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# Acceptability of digital vending machines to access STI and HIV tests in two UK cities

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## ABSTRACT

**Objectives** Prompt HIV and STI diagnosis and treatment is a public health priority and relies on accessible testing. Technology-based approaches to distribute test kits have the potential to increase access to testing. We evaluated the acceptability and uptake of vending machines in publicly available settings in Brighton and Hove (BH) and Bristol, North Somerset and South Gloucestershire (BNSSG), to distribute HIV rapid self-test and STI self-sample kits.

**Methods** Seven machines were installed in BH and four in BNSSG. User characteristics, proportion of kits returned and test results, taken from the machine database and clinic records, combined with online questionnaires completed by self-recruited users and analysed using Stata and SPSS.

**Results** 2536 kits were dispensed over 12 months (April 2022 to March 2023). The STI self-sample kits were most popular (74% of vends). 78% of kits dispensed were among users aged 16–35 years and 56% identified as male. 68% and 59% of users had either not tested in the last 12 months or never tested for HIV and STIs, respectively. 51% of STI kits were returned via post, lower than the local online service (65%). 208 users completed questionnaires. Convenience, desire for instant access and increased confidentiality were the most common reasons for using machines. 92% of respondents thought the machines were user-friendly and 97% would recommend the service. Concerns about safety and privacy while using the machine were reported by 42% and 66% of respondents.

**Conclusions** This study demonstrates that vending machines are an acceptable and effective means of accessing infrequent or never testers in the general population and can act as a horizontal intervention to tackle HIV and STIs. Research is needed to understand optimal machine locations to assure privacy and safety along with the long-term impact on sexual health services.

## INTRODUCTION

Consultations, tests and diagnoses for sexually transmitted infections (STIs) fell during the COVID-19 pandemic and remained below pre-pandemic levels in 2022.<sup>1</sup> In contrast, high-risk sexual behaviour increased above levels reported pre-pandemic.<sup>2</sup> Given the asymptomatic nature of most STIs and

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Vending machines dispensing HIV self-test kits located in settings targeting individuals at high risk of infection have been previously found to be acceptable with the potential to increase testing.

## WHAT THIS STUDY ADDS

⇒ This is the first time that vending machines dispensing both STI self-sampling and HIV self-test kits have been used in publicly available settings to increase testing among people not engaging with sexual health services. Vending machines in community settings were convenient, easy to use and successful in reaching people who either infrequently or never tested for HIV and STIs.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Vending machines dispensing both STI self-sampling and HIV self testing kits should be considered as part of the digital offer of sexual health services pending further research to understand optimal machine locations to assure privacy and safety.

early HIV infection, regular testing is needed to detect subclinical, yet transmissible, cases.<sup>3</sup>

In England, in 2022 approximately 50% of consultations were face-to-face<sup>1</sup>; however, barriers for attending sexual and reproductive health services (SHS) have been identified such as difficulty getting appointments, time and financial travel costs, time in the waiting room (including risk of being recognised by someone they know) and stigma from healthcare professionals.<sup>4–6</sup> NICE guidance recommends that in addition to in-person testing, STI testing should include the option for remote self-sampling for asymptomatic people.<sup>7</sup> The digitalisation of health services and utilisation of postal STI and HIV test kits has exponentially increased in recent years<sup>8,9</sup> and demonstrates the acceptability and potential demand for self-administered services. However, postal testing requires internet access and a postal address, which may not be possible for the digitally excluded people experiencing homelessness or those who do not want a test kit delivered to their home.



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Research in Brighton and Hove (BH) suggests that free at the point of use vending machines dispensing instant HIV self-test kits (HIVST) installed in commercial sex venues for men-who-have-sex-with-men (MSM) are acceptable and feasible with the potential to increase access to testing of high-risk populations including those not testing through other routes.<sup>10,11</sup> The machines offered increased confidentiality, convenience and reduced embarrassment compared with attending clinic; however, concerns were raised that access to HIVST via machines would reduce testing for STIs.<sup>10,12</sup> Following this, second-generation machines were developed that distribute HIVST for HIV antibodies and STI self-sample kits (STISS) for chlamydia, gonorrhoea, syphilis and HIV. In 2022, seven second-generation machines were installed in BH and four machines were installed in Bristol, North Somerset and South Gloucestershire (BNSSG). Both areas experience higher STI diagnoses (excluding chlamydia) and lower HIV testing coverage than the average national rate for England and are part of the Fast-Track Cities initiative for HIV elimination.<sup>13–16</sup> Increased access to STI and HIV testing among MSM, people from black African and black Caribbean heritage communities (black communities) and young people (16–25 years) was a priority for both the BH and the BNSSG as these groups have high risk of infection and do not regularly engage in HIV and STI testing.<sup>13–16</sup> This study aimed to investigate the acceptability and uptake of publicly available machines dispensing STI and HIV test kits.

