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Uptake and Impact of Short Message Service Reminders via Sexually Transmitted Infection Partner Services on Human Immunodeficiency Virus/Sexually Transmitted Infection Testing Frequency Among Men Who Have Sex With Men

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Abstract

Background: Sexually transmitted infection (STI) partner services (PS) allow provision of human immunodeficiency virus (HIV)/STI prevention interventions to high-risk individuals, including testing reminders via short message service (SMS).

Methods: In King County, Washington, PS attempt to reach all men who have sex with men (MSM) with early syphilis and those with gonorrhea or chlamydia as resources allow. Since 2013, PS offered quarterly SMS testing reminders. We evaluated correlates of reminder uptake and the association between reminder uptake and postinterview asymptomatic STI diagnosis using Poisson regression, and the association between preinterview SMS reminder use and intertest interval among HIV-negative MSM using median regression.

Results: During July 1, 2013 to January 17, 2018, 8236 MSM were reported with 1 or more STI diagnoses and 5237 received PS interviews. Of these, 4087 (78%) were offered SMS reminders; 545 (13%) accepted, 265 (7%) were already receiving SMS, 3277 (80%) refused. Of 2602 patients who refused and were asked about other reminders, 37% used none, 16% received reminders from medical providers, 20% tested at routine physicals, and 26% used other reminders. SMS reminder use before and after PS interview was associated with negative HIV status, younger age, and diagnosis with gonorrhea or chlamydia (vs. syphilis) ($P < 0.05$ for all). Preinterview intertest interval was longer among MSM testing at physicals (9.6 months) than those using no reminder (5.6), SMS reminders (4.7, $P < 0.05$ vs. physicals), and non-SMS reminders (3.6, $P < 0.001$ vs. SMS). Reminder uptake was not associated with postinterview STI diagnosis.

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Conclusions: Offering SMS reminders through STI PS is feasible. Uptake was low, but higher among young MSM not on preexposure prophylaxis. The SMS reminders may increase testing frequency.

The US burden of bacterial sexually transmitted infections (STIs) (syphilis, chlamydia, and gonorrhea) and human immunodeficiency virus (HIV) is concentrated in men who have sex with men (MSM). Although they make up 2% of the US population, MSM experienced 68.2% of the 30,644 cases of primary and secondary syphilis in 2017,[1] and 67% of the 40,324 new HIV diagnoses in 2016.[2] Centers for Disease Control and Prevention guidelines recommend that MSM test at least annually for syphilis, chlamydia, gonorrhea, and HIV, to enable timely linkage to care and prevention of future transmission. More frequent HIV and STI testing, every 3 to 6 months, is recommended for MSM with a prior STI or HIV diagnosis, or those taking HIV preexposure prophylaxis (PrEP).[3,4] Promoting regular STI and HIV testing of individuals at risk is a high priority for HIV/STI prevention and control efforts. Mathematical models suggest that increasing HIV/STI testing frequency could decrease the incidence of several infections.[5–7]

STI partner services (PS) present an opportunity to link all individuals diagnosed with STIs —who are at elevated risk of subsequent infection—to prevention services, including regular testing for STIs and HIV.[8] How to most effectively promote testing is unclear. One promising and affordable approach to increase HIV/STI testing frequency is the use of automated SMS reminders. The vast majority of Americans (95%) own a mobile phone and have access to SMS communication; access is highest among people aged 18 to 29 years (100%), lowest among those age 65 years and older, and varies little by race and ethnicity (98%, 97%, and 94% among black, Hispanic, and white, respectively).[9] SMS interventions have been shown to improve retention in care and medication adherence in people living with HIV.[10–12] Data on the impact of SMS reminders on HIV/STI testing are less conclusive.[13,14] Increased HIV or STI testing rates have been reported in recipients of SMS reminders in observational pre-post studies,[15–18] a quasi-experimental study,[19] and randomized studies[20,21]; however, one pre-post study[22] did not detect any impact of SMS reminders on testing. Additionally, prior studies have not examined client characteristics associated with SMS reminder uptake, leaving open the question of which client populations are most likely to take up and benefit from this intervention if offered in public health practice.

Since July 2013, PS in King County, Washington, have offered quarterly SMS reminders for HIV and STI testing to MSM diagnosed with early syphilis, gonorrhea, and/or chlamydia. This initiative was delivered as part of a broader effort to leverage STI PS for HIV prevention in Washington State, where greater than 70% of people living with HIV are MSM.[23,24] In this program evaluation, we present data on uptake of SMS testing reminders offered through STI PS and their impact on HIV/STI testing frequency.

