Conclusions

Adding BI to reminder messages was successful in improving return rates at no additional cost.

Keywords: behavioural interventions, HIV diagnostic tests, public health, randomized controlled trial, text messaging

Accepted 20 April 2018

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Introduction

HIV infection remains a public health problem in the UK. In 2015, more than 100 000 people were living with HIV, of whom an estimated 13 500 were undiagnosed [1]. HIV testing is an important intervention, as early diagnosis significantly reduces the chances of premature mortality, morbidity and onward transmission [1]. HIV tests are

offered in a variety of sites (e.g. clinical and community services) and can also be ordered online for individuals to complete at home. Home-based options can help reduce the barriers associated with traditional testing [2,3] and include self-sampling (where the individual takes the sample but is provided with the result) and self-testing (where the individual interprets the result).

There is growing evidence that the way we design forms and encourage individuals to attend sexual health services can have a large impact on behaviours that impact sexual health outcomes. For example, short message service (SMS) reminders have been used to prompt individuals to attend HIV/sexually transmitted infection (STI) screening, and to re-test in randomized controlled trials (RCTs) [4]. However, these studies focused on testing performed at sexual health clinics and not on home-based self-sampling/tests. A 2012 systematic review on the scope and effectiveness of mobile phone messaging for HIV care [5] identified a robust study which concluded that SMS reminders were effective in increasing the rate of re-testing [6]. A systematic review of smartphone, internet and web 2.0 interventions showed a positive impact of eHealth (using information and communication technologies for health) and mHealth (using mobile devices for health) technologies across the HIV continuum of care, including for home-testing [7]. SMS reminders were, however, excluded from this review. Little research has been carried out with regard to home-based self-sampling kits specifically, and the effectiveness of SMS reminders in increasing their return rate is unknown.

England's national HIV self-sampling service, co-funded by Public Health England (PHE) with local authorities since November 2015, has a kit return rate of approximately 50%. In this study, we used an RCT to test whether behaviourally informed text messages could increase the kit return rate further.

Methods

Trial design

We identified two existing opportunities where behavioural insights (BI) could be applied within the provider's standard service for online ordering of test kits from www.freetesting.hiv (Preventx Limited, Sheffield, England): (1) a text reminder sent 3 days following kit dispatch; (2) another text reminder sent 7 days after dispatch. We reworded both messages and identified an additional opportunity for communication. The majority of individuals complete and return the kit the day they receive it and we therefore trialled an additional primer message sent prior to the kit's arrival.

This was an RCT with a 2×2 factorial design (Fig. 1). Eligible individuals who ordered a kit were randomized by the provider into one of four trial arms (1:1:1:1):

- (1) control (standard reminders);
- (2) primer + standard reminders;
- (3) BI reminders (no primer);
- (4) primer + BI reminders.

Message development

Message development was informed by feedback left on the service provider's website, reviewing the existing literature [6,8–14] and the results of a service evaluation questionnaire we carried out between 27 September and 31 October 2016. The questionnaire link, including the offer of a prize draw for a £100 Amazon voucher, was sent in a text message to service users who had ordered the self-sampling kit > 3 weeks ago but had not returned it (the survey questions are presented in the Appendix). A total of 478 responses were received.

Mapping behaviours onto the COM-B model

The COM-B ('capability', 'opportunity', 'motivation' and 'behaviour') model breaks behaviour down into physical and psychological capability, physical and social opportunity, and reflective and automatic motivation [15]. We analysed the survey responses using the COM-B framework to explore the barriers service users faced. People reported barriers to physical opportunity, for example being away from home, while social opportunity was less of an issue, with around 60% agreeing that most people similar to them were getting tested for HIV. Ninety-five per cent of survey respondents agreed that it was important for them to know if they had HIV, indicating that they had the reflective motivation required to test, yet they still did not return their samples. Many people were too busy, did not have enough time or simply just forgot to complete the test, suggesting that there were also barriers to automatic motivation, and that primer and reminder messages could help improve the return rate. As we suspected, the most common reason (given by > 200 people) for not returning the kit was difficulty in drawing the blood sample. As well as this physical capability barrier, 1 in 5 respondents found the instructions difficult to follow, suggesting that psychological capability was also important. We therefore wanted our intervention to make the process of collecting the blood for the sample seem easier and to improve self-efficacy.