## METHODS

### Design of the vending machine

Freestanding and wall-mounted machines were co-designed with designers, healthcare professionals and members of the public and LGBTQ communities in BH.<sup>10</sup> In the BNSSG, the interface was refined using the Person-Based Approach<sup>17</sup> through an iterative process via separate workshops and written feedback with young people, MSM and members of the black community to ensure that they were suitable for dispensing both STI and HIV kits for the target audience.

Machine users were required to answer six questions (age, gender, gender of sexual partners, place of residence and time since last STI and HIV test) before selecting either an STISS or HIVST kit (online supplemental file 1). Users who choose the STISS then selected a penis pack (urine pot and finger prick), vagina pack (vagina swab and finger prick) or X pack (throat, rectal and vagina swab, urine pot and finger prick) based on their gender and sexual partners. Users provided their mobile number to receive an SMS verification code (without the need for a smartphone, internet access or phone credit) that when entered back into the machine released the selected test kit (online supplemental file 2a). Users returned STISS to the SHS via freepost. Kits were processed, analysed and results added to the clinic records as per postal samples and samples obtained in clinic. Results were communicated by SHS staff within 21 days (average 5–10 days) via phone (positive for linkage into care) or text (negative, unequivocal or not processed). The HIVST contained an oral swab that provided a result within 20 min. HIVST users were not required to report their results but were signposted to a 24-hour Ora-quick helpline and the SHS for further support. Any persons younger than 18 years in BH, 16 years in BNSSG, with symptoms or with a recent history of condomless anal sex with a man and in need of post-exposure prophylaxis were directed to contact the SHS and advised to not use the machine.

### Study setting

This study took place across BH between April 2022 and March 2023 and BNSSG between September 2022 and March 2023. Seven machines were placed in BH: library, university students union, MSM sex on premise venue (Sauna), commercial office, two GP surgeries and community centre for the black community (community centre). Four machines were placed in BNSSG: two shopping centres, a co-working community enterprise with a café and an arts centre. Selection of BNSSG locations was informed by the public involvement workshops. The venues involvement with monitoring and restocking the machines were locally agreed (online supplemental file 2b).

### Study participants

Participants were self-recruited machine users over the age of 18 years in BH and 16 years in BNSSG due to local commissioning guidelines.

### Data collection

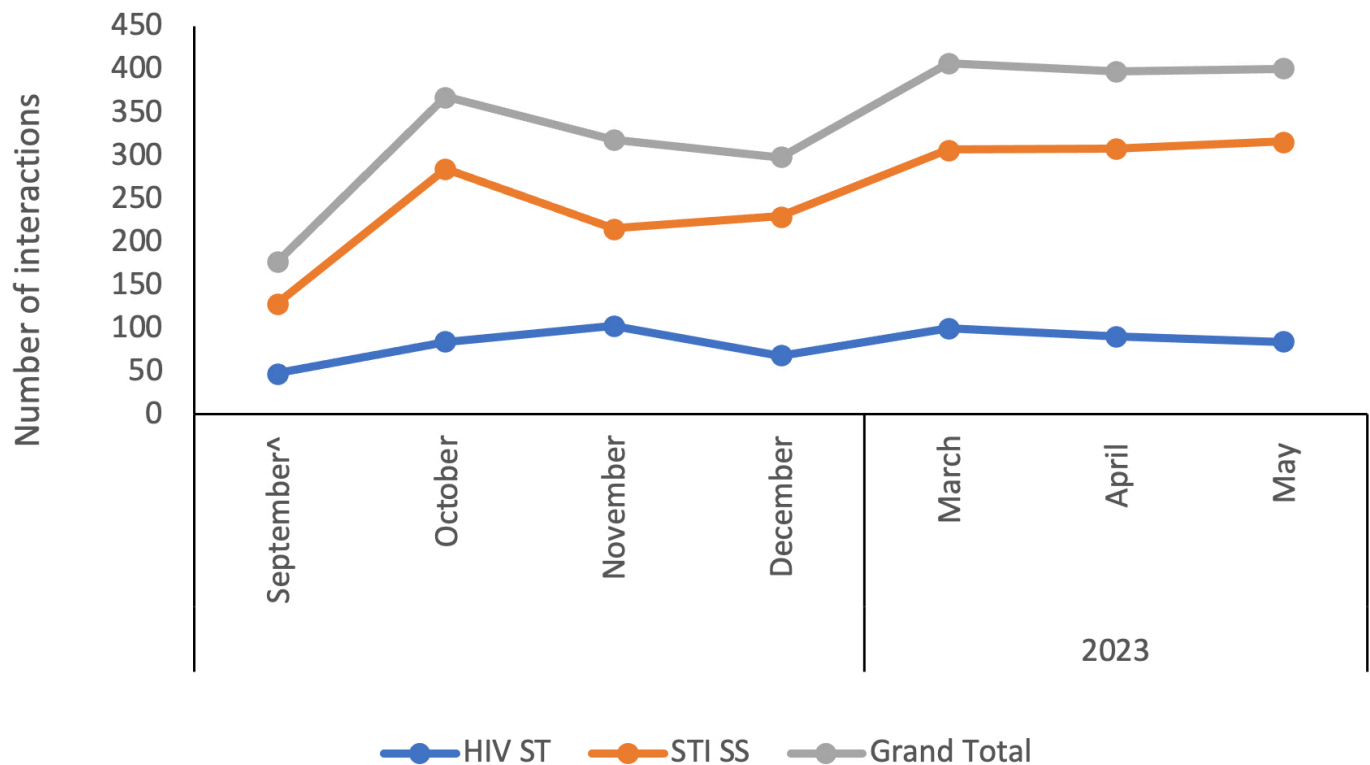
The machines were remotely connected to Vendlive, the online platform which stored user characteristics, choice of kit, machine location and date and time of vend for each interaction (kit dispensed) using a unique transaction code. STISS were traced back to the SHS to identify return rates and results.