MATERIALS AND METHODS

STI Case Reporting

Medical providers in Washington State are legally required to complete a case report for each person they diagnose with syphilis, gonorrhea, or chlamydia. Clinical laboratories are also required to report these infections, and public health staff follow-up on laboratory-reported cases to ensure case reports are complete. The case report includes gender of sex partners and anatomical site of gonococcal and chlamydial infection, allowing health departments to identify MSM.

Partner Services SMS Reminder Intervention

Since 2012, PS in King County, Washington, have attempted to reach all MSM with early syphilis and those with gonorrhea or chlamydia as resources allow. Resource allocation was based on available funding, with priority given to untreated individuals and those who could be linked with other services offered by the public health department. In July 2013, PS began offering quarterly SMS testing reminders to interviewed MSM, using an external vendor, 2SMS[25]; HIV-positive MSM were offered STI testing reminders, and HIV-negative MSM were offered HIV/STI testing reminders. The computer-based questionnaire used for data collection in the PS interview displayed a standardized script to prompt the PS interviewer to offer SMS reminders. The content of the SMS reminders was: “It’s time for your follow-up testing at Harborview” (Harborview is a large county hospital with several outpatient clinics, including an HIV clinic and the county STD clinic). From February 2014, men who refused SMS were asked if they used another type of reminder.

Study Population and Data Sources

This analysis used STI surveillance and PS data, matched to the Washington State Enhanced HIV/acquired immune deficiency syndrome Reporting System. The analysis was restricted to MSM, defined as individuals identified as cis or trans male gender in their case report form or PS interview, and who met any of the following criteria: (1) they reported sex with men in the prior year during PS interviews, (2) their provider indicated male sex partners on the case report, or (3) they were diagnosed with rectal gonorrhea or rectal chlamydia. The STI diagnoses between July 1, 2013, and January 17, 2018. All activities were part of public health program evaluation and therefore not considered human subjects research.

Statistical Analysis

We conducted analyses to determine (1) the level and correlates of SMS reminder use at and before PS interviews, and (2) the effect of SMS reminder use on HIV/STI testing frequency.

We identified correlates of SMS use before PS interview and correlates of SMS acceptance at PS interview using Poisson regression with robust standard errors. For clients with multiple PS interviews at which they were offered SMS reminders, only the first response was included in all analyses to standardize the exposure definition in all clients to 1 offer of SMS reminders. Thirty-two individuals who initially refused SMS reminders subsequently accepted them; these are counted as refused in this analysis. Univariable and multivariable

analyses were conducted; all variables significantly associated with SMS use/acceptance in univariable analysis at a *P* value of 0.1 or less were included in the multivariable model.

We assessed the effect of SMS reminders on testing through two approaches: (1) association between SMS reminder use and testing frequency before PS interview, and (2) association between acceptance of SMS reminders at PS interview and *subsequent* testing.

We determined the association between SMS reminder use before PS interview and time from most recent HIV test to the current STI diagnosis using median regression. Time from last HIV test was used as a proxy for HIV and STI testing frequency and was determined based on client self-report in the PS interview.[26,27] Data on past bacterial STI testing were not available, but last HIV test was chosen as a proxy based on the observation that HIV testing among MSM diagnosed with bacterial STIs is near universal in King County.[28] This analysis was restricted to HIV-uninfected men diagnosed with an asymptomatic STI. Asymptomatic STIs were defined as rectal or pharyngeal chlamydia or gonorrhea, urethral chlamydia without symptoms, or early latent syphilis. Site of infection was based on case report; symptoms were based on case report and PS interview. Analysis was restricted to asymptomatic STIs because symptoms would be expected to influence care seeking and restricted to HIV-uninfected men because HIV-infected men would not be expected to test routinely for HIV. This analysis was additionally restricted to diagnoses after February 1, 2014, when data on non-SMS reminder use began being collected. Unadjusted and adjusted analyses were conducted; all variables identified as univariable correlates of SMS reminder use before PS interview at a *P* value of 0.1 or less were included in the adjusted analysis.[29]

We determined the association between SMS reminder uptake at PS interview and subsequent diagnosis with an asymptomatic STI within 1 to 12 months after the initial STI diagnosis, using Poisson regression with robust standard errors. This analysis was restricted to asymptomatic STIs because symptoms would be expected to influence care seeking. This analysis was also restricted to initial diagnoses before January 17, 2017 (1 year before data freeze) to allow all cases equal opportunity to experience the outcome. Unadjusted and adjusted analyses were conducted; all variables identified as univariable correlates of SMS reminder uptake at PS interview at a *P* value of 0.1 or less were included in the adjusted analysis.