Primer

The primer message was designed to act as a 'planning prompt' to set aside time to complete the test and return the kit. Individuals who plan ahead are more likely to

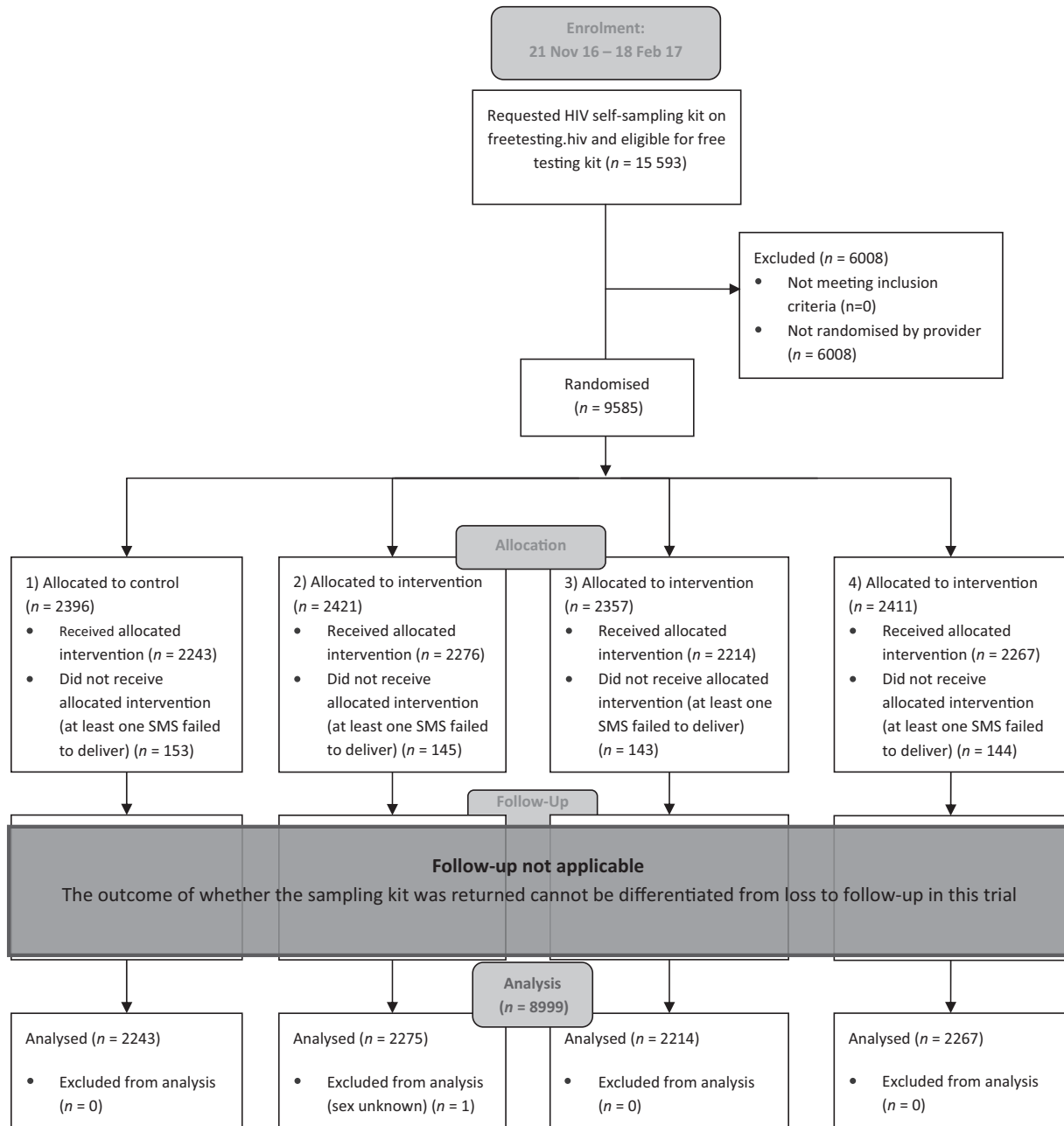


Fig. 1 Participant flow diagram. SMS, short message service. Follow-up not applicable: The outcome of whether the sampling kit was returned cannot be differentiated from loss to follow-up in this trial.

complete a behaviour [16,17]. The primer also aimed to build self-efficacy by providing a ‘top tip’.

BI reminders

The first reminder message was designed to evoke reciprocity with ‘we have already paid’ as people are more likely to complete a behaviour if they believe someone has

given them something first [18]. Friction costs are seemingly irrelevant details that make tasks marginally more effortful but disproportionately discourage action [19–21]. By reminding service users that postage has already been paid, this message also makes returning the kit seem more achievable. The second reminder was designed to act as a prompt to return the kit. It included a deadline and kit

expiry date, urging action in the moment rather than an 'I'll do it later' mind-set [22,23].

The exact wording of the messages in the four intervention conditions is shown in Supporting Information Table S1.

Participants

Participants were individuals who ordered an HIV self-sampling kit from www.freetesting.hiv between 21 November 2016 and 18 February 2017 and who were eligible to receive a free kit from the national HIV self-sampling service. Men who have sex with men (MSM) and black African heterosexuals are the groups primarily targeted by the national HIV self-sampling service, but free kits are available to anyone in a 'higher risk' category, including anyone aged ≥ 16 years who: (1) was born in a country with high rates of HIV infection, (2) has ever injected drugs, (3) has ever paid/been paid to have sex, or (4) has had condomless sex with anyone in the above-mentioned groups, including MSM/black Africans. Eligible individuals were sent a kit to their home address free of charge and were provided with a freepost envelope to return their sample.

This study received ethical clearance from the PHE Research Ethics and Governance Group (R&D 300).

Outcomes

The primary outcome was the percentage of kits returned according to intervention combination. The secondary outcomes were kit return rates by age, sexual behaviour and gender identity, ethnicity and deprivation. Kit return was measured at the end of the trial period, while sociodemographic factors were captured as part of the online registration for the service.

Sample size

Based on the number of kits ordered in the previous year, we expected to have a sample of approximately 16 000 individuals. Power calculations based on the pre-existing return rate of 51.8% estimated a minimal detectable effect of 3.2%.

Randomization

For pragmatic reasons, this study used a pseudo-randomization process based on the provider's system (based on the Microsoft.NET random number generator). The provider assigned individuals to one of the four trial arms at the time of kit request. Blinding was not possible.

Analysis

Statistical analyses were performed in STATA v13 (Stata-Corp, College Station, Texas, USA). Data were excluded where individuals had no assigned trial arm, SMS delivery failed at least once or sex was unknown. We used publicly available census data to create variables for region and deprivation based on Lower Super Output Area codes [24–26] and used χ^2 tests to determine whether these and other sociodemographics and risk behaviours were distributed evenly across intervention groups.

Kit return rate was calculated for each intervention combination and we used logistic regression to investigate the main effect of the primer and BI reminders and their interaction and to compare across trial arms. We adjusted for age, sexual behaviour and gender identity, ethnicity and deprivation as a robustness check and also explored how these key sociodemographic characteristics were associated with kit return in their own right.

Results

Descriptives

The trial began on 21 November 2016 and ended on 18 February 2017 as this is when we met the sample size specification to enable analysis. As shown in Figure 1, 15 593 people requested a kit during the trial period. However, at the data analysis stage, we realized that, as a consequence of a data collection error, 6008 individuals could not be included in our analyses as they had not been randomized to one of the trial arms. Unfortunately, we were unable to extend the trial to increase our sample size, which meant we were underpowered for some of our analyses. A further 585 individuals were excluded because of message delivery failure. One person was removed as their sex was unknown. Of the 8999 people included in the analysis, 4542 received the primer message on day 1 and 4481 received the BI reminders on days 3 and 7. The numbers in each intervention combination are shown in Figure 1.

Table 1 shows that the majority of participants were aged 16–34 years (71.95%) and two-thirds were MSM. The largest ethnic group was white (76.42%), and 55.48% of participants were in the lowest two quintiles of deprivation. Participant sociodemographic and behavioural characteristics were similar across intervention groups. Only region and drug use varied slightly but, given the multiple balance checks carried out, this probably occurred by chance.

Table 1 Baseline sociodemographic characteristics and risk behaviours by intervention group