All analyses were conducted in Stata version 13 (College Station, TX). A *P* value cutoff of 0.05 was used to determine statistical significance.

RESULTS

Participant Characteristics

Between July 1, 2013, and January 17, 2018, medical providers and laboratories reported cases of bacterial STI in 8236 unique MSM in King County. Of these, public health staff interviewed 5237 (64%) MSM for PS, and offered 4087 (78%) of them SMS reminders. Proportions interviewed by PS were similar across race and age groups, but varied by STI and HIV status: 76% of syphilis cases were interviewed compared with 36% of chlamydia cases, and 98% of HIV-negative compared with 51% of HIV-positive cases. Table 1

summarizes the demographic characteristics of MSM offered SMS reminders. Most men were white (62%) or Hispanic/Latinx (18%) and younger than 35 years (62%). Four hundred sixty (11%) cases were diagnosed with early syphilis (with or without other STIs), 2380 (58%) with gonorrhea in the absence of early syphilis, and 1247 (31%) with chlamydia alone. Around a quarter of participants (24%) were known to be living with HIV, and 30% of HIV-uninfected men were using PrEP.

Uptake and Prior Use of SMS Reminders

Among 4087 MSM offered SMS testing reminders during PS interviews, 545 (13%) accepted (Fig. 1). Two hundred sixty-five men (7%) were already receiving SMS reminders for HIV/STI testing through enrollment outside of PS (from community organizations or websites), and the remaining 3277 (80%) refused. Of those who refused, 2602 were asked what, if any, non-SMS reminder systems they were using to prompt them to test for HIV/STI. Approximately a quarter (679, 26%) used reminders, such as smartphone apps, calendar reminders, notes to self, or other un-specified methods; 531 (20%) tested as part of HIV well-care visits or routine physical examinations; 425 (16%) were reminded to test by health care providers outside of Public Health-Seattle & King County; 967 (37%) had no reminder in place.

Table 2 summarizes the characteristics associated with already using SMS reminders at the time of initial PS interview through enrollment from another source. In univariable analysis, already using SMS reminders was associated with younger age (9% of men ≤24 years old accepted SMS reminders vs. 3% of men ≥45 years old), diagnosis by an HIV/STI specialist provider (defined as an STI clinic, HIV/STI testing program, or medical provider specializing in HIV or STI care or MSM health; 9% uptake among those diagnosed by a specialist vs. 2% diagnosed by nonspecialist), and not having health insurance (11% uptake among uninsured vs. 6% among insured). Prior SMS reminder use was associated with type of STI diagnosis: it was highest among men diagnosed with chlamydia only (8% uptake), followed by those diagnosed with gonorrhea (7%), and significantly lower among men diagnosed with syphilis (1%). Reminder use was also associated with HIV status: it was significantly higher among HIV-negative men not using PrEP (8%) than HIV-positive men (1%). There was also a secular decline in SMS reminder use over calendar time (relative risk (RR), 0.81 [0.73–0.89] per calendar year increase). In multivariable regression, use of SMS reminders before PS interview was associated with younger age, nonsyphilis STI diagnosis, negative HIV status, diagnosis by an HIV/STI specialist, and earlier calendar year of diagnosis.

Table 3 summarizes sociodemographic, behavioral, and clinical characteristics associated with uptake of SMS testing reminders offered at PS interview among men who were not already receiving SMS before PS interview. Characteristics associated with SMS reminder uptake at PS interview were similar to those associated with use before PS interview. In univariable analyses, uptake of SMS reminders was associated with younger age (23% of men ≤24 years old accepted SMS reminders vs. 9% of men ≥45 years old) and nonwhite race/ethnicity (12% uptake by white men vs. 18% uptake by men of color). Reminder uptake was highest among men diagnosed with chlamydia only (19% uptake) than those with

gonorrhea (14%) or syphilis (2%). It was also associated with diagnosis by an STI specialist provider (15% uptake among those diagnosed by a specialist vs. 13%), with not having health insurance (23% uptake among uninsured vs. 12%), and with HIV status and PrEP usage (13% uptake among HIV-negative men not using PrEP, 3% among HIV-negative men using PrEP, and 7% among HIV-positive men). There was also a secular decline in SMS uptake over calendar time (RR, 0.56 [0.52–0.60] per calendar year increase). In multivariable regression, SMS reminder uptake remained associated with younger age, STI diagnosis, HIV-negative status not using PrEP, and earlier calendar year of diagnosis ($P < 0.05$ for all).