	No primer (<i>n</i> = 4457) <i>n</i> (%)	Primer (<i>n</i> = 4542) <i>n</i> (%)	Standard reminders (<i>n</i> = 4518) <i>n</i> (%)	BI reminders (<i>n</i> = 4481) <i>n</i> (%)	Total (<i>n</i> = 8999) <i>n</i> (%)
Age group					
16–24 years	1561 (35.02)	1686 (37.12)	1616 (35.77)	1631 (36.4)	3247 (36.08)
25–34 years	1631 (36.59)	1597 (35.16)	1641 (36.32)	1587 (35.42)	3228 (35.87)
35–49 years	912 (20.46)	942 (20.74)	927 (20.52)	927 (20.69)	1854 (20.6)
50–64 years	311 (6.98)	285 (6.27)	298 (6.60)	298 (6.65)	596 (6.62)
≥ 65 years	42 (0.94)	32 (0.70)	36 (0.80)	38 (0.85)	74 (0.82)
Ethnic group					
White	3377 (75.77)	3500 (77.06)	3480 (77.03)	3397 (75.81)	6877 (76.42)
Black African	456 (10.23)	448 (9.86)	459 (10.16)	445 (9.93)	904 (10.05)
Black other	271 (6.08)	249 (5.48)	234 (5.18)	286 (6.38)	520 (5.78)
Asian	221 (4.96)	237 (5.22)	231 (5.11)	227 (5.07)	458 (5.09)
Other	102 (2.29)	82 (1.81)	86 (1.90)	98 (2.19)	184 (2.04)
Unknown	30 (0.67)	26 (0.57)	28 (0.62)	28 (0.62)	56 (0.62)
Sexual behaviour and gender identity with risk factors for heterosexuals					
MSM	2920 (65.51)	2979 (65.59)	2952 (65.34)	2947 (65.77)	5899 (65.55)
WSW	142 (3.19)	153 (3.37)	136 (3.01)	159 (3.55)	295 (3.28)
Trans	27 (0.61)	30 (0.66)	25 (0.55)	32 (0.71)	57 (0.63)
Trans-female	15 (0.34)	12 (0.26)	13 (0.29)	14 (0.31)	27 (0.30)
Trans-male	12 (0.27)	18 (0.40)	12 (0.27)	18 (0.40)	30 (0.33)
Heterosexuals	1368 (30.69)	1380 (30.38)	1405 (31.1)	1343 (29.97)	2748 (30.54)
Heterosexual women					
Black African	255 (30.00)	249 (29.60)	252 (29.91)	249 (30.55)	501 (29.80)
Born in an HIV endemic country	68 (8.00)	56 (6.74)	69 (7.97)	55 (6.75)	124 (7.38)
Injects drugs*	21 (2.47)	18 (2.17)	13 (1.5)	26 (3.19)*	39 (2.32)
Paid/been paid for sex	54 (6.35)	46 (5.54)	50 (5.77)	50 (6.13)	100 (5.95)
Partner has HIV infection	482 (56.71)	486 (58.48)	521 (60.16)	447 (54.85)	968 (57.58)
Heterosexual men					
Black African	151 (29.15)	163 (29.69)	165 (30.61)	149 (28.22)	314 (29.43)
Born in an HIV endemic country	39 (7.53)	33 (6.01)	35 (6.49)	37 (7.01)	72 (6.75)
Injects drugs	48 (9.27)	49 (8.93)	46 (8.53)	51 (9.66)	97 (9.09)
Paid/been paid for sex	181 (34.94)	200 (36.43)	186 (34.51)	195 (36.93)	381 (35.71)
Partner has HIV infection	187 (36.1)	218 (39.71)	205 (38.03)	200 (37.88)	405 (37.96)
IMD quintile					
1 (most deprived)	1287 (28.88)	1297 (28.56)	1313 (29.06)	1271 (28.36)	2584 (28.71)
2	1175 (26.36)	1234 (27.17)	1218 (26.96)	1191 (26.58)	2409 (26.77)
3	881 (19.77)	875 (19.26)	890 (19.70)	866 (19.33)	1756 (19.51)
4	647 (14.52)	637 (14.02)	615 (13.61)	669 (14.93)	1284 (14.27)
5 (least deprived)	467 (10.48)	499 (10.99)	482 (10.67)	484 (10.80)	966 (10.73)
Last HIV test					
Never tested	1445 (32.42)	1516 (33.38)	1502 (33.24)	1459 (32.56)	2961 (32.9)
Within the last year	1463 (32.82)	1466 (32.28)	1471 (32.56)	1458 (32.54)	2929 (32.55)
Over 1 year ago	1508 (33.83)	1519 (33.44)	1502 (33.24)	1525 (34.03)	3027 (33.64)
Unknown	41 (0.92)	41 (0.90)	43 (0.95)	39 (0.87)	82 (0.91)
Unprotected sex within the last 12 months (number of occasions)					
None	603 (13.53)	645 (14.2)	623 (13.79)	625 (13.95)	1248 (13.87)
1	1797 (40.32)	1814 (39.94)	1799 (39.82)	1812 (40.44)	3611 (40.13)
2–5	1718 (38.55)	1752 (38.57)	1753 (38.8)	1717 (38.32)	3470 (38.56)
6–12	212 (4.76)	213 (4.69)	217 (4.8)	208 (4.64)	425 (4.72)
>12	107 (2.40)	108 (2.38)	108 (2.39)	107 (2.39)	215 (2.39)
Unknown	20 (0.45)	10 (0.22)	18 (0.40)	12 (0.27)	30 (0.33)
Sex under the influence of alcohol or recreational drugs					
Never	1625 (36.46)	1669 (36.75)	1634 (36.17)	1660 (37.05)	3294 (36.6)
Sometimes	2192 (49.18)	2182 (48.04)	2176 (48.16)	2198 (49.05)	4374 (48.61)
Usually	499 (11.2)	515 (11.34)	534 (11.82)	480 (10.71)	1014 (11.27)
Always	110 (2.47)	153 (3.37)	143 (3.17)	120 (2.68)	263 (2.92)
Unknown	31 (0.70)	23 (0.51)	31 (0.69)	23 (0.51)	54 (0.60)
Number of kits ordered previously					
0	4357 (97.76)	4448 (97.93)	4425 (97.94)	4380 (97.75)	8805 (97.84)

Table 1 (Continued)

	No primer (<i>n</i> = 4457) <i>n</i> (%)	Primer (<i>n</i> = 4542) <i>n</i> (%)	Standard reminders (<i>n</i> = 4518) <i>n</i> (%)	BI reminders (<i>n</i> = 4481) <i>n</i> (%)	Total (<i>n</i> = 8999) <i>n</i> (%)
1	100 (2.24)	92 (2.03)	93 (2.06)	99 (2.21)	192 (2.13)
2	0 (0.00)	2 (0.04)	0 (0.00)	2 (0.04)	2 (0.02)
Region [†]					
London	1113 (24.97)	1116 (24.57)	1123 (24.86)	1106 (24.68)	2229 (24.77)
East	432 (9.69)	454 (10)	460 (10.18)	426 (9.51)	886 (9.85)
East Midlands	326 (7.31)	392 (8.63)	358 (7.92)	360 (8.03)	718 (7.98)
North East	197 (4.42)	207 (4.56)	205 (4.54)	199 (4.44)	404 (4.49)
North West	663 (14.88)	654 (14.4)	669 (14.81)	648 (14.46)	1317 (14.63)
South East	640 (14.36)	688 (15.15)	651 (14.41)	677 (15.11)	1328 (14.76)
South West	370 (8.30)	317 (6.98)	344 (7.61)	343 (7.65)	687 (7.63)
West Midlands	363 (8.14)	317 (6.98)	348 (7.70)	332 (7.41)	680 (7.56)
Yorkshire and The Humber	353 (7.92)	397 (8.74)	360 (7.97)	390 (8.70)	750 (8.33)

Service user data are for the trial period only. Balance checks are across interventions, comparing distribution of sociodemographics and risk factors for each intervention separately. Most variables are balanced across intervention groups.

BI, behavioural insights; IMD, Index of Multiple Deprivation; MSM, men who have sex with men; WSW, women who have sex with women.

[†]Injects drugs was unbalanced only by receipt of the behavioural insights reminders among heterosexual women ($P = 0.016$).

[‡]Region was unbalanced by receipt of the primer intervention ($P = 0.024$). This probably occurred by chance and intervention groups are therefore considered balanced in all respects.

Table 2 Kit return rate by intervention combination

	Percentage of kits returned (95% CI) [<i>n</i>]		
	No primer	Primer	Marginal total
Standard reminders	(1) 52.39 (50.31–54.45) [2243]	(2) 52.92 (50.87–54.97) [2275]	52.66 (51.20–54.11) [4518]
BI reminders	(3) 55.19 (53.11–57.26) [2214]	(4) 56.29 (54.23–58.32) [2267]	55.75 (54.29–57.20) [4481]
Marginal total	53.78 (52.31–55.24) [4457]	54.60 (53.15–56.05) [4542]	54.19 (53.16–55.22) [8999]

The numbers in bold correspond to trial arms. χ^2 for difference between trial arms $P = 0.025$.

BI, behavioural insights; CI, confidence interval.

Table 3 Comparison of kit return between trial arms and interventions

(a) Trial arms	(1) No primer + standard reminders	(2) Primer + standard reminders	(3) No primer + BI reminders	(4) Primer + BI reminders
(1) No primer + standard reminders	–	–	–	–
(2) Primer + standard reminders	1.02 (0.91–1.15)	0.717	–	–
(3) No primer + BI reminders	1.12 (1.00–1.32)	0.060	1.10 (0.97–1.23)	0.127
(4) Primer + BI reminders	1.17 (1.04–1.32)	0.009	1.15 (1.02–1.29)	0.023
(b) Interventions*				
Primer (2 + 4) vs. no primer (1 + 3)	1.03 (0.95–1.12)	0.438	–	–
BI reminders (3 + 4) vs. standard reminders (1 + 2)	1.13 (1.04–1.23)	0.003	–	–

Values are unadjusted results from logistic regressions. $n = 8999$. Numbers represent unadjusted odds ratios (95% confidence intervals) and P -values. Odds ratios > 1 represent a favourable outcome for the relevant trial arm (a: vertical compared to horizontal) or intervention (b). Significant values are shown in bold.

BI, behavioural insights.

*Adjusted for factorial design: comparisons are for the intervention compared with its respective control. The results did not differ when the model was adjusted for other participant characteristics (see Tables S2 and S3 for adjusted results). The interaction between the interventions was insignificant (interaction coefficient = 1.02; 95% CI 0.87 to 1.21; $P = 0.789$).

Kit return by intervention

The overall kit return rate was 54.19% (Table 2). The rate varied from 52.39% for those who received neither intervention, to 56.29% for those who received both the primer and the BI versions of the reminder messages.

Univariate logistic regression results (Table 3) show that the return rate was higher in all three intervention arms compared with the control, but only statistically significantly so for the fourth trial arm. This combination of both interventions was 1.17 times more effective than the control [95% confidence interval (CI) 1.04–1.32].