Association Between SMS Reminder Use and HIV/STI Testing Before PS Interview

We evaluated the association between SMS use before PS interview and time from last negative HIV test to the current STI diagnosis, among HIV-uninfected men diagnosed with an asymptomatic STI. Among 1457 men included in this analysis, 167 (12%) were using SMS reminders, 52 (4%) were tested as part of routine physicals, 724 (50%) used other non-SMS reminder systems, and 514 (35%) had no reminder system in place. Table 4 summarizes the median time since last HIV test by testing reminder. Overall, the median time since last HIV test was 4.1 months (IQR 2.9–7.7). Median time since last HIV test was shortest in men using non-SMS reminders, such as apps, calendar reminders, or reminders from providers outside Public Health-Seattle and King County (3.6 months [2.6–5.7]), followed by those using SMS reminders (4.7 months [3.1–7.7]), no reminder (5.6 months [3.3–10.7]), and physicals (9.6 months [4.0–17.5]). In multivariable analysis adjusted for client characteristics associated with SMS uptake before PS (age, PrEP use, STI, health insurance status, diagnosing provider and calendar year) men using physicals as their reminder had a significantly longer time since last HIV test, compared with men using SMS reminders (β, 4.33 [2.86 to 5.81]). There was a nonsignificant trend for longer time since last test in men using no reminder compared with those using SMS reminders (β = 0.80 [−0.08 to 1.68]).

Association Between SMS Reminder Uptake and Asymptomatic STI Diagnosis After PS Interview

The second measure of association between SMS reminder uptake and testing frequency was repeat diagnosis with an asymptomatic STI 1 to 12 months after initial STI diagnosis. Of 3376 men who were offered SMS reminders and included in this analysis, 759 (23%) had a subsequent asymptomatic STI diagnosis within 1 to 12 months (Table 5). The frequency of subsequent diagnosis with an asymptomatic STI was not significantly associated with SMS reminder uptake at PS interview (19% subsequently diagnosed) or having been enrolled in SMS reminders before PS (25% subsequently diagnosed, $P > 0.05$ for both). Multivariable regression adjusted for variables associated with uptake of SMS reminders (age, race, HIV/PrEP status, STI, health insurance status, diagnosing provider, and calendar year) did not alter the effect estimates.

DISCUSSION

In this analysis of public health programmatic data, we found that offering SMS testing reminders to MSM diagnosed with STIs through PS interviews was feasible, with 80% of clients interviewed between 2013 and 2018 being offered the service. However, SMS reminder uptake was low (13%) and declined over the period of analysis. Most MSM who refused SMS reminders cited having other reminder systems in place. SMS reminder uptake at PS interview was highest in younger MSM, those diagnosed with chlamydia only, and HIV-negative MSM who were not using PrEP. We found that HIV-negative MSM who used SMS reminders before PS interview had a shorter time since last HIV test (used as a proxy for STI testing frequency) compared with those using annual physical examinations as a reminder, and a trend for shorter time compared with those using no reminders. However, postinterview diagnosis with an asymptomatic STI was not associated with SMS reminder use either before or as a result of PS interview.

SMS messaging has been identified as a promising intervention to promote regular HIV/STI testing based on 3 main premises. First, SMS messaging is considered a relatively feasible, affordable intervention that places lower burden on the health system than in-person testing promotion or phone calls. Second, use of mobile technology, which now has almost universal penetration in the US,[9] has been proposed to be effective at reaching communities underserved by clinic-based contact with the health system.[30] This approach may therefore enable greater promotion of HIV/STI testing among hard-to-reach populations, who may also be the populations at highest risk of HIV/STI acquisition. Finally, several studies have found that SMS messaging improves medication adherence among patients diagnosed with HIV and other chronic diseases.[10–12] Fewer data exist on the impact of SMS messaging on HIV/STI testing,[13,14] but small studies have suggested some benefit.[15–21]

Our findings speak to each of these premises. Consistent with prior studies,[15–18,22] we found that offering SMS testing reminders in the context of routine service delivery was feasible. We also found that young age and being HIV-negative and not on PrEP were both independent predictors of SMS reminder up take. The latter is likely explained by individuals who are receiving HIV care or PrEP already receiving regular HIV/STI testing through their ongoing care. Nonwhite race was also associated with uptake in unadjusted analysis. Importantly, young MSM, particularly young MSM of color, and MSM not on PrEP are groups at elevated risk of HIV and STI acquisition and therefore a high priority for promotion of HIV/STI testing.[1] These findings suggest that SMS reminders may preferentially be taken up by populations prioritized in testing promotion, and may therefore be a useful tool in addressing disparities in health system engagement. In addition, uptake at PS interview and use before interview were both found to differ by STI diagnosis, which may indicate distinct behavioral or network correlates and suggest that different approaches may be needed for MSM with syphilis. Although analysis of correlates of use before PS interview examined factors measured *after* the decision to use SMS reminders, current STI diagnosis is known to be associated with prior diagnosis and risk behavior.[31] The similarity in correlates of SMS reminder uptake at and before PS interview suggests that offering reminders at PS interviews did not target a distinct population from that reached by other SMS reminder initiatives. Notably, although the SMS reminder intervention was feasible and

had higher uptake in priority groups, absolute uptake was relatively low: 13% of all interviewed MSM accepted reminders (23% of MSM ≤24 years), and acceptance declined over the data collection period. Roughly two thirds of those who refused stated that they had other systems in place to prompt them to test, suggesting that SMS reminders may not have been perceived by most MSM as offering a benefit beyond approaches that they already used.

Our analyses of the impact of SMS reminder use on testing frequency yielded two differing results. Analysis of SMS reminder use and HIV testing before PS interview indicated that SMS reminders were associated with more frequent testing than only testing concurrent with physical examinations. There was also a trend for more frequent testing in SMS users than those with no reminders, but no difference with users of other non-SMS reminders. This suggests that MSM who state they are using annual physical examinations as their reminder or have no testing reminder in place may benefit from targeted promotion of SMS reminders, and messaging that annual physicals do not constitute an adequate reminder system for at-risk MSM. The observational design of this study limited our ability to infer causality; however, our observation of shorter intertest interval when adjusting for client characteristics associated with SMS reminder uptake supports prior studies, suggesting that SMS reminders lead to more frequent testing.[15,17–21] In contrast, we found no association between SMS reminder uptake at PS interview and STI diagnosis *after* it. This analysis was limited by our inability to ascertain testing directly using available data sources; instead, we relied on STI diagnosis data. It is therefore possible that testing frequency was higher among MSM who accepted SMS reminders, but that the underlying STI acquisition risk was lower in this group, impairing our ability to detect the association when evaluating STI diagnoses. Similarly, although a multivariable analysis was conducted adjusting for factors associated with SMS reminder uptake, it is possible that our estimate was residually confounded by other participant characteristics. Additionally, it is important to note that overall testing frequency in this population was high: median time since last HIV test was 4.1 months. This may have limited our statistical power to detect a difference in testing frequency between groups. Evaluation of this approach in contexts with lower baseline testing rates, with prospective ascertainment of testing events, and in a randomized design would be valuable.

The mechanism by which SMS messaging modifies human behavior is unclear. In the context of medication adherence, increasing access to information and building trust and two-way communication between patients and providers are thought to be important.[10] The intervention evaluated in this study was designed as a simple reminder rather than a channel for education or communication with the clinic. Published SMS interventions to promote testing have varied in content, including reminders[15–17,20] or more complex educational content.[19,21] One study reported that personalized messages were more efficacious than generic reminders.[17] Studies suggest that barriers to frequent HIV/STI testing include factors beyond forgetfulness, such as low-risk perception, anticipated stigma, and mis-trust of the medical system.[32] It is encouraging that the simple reminders evaluated in this study had some association with intertest interval. Future research evaluating message content that addresses additional barriers to testing may yield more pronounced effects.[33]

In conclusion, this work adds to the literature supporting the use of SMS messaging to promote HIV/STI testing. The intervention was feasibly delivered as part of an expanded PS program,[8] reached priority groups, and was associated with some evidence of increased HIV/STI testing frequency. However, the magnitude of the intervention's effect was modest: SMS reminder uptake was low, in part due to use of other reminder systems, and testing frequency in this population in the absence of SMS reminders was relatively high. The intervention's cost was low: SMS messaging fees were 7.5 cents per SMS, and costing analysis of the expanded PS program as a whole (including SMS reminders) indicated marginal cost increase over standard PS.[34] Given the intervention's low cost, it may be cost-effective even with a modest effect. Formal cost-effectiveness analysis is warranted. Use of this feasible, affordable intervention may reduce testing disparities and benefit individuals who do not have other testing reminders in place, especially if they use annual physicals as their testing prompt.