Table 4 Percentage of kits returned and odds of kit return by key sociodemographics

	Kits returned		Unadjusted univariate analysis		Adjusted multivariable analysis*	
	<i>n</i> (%)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	AOR (95% CI)	<i>P</i> -value
Age group						
16–24 years	1680 (51.74)	<0.001	1.00 (ref.)	<0.001		<0.001
25–34 years	1710 (52.97)		1.05 (0.95–1.16)	0.320	1.01 (0.91–1.11)	0.922
35–49 years	1046 (56.42)		1.21 (1.08–1.35)	0.001	1.16 (1.04–1.31)	0.011
50–64 years	385 (64.60)		1.70 (1.42–2.04)	<0.001	1.54 (1.23–1.85)	<0.001
≥ 65 years	56 (75.68)		2.90 (1.70–4.96)	<0.001	2.41 (1.41–4.12)	0.001
Sexual behaviour and gender identity						
MSM	3450 (58.48)	<0.001	1.00 (ref.)	<0.001	1.00 (ref.)	<0.001
Heterosexuals	1279 (46.54)		0.62 (0.56–0.68)	<0.001	–	–
Heterosexual women	776 (46.16)		0.61 (0.55–0.68)	<0.001	0.65 (0.57–0.73)	<0.001
Heterosexual men	503 (47.14)		0.63 (0.56–0.72)	<0.001	0.65 (0.56–0.74)	<0.001
WSW	133 (45.08)		0.58 (0.46–0.74)	<0.001	0.63 (0.50–0.80)	<0.001
Trans	15 (26.32)		0.25 (0.14–0.46)	<0.001	–	–
Trans-female	8 (29.63)		0.30 (0.13–0.68)	0.004	0.32 (0.14–0.73)	0.007
Trans-male	7 (23.33)		0.22 (0.09–0.50)	<0.001	0.22 (0.09–0.52)	<0.001
Ethnic group						
White	3831 (55.71)	<0.001	1.00 (ref.)	<0.001	1.00 (ref.)	0.006
Black African	443 (49.00)		0.76 (0.67–0.88)	<0.001	1.06 (0.90–1.24)	0.493
Black other	219 (42.12)		0.58 (0.48–0.69)	<0.001	0.75 (0.62–0.90)	0.002
Asian	245 (53.49)		0.92 (0.76–1.11)	0.356	1.02 (0.84–1.24)	0.837
Other	99 (53.8)		0.93 (0.69–1.24)	0.608	1.00 (0.75–1.35)	0.983
Unknown	40 (71.43)		1.99 (1.11–3.56)	0.021	2.00 (1.11–3.58)	0.020
IMD quintile						
1 (most deprived)	1338 (51.78)	0.006	1.00 (ref.)	0.006	1.00 (ref.)	0.242
2	1297 (53.84)		1.09 (0.97–1.21)	0.145	1.06 (0.95–1.19)	0.325
3	955 (54.38)		1.11 (0.98–1.25)	0.092	1.07 (0.95–1.21)	0.289
4	739 (57.55)		1.26 (1.10–1.45)	0.001	1.16 (1.01–1.33)	0.035
5 (least deprived)	548 (56.73)		1.22 (1.05–1.42)	0.009	1.13 (0.97–1.32)	0.108

N = 8999. Significant values are shown in bold.

AOR, adjusted odds ratio; CI, confidence interval; MSM, men who have sex with men; OR, odds ratio; ref., reference; WSW, women who have sex with women.

*Adjusted for interventions (intervention coefficients not shown as presented in Table 3 and Table S2), and other sociodemographic characteristics: age, sexual behaviour and gender identity, ethnicity and Index of Multiple Deprivation (IMD).

We found strong evidence for an independent positive effect of the BI reminders on kit return rate but no evidence for an independent effect of the primer. We found no evidence of an interaction between the interventions (interaction coefficient 1.02; 95% CI 0.87–1.21; *P* = 0.789), suggesting that their effects were additive rather than multiplicative (although we were underpowered to test for an interaction). Effects did not vary greatly after adjusting for age, sexual behaviour and gender identity, ethnicity and deprivation (Table S2).

Kit return by sociodemographic characteristics

As shown in Table 4, odds of kit return varied significantly by age, sexual behaviour and gender identity, ethnic group and deprivation in unadjusted analyses, and by all of these characteristics except for deprivation once the interventions had been controlled for. The likelihood of returning the kit increased with age, and service users aged ≥ 65 years were almost 2.5 times more likely to return the kit than those aged 25–34 years [odds ratio

(OR) 2.41; 95% CI 1.41–4.12]. MSM were 1.5–4.5 times more likely to return the kit compared with other sexual behaviour and gender identity groups, with trans-male individuals being the least likely to return the kit (OR 0.22; 95% CI 0.09–0.52). Non-African black clients were 25% less likely (OR 0.75; 95% CI 0.62–0.90) and those of unknown ethnicity were twice as likely (OR 2.00; 95% CI 1.11–3.58) to return the kit compared with other ethnicities.

Discussion

Our trial showed that the addition of BI to text messages was effective in improving the kit return rate. To our knowledge, this is the first study investigating how behaviourally informed SMS primers and reminders could be used to improve the return rate of HIV self-sample kits.

Mobile technologies are an increasing part of health care. A recent systematic review of mobile health behavioural interventions to improve uptake of HIV testing found that more than half of the studies reported a

significant increase in HIV testing [27]. Not all of these were text message based, however, and the behaviour targeted differed slightly from that in the present study. In contrast to targeting individuals who may not have already made the choice to test, the text messages in our trial targeted people who had already decided to test, and aimed to encourage them to both complete the test and return it. Our study therefore builds on this research by targeting different users, who demonstrate their intention to test, but may lack the capability or motivation to complete the behaviours required.

While other mobile technologies may be more effective [27], we chose to use SMS as our mode of intervention delivery because this allowed the trial to be easily incorporated into the existing service. As recent meta-analyses have shown, text messages have been helpful in the provision of HIV treatment, increasing adherence to medication, reducing nonattendance and increasing retention in HIV care [28,29]. The effect size in our study was, however, relatively small in comparison to those found in SMS interventions for other components of HIV care. For example, HIV-infected patients who received text reminders for their follow-up appointments were two times more likely to return to care than those who did not receive reminders [29]. HIV testing focused SMS interventions have also found much larger effect sizes than in the present study. For example, reminders increased re-testing rates four-fold in an Australian study [6] but our largest OR was only 1.17 (trial arm 4 vs. 1). This is probably attributable to differences in comparators. Our control group still received reminders, whereas people who received reminders in other studies were often compared with people who received no messages at all.

We did not find any evidence to suggest that the primer message had a positive independent effect on kit return in our study. Research in a UK sexual health clinic found that simply sending SMS messages to patients to encourage re-attendance had no effect [30] but that the addition of a more personalized message with a patient's name resulted in higher rates of re-attendance [31]. In contrast, names were already included in the standard service in our study, which may explain the lack of the effect we observed. We believe that our null finding is attributable to having a smaller sample size than anticipated, meaning that we were underpowered to detect significance, although the effect was still in the predicted direction. Our small sample size may also explain why we found no evidence for an interaction between the primer and BI reminder messages.

A recent systematic review emphasized the importance of identifying the minimally effective dosage of text message-based HIV testing interventions [27]. Our trial

participants received either two or three messages; it is possible that the return rate could be further improved if more messages are sent out [32]. Getting the number of texts right is important in order to avoid irritating service users [33]. We did not collect any data on the acceptability of the intervention, but receiving two or three messages is unlikely to have caused annoyance.

The content of the messages is probably even more important than the number of messages received. We only know of one study that compared the effectiveness of various types of text message formats and it compared informational with motivational content [32]. Our study compared existing service text messages with messages that had been tweaked to include insights from behavioural science. Both the standard service messages and the intervention messages provided informational and motivational content, but the specific content of the intervention messages was adapted to include the BI techniques of planning prompts, reducing friction costs, implementing deadlines and encouraging self-efficacy and reciprocity. Although the 2×2 factorial design enabled us to investigate the independent effects of receiving the primer and the reminder messages, we are unable to say which specific BI techniques were responsible for the effects seen.

While the content of our messages may have improved knowledge of the testing process and encouraged self-efficacy, one important barrier we did not address is the fear of knowing one's HIV status. Further message development could consider including reassurance and links to advice and support for those who are concerned about testing positive, as was suggested in qualitative work with African communities in the UK [33].

The national self-sampling service attracts a mixed group of clients and it could be that some sociodemographic groups responded more favourably to the intervention messages than others. We were underpowered to check for such interactions, but we expect that adjusting messages according to recipient characteristics would further improve the return rate. Qualitative work with African communities in the UK and black MSM in the USA has suggested that messages should be personalized and tailored to the recipient so that information is delivered in a culturally appropriate, locally relevant and supportive manner [33–35]. The individual's first name was included in the messages, but we did not tailor content further to take account of other sociodemographic characteristics of the individual. This would require researching and developing new message content for each group, and would be a time- and resource-intensive process [33].

There were a couple of issues that may have affected the generalizability of our results. Those individuals who

declined to take part in future research were not randomized. We compared them to those who were randomized and noted that they tended to be younger, and were more likely to be heterosexual and to live in less deprived areas. There was also a greater proportion of Asians in this group and a smaller proportion of black Africans (data not shown). Importantly, they were also more likely to return the kit (55.84% vs. 53.07%; $P = 0.001$). People opting out of future research therefore appeared to be systematically different from those included in our study. Although they had a relatively high return rate, we are unable to say whether receiving the intervention messages would have further improved their likelihood of kit return.

We conducted an on-treatment analysis because we had SMS delivery data. When we compared individuals who did not receive all messages with those that did, we found that they differed significantly in terms of age, sexual behaviour and gender identity, and various risk factors. They also had a lower rate of kit return (35.90% vs. 54.19%; $P < 0.001$; data not shown). Running an intention-to-treat analysis (i.e. not accounting for successful message delivery) did not, however, affect our results: effect sizes changed very little and the significance and direction of associations did not change. Again, we can only speculate that their return rate would have improved if they had received all of the intervention messages.