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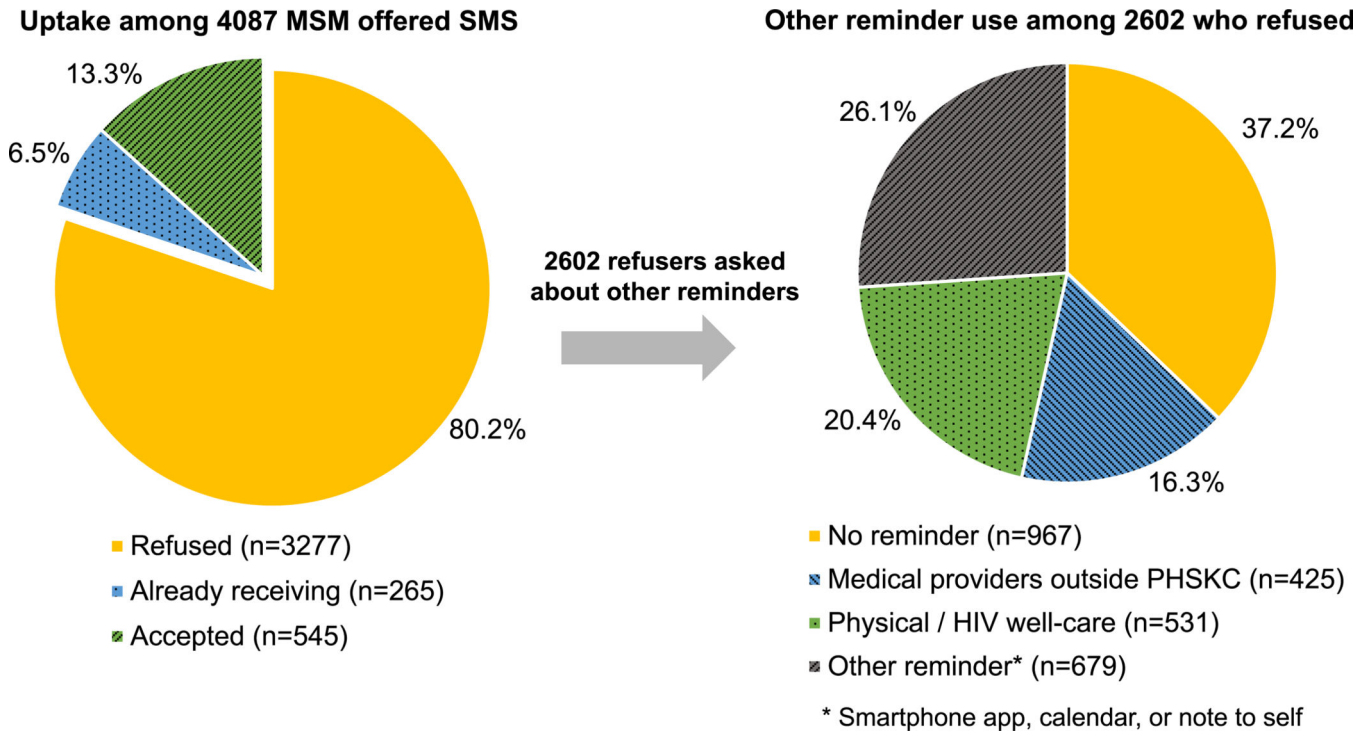

Figure 1.

Uptake of SMS reminders and other reminder use among MSM interviewed by partner services in King County, WA, 2013 to 2017.

TABLE 1.

Sociodemographic, Clinical, and Behavioral Characteristics of MSM Offered SMS Testing Reminders Through STI Partner Services in King County, WA, 2013–2017

	N	n (%) or median (IQR)
Overall	4087	
Age	4086	
≤24		808 (19.8)
25–34		1692 (41.4)
35–44		800 (19.6)
≥45		786 (19.2)
Race/ethnicity *	4061	
Asian		289 (7.1)
Black		279 (6.9)
Hispanic/Latinx		728 (17.9)
White		2531 (62.3)
Other		234 (5.8)
STI	4087	
Chlamydia only		1247 (30.5)
Early syphilis (includes co-infections)		460 (11.3)
Gonorrhea (no syphilis)		2380 (58.2)
HIV status	4087	
Negative		3114 (76.2)
Previous positive		942 (23.1)
Newly diagnosed positive		31 (0.8)
Used PrEP †	2538	762 (30.0)
Diagnosed by HIV/STI specialist ‡	4087	2740 (67.0)
Has health insurance	3855	3245 (84.2)
Used methamphetamine	3816	307 (8.1)
Used inhaled nitrates	3823	995 (26.0)
Injected drugs	3803	142 (3.7)
No. sex partners in last year	3569	6 (3–12)

* Individuals of any race who identify as Latinx are classified as Latinx.

All other groups are non-Latinx.

† Among 3114 HIV-negative.

‡ Defined as an STI clinic, HIV/STI testing program, or medical provider specializing in HIV or STI care or MSM health.

TABLE 2.

Correlates of Receiving SMS Testing Reminders Before STI Partner Services Interview among all MSM Offered SMS Reminders in King County, WA, 2013–2017

	N	n using SMS (%) or median (IQR)	RR (95% CI)	P	aRR (95% CI)	P
Overall	4087	265 (6.5)				
Diagnosis year	4087	2015 (2014–2016)	0.81 * (0.73–0.89)	<0.001	0.78 * (0.66–0.92)	<0.001
Age						
≤24	808	76 (9.4)	Reference			
25–34	1692	131 (7.7)	0.82 (0.63–1.08)	0.16	0.82 (0.59–1.14)	0.23
35–44	800	35 (4.4)	0.47 (0.32–0.69)	<0.001	0.68 (0.42–1.08)	0.10
≥45	786	23 (2.9)	0.31 (0.20–0.49)	<0.001	0.42 (0.23–0.76)	<0.001
Race/ethnicity †						
Asian	289	15 (5.2)	0.86 (0.52–1.45)	0.58	0.78 (0.43–1.41)	0.40
Black	279	17 (6.1)	1.01 (0.62–1.65)	0.95	1.42 (0.78–2.56)	0.25
Hispanic/Latinx	728	54 (7.4)	1.24 (0.92–1.67)	0.17	1.28 (0.87–1.86)	0.21
White	2531	152 (6.0)	Reference			
Other	234	26 (11.1)	1.85 (1.25–2.74)	0.002	1.77 (1.1–2.83)	0.02
STI						
Chlamydia only	1247	100 (8.0)	Reference			
Early syphilis (includes coinfections)	460	5 (1.1)	0.14 (0.06–0.33)	<0.001	0.19 (0.06–0.6)	<0.001
Gonorrhea (no syphilis)	2380	160 (6.7)	0.84 (0.66–1.07)	0.15	1.16 (0.85–1.59)	0.35
HIV/PrEP status						
HIV-negative not on PrEP	1454	113 (7.8)	Reference			
HIV-negative on PrEP	761	46 (6.0)	0.77 (0.56–1.08)	0.14	0.86 (0.62–1.19)	0.36
HIV-positive	942	8 (0.8)	0.11 (0.05–0.22)	<0.001	0.09 (0.04–0.19)	<0.001
Diagnosed by HIV/STI specialist ‡	2740	241 (8.8)	4.94 (3.26–7.47)	<0.001	5.61 (3.36–9.39)	<0.001
Has health insurance	3245	183 (5.6)	0.54 (0.41–0.70)	<0.001	0.83 (0.58–1.18)	0.29
Used methamphetamine	307	20 (6.5)	0.95 (0.61–1.48)	0.86		
Used inhaled nitrates	995	76 (7.6)	1.19 (0.92–1.54)	0.39		

	N	n using SMS (%) or median (IQR)	RR (95% CI)	*P*	aRR (95% CI)	*P*
Injected drugs	142	9 (6.3)	0.93 (0.49–1.77)	0.89		
No. sex partners in last year	3569	6 (3–12)	1.00 (1.00–1.00)	0.11		

[*] RR per 1-year increase.

[†] Individuals of any race who identify as Latinx are classified as Latinx. All other groups are non-Latinx.

[‡] Defined as an STI clinic, HIV/STI testing program, or medical provider specializing in HIV or STI care or MSM health.

TABLE 3.

Correlates of SMS Testing Reminder Uptake at STI Partner Services Interview Among MSM Not Already Receiving SMS Reminders in King County, WA, 2013–2017