Conclusion

The group receiving both interventions had a return rate 3.9% higher than the group that only received the standard messages. Within the field of BI we know that small changes can have large effects. While the absolute percentage is small, this trivial change to an existing system has the potential to impact thousands of individuals, with little to no additional cost. A 3.9% improvement to a service that has approximately 40 000 users a year [36] would translate to 1500 additional test kits completed and return. The provider decided to implement the fourth trial arm messages in mid-May 2017 as a result of the findings of this trial, and continues to monitor the return rate to see if there is an impact on the overall service. Our results show that small but significant improvements can be made with simple low-cost interventions, and we therefore recommend that BI should be considered for inclusion in other similar health care services.

Acknowledgements

The study was registered with researchregistry.com (trial registration number: researchregistry1963). PHE covered the costs of the HIV self-sampling kits from 21 November

2016 to 10 January 2017. The authors wish to thank Tim Alston from Preventx (the service provider) for collecting and providing the trial data. HIV self-sampling steering group: Peter Taylor, Simon How, Louise Logan, John Dunn, Noel Gill, Carol Ford, Tim Alston, Robert Carroll, Stephen Jones, Kirsty Foster, Lesley Talbot, Helen Robinson, Stephen Nicholson and Tony Lacey.

Conflicts of interest: There are no conflicts of interest.

Financial disclosure: All funding came from Public Health England (PHE).

Author contributions

LJB planned the analysis, cleaned and analysed the data and wrote the draft manuscript. KST played a key role in conceiving the study, developed the intervention content, designed the trial, contributed to the analysis plan and the draft manuscript and provided critical review of the draft manuscript. LEG played a key role in conceiving the study, provided insight into the national self-sampling service, contributed to the analysis plan and provided critical review of the draft manuscript. CJN conceived the study and brought together the PHE team and the service providers so it could happen and conducted the nonreturner survey. AN played a key role in conceiving the study, provided insight into the national self-sampling service, contributed to the analysis plan and provided critical review of the draft manuscript.

Appendix 1: The nonreturner survey

Action 1: text message

Original message

Hi [First Name], we noticed that you have not yet returned your test. Please help us improve services in your local area by completing a 5-minute, confidential survey. All participants who complete the survey will be entered into a draw to win £100 voucher to Amazon.co.uk.

Click here to begin.

Message sent after low response

Hi [First Name], we see you haven't returned your test kit ([PX Code]). Be entered to win a

£100 Amazon gift voucher by filling out this quick, confidential survey at [http://test.hiv/s/\[ID Number\]](http://test.hiv/s/[ID Number])

Action 2: survey questions

(1) Why did you request the test (tick all that apply)?

- a) I know that it is important to be aware of my HIV status (knowledge)
- b) Knowing about my health is important
- c) People who are important to me have been tested for HIV (or have HIV)
- d) Not knowing my HIV status makes me feel nervous
- e) I saw advertising for HIV testing
- f) Other (please state)

(2) How easy or difficult did you think it would be to complete and return the HIV testing kit prior to receiving it?

Very easy	Somewhat easy	Somewhat difficult	Very difficult
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(3) How easy or difficult did you find the instructions for completing the test kit after receiving it?

Very easy	Somewhat easy	Somewhat difficult	Very difficult	Did not read instructions
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(4) What were your reasons for not returning the test to us (tick all that apply)?

- a) I did not receive a test
- b) I got tested elsewhere
- c) I found it too difficult to draw the blood sample
- d) I decided I did not want to send the blood sample to the laboratory for testing
- e) I lost the test
- f) People who are important to me got tested and do not have HIV
- g) I am worried about the consequences of having HIV
- h) Other (please state)

(5) Do you still have the test available for you to use?

- a) Yes (go to q7)
- b) No (go to q6)

(6) When did you dispose of the test kit?

- a) Immediately

- b) Within 3–7 days of receiving it
- c) Within a week to a fortnight of receiving it
- d) Over a fortnight after receiving it
- e) I can't remember

(7) Please indicate how strongly you agree or disagree with the following statement:

- a) I intend to get tested for HIV in the next 3 months

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
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- b) Most people who are important to me think that I should get tested for HIV

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
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- c) For me, it is important that I know if I have HIV

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
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- d) I would recommend my friends/family use the online test service

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
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- e) Most people similar to me are getting tested for HIV

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
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Action 3: thank you and new kit reminder

Thank you for taking part in the survey. Your information will help us to improve the service. If you would like to order another kit please go to www.freetesting.hiv

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Control and intervention conditions.

Table S2. Comparison of kit return between trial arms and interventions.

CONSORT Checklist.