	N	n, Accepting SMS Reminder (%) or Median (IQR)	RR (95% CI)	*P*	aRR (95% CI)	*P*
Overall	3882	545 (14.3)				
Diagnosis year	3822	2015 (2014–2016)	0.56* (0.52–0.60)	<0.001	0.55* (0.48–0.62)	<0.001
Age						
≤24	732	170 (23.2)	Reference		Reference	
25–34	1561	220 (14.1)	0.60 (0.51–0.73)	<0.001	0.80 (0.61–1.06)	0.12
35–44	765	83 (10.8)	0.47 (0.37–0.60	<0.001	0.66 (0.46–0.94)	0.02
≥45	763	72 (9.4)	0.41 (0.31–0.53)	<0.001	0.54 (0.36–0.81)	<0.001
Race/ethnicity†						
Asian	267	50 (18.2)	1.51 (1.15–1.99)	0.003	1.31 (0.9–1.89)	0.16
Black	242	41 (15.6)	1.30 (0.96–1.75)	0.09	1.21 (0.78–1.86)	0.39
Hispanic/Latinx	650	124 (18.4)	1.53 (1.26–1.85)	<0.001	1.29 (0.95–1.75)	0.10
White	2263	287 (12.1)	Reference		Reference	
Other	200	40 (19.2)	1.59 (1.18–2.15)	0.002	1.32 (0.83–2.09)	0.24
STI						
Chlamydia only	1125	221 (19.3)	Reference		Reference	
Early syphilis (includes coinfections)	426	9 (2.0)	0.10 (0.05–0.20)	<0.001	0.20 (0.09–0.42)	<0.001
Gonorrhea (no syphilis)	2096	315 (14.2)	0.74 (0.63–0.86)	<0.001	0.78 (0.61–0.99)	0.04
HIV/PrEP status						
HIV-negative not on PrEP	1271	176 (13.1)	Reference		Reference	
HIV-negative on PrEP	696	23 (3.2)	0.25 (0.16–0.37)	<0.001	0.32 (0.21–0.48)	<0.001
HIV-positive	902	66 (7.1)	0.54 (0.41–0.71)	<0.001	0.38 (0.27–0.53)	<0.001
Diagnosed by HIV/STI specialist‡	2459	379 (15.2)	1.21 (1.02–1.43)	0.03	1.04 (0.82–1.33)	0.74
Has health insurance	2908	359 (11.7)	0.52 (0.43–0.63)	<0.001	0.8 (0.59–1.09)	0.16
Used methamphetamine	275	38 (13.2)	0.87 (0.64–1.19)	0.39		
Used inhaled nitrates	891	129 (14.0)	0.91 (0.76–1.10)	0.34		

	N	n, Accepting SMS Reminder (%) or Median (IQR)	RR (95% CI)	*P*	aRR (95% CI)	*P*
Injected drugs	125	20 (15.0)	1.00 (0.66–1.50)	0.99		
No. sex partners in last year	3331	6 (3–12)	1.00 (0.99–1.00)	0.59		

[*] RR per 1-year increase.

[†] Individuals of any race who identify as Latinx are classified as Latinx. All other groups are non-Latinx.

[‡] Defined as an STI clinic, HIV/STI testing program, or medical provider specializing in HIV or STI care or MSM health.

TABLE 4.

Association between Reminder Use Before STI Partner Services Interview and Time from Last HIV Test to Asymptomatic STI Diagnosis among HIV-negative MSM in King County, WA, 2014–2017

		Months Since Last Test	Univariable		Multivariable*	
	N	Median (IQR)	β (95% CI)	*P*	β (95% CI)	*P*
Overall	1457	4.1 (2.9–7.7)				
SMS reminder	167	4.7 (3.1–7.7)	Reference			
No reminder	514	5.6 (3.3–10.7)	0.90 (0.13 to 1.37)	0.02	0.80 (−0.08 to 1.68)	0.08
Non-SMS reminder	724	3.6 (2.6–5.7)	−1.07 (−1.81 to −0.32)	0.005	−0.40 (−1.27 to 0.47)	0.37
Physical	52	9.6 (4.0–17.5)	5.03 (3.66 to 6.41)	<0.001	4.33 (2.86 to 5.81)	<0.001

*Adjusted for age, PrEP use, STI, health insurance status, diagnosing provider, and calendar year; N = 1228 with complete data.

TABLE 5.

Association Between SMS Testing Reminder Uptake at Partner Services Interview and Diagnosis With an Asymptomatic STI Within 1–12 Months after Initial Diagnosis in MSM in King County, WA, 2013–2017

			Univariable		Multivariable*	
	N	Second Diagnosis, n (%)	RR (95% CI)	*P*	RR (95% CI)	*P*
Overall	3376	759 (22.5)				
No SMS reminder	2629	601 (22.9)	Reference			
SMS reminder accepted	521	101 (19.4)	0.85 (0.70–1.02)	0.09	0.80 (0.61–1.07)	0.13
Already enrolled	226	57 (25.2)	1.10 (0.87–1.40)	0.41	1.08 (0.76–1.54)	0.68

*Adjusted for age, race, HIV/PrEP status, STI, health insurance status, diagnosing provider, and calendar year; N = 2349 with complete data.