Users were invited to complete a short (approximately 5 min), online questionnaire (hosted on either Online Surveys (BH) or RedCap (BNSSG)) regarding their views and experiences of using the machine (online supplemental file 3). The link for the questionnaire was included with the same SMS verification code, and in the BNSSG, details of the questionnaire were also included on the machine interface, in posters at the machine and via social media posts by community partners. Participant information sheets and consent forms were embedded within the questionnaire. Users completing the questionnaire received a £10 high street shopping voucher in BH via email and in the BNSSG were entered into a cash prize draw of £100, the choice of incentive scheme was based on the resources available in the two areas. Participants were also invited to participate in interviews (findings reported separately).

Vendlive and the questionnaire data were stored anonymously in separate online databases in compliance with the General Data Protection Regulation (2018) and University of Bristol and Sussex data protection policies.

### Data analysis

Stata (V.17) was used to calculate the percentage reported for the six questions collected on Vendlive and return rates and testing outcomes for STISS. Vendlive records with all six questions completed were included in the denominator. Venues were grouped into five categories: general public (4 sites in BNSSG, library in BH), targeted (sauna, community centre), university, workplace and health service (2 GP practices) settings. Last STI and HIV tests were regrouped to recent tests (last test was either <3 months or 3–12 months ago) and infrequent or never tested (never tested or whose last tests were >12 months ago). Missing data was excluded from analysis.  $\chi^2$  tests were used to compare user characteristics by kit choice (HIV vs STI kits), geography (BH vs BNSSG) and venue type (targeted vs other). A p value of <0.05 was used to determine significance. SPSS Statistics V.28 was used to summarise the questionnaire responses.



**Figure 1** Number of interactions by test pack type, September 2022 to 31 March 2023. Includes data from September when service was fully implemented, data for 167 kits dispensed in April to August 2022 not included. STI, sexually transmitted infection; STISS, STI self-sample kits.

## RESULTS

### Uptake of HIV and STI tests

There were a total of 2536 interactions with the machines (1141 in BH from 1 April 2022 to 31 March 2023 and 1395 in BNSSG from 20 September 2022 to 31 March 2023).

Machine use steadily increased from September 2022 when all machines were installed (figure 1). Low stock of STISS and machine downtime in the BNSSG contributed to the lower number of kits dispensed in November. The further drop in December 2022 was due to problems with supply of materials for STISS in BH. 74.4% of users chose STISS, increasing from 72.9% of all kits dispensed in September 2022 to 79.1% in March 2023.

Vendlive data indicated that over three-quarters of the interactions were among people aged 16–35 (48.4% were aged 16–25 years and 29.3% were 26–35 years old), while 2.8% were aged 56 years and older (table 1). Over 50% of the interactions were among people identified as male (including four trans-male), 40.6% as female (including five trans-female) and a further 3.8% as non-binary; 38.3% of interactions were among women-who-have-sex-with-men or with men and women (WSM/WM), 33.1% men-who-have-sex-with-women only (MSW), 22.4% were men-who-have-sex-with men only or women and men (MSM/WM) and 2.3% women-who-have-sex-with women only (WSW). 68.2% and 59% of users were among people that had infrequently or never tested for HIV and STIs, respectively; 82.4% of interactions with the machines were on a weekday with two-thirds taking place within 09:00 am to 17:00 pm. This varied between vending machine sites (online supplemental file 4).

A higher proportion of interactions in the BNSSG compared with BH were in people aged above 25 years old (56.2% vs 45.8%,  $p=0.000$ ), male (58.3% vs 52.2%,  $p=0.002$ ), MSW

(37.4% vs 27.9%,  $p=0.000$ ), stated that they were infrequent or never tested for HIV (70.4% vs 65.5%,  $p=0.008$ ) and were local residents (94.0% vs 86.6%,  $p=0.000$ ) (table 1).

Differences in the characteristics of those opting for HIVST over STISSs include gender, sexual partners, recent testing history for STIs and place of residence. A higher proportion of interactions for the HIVST were male (65.7 vs 52.1%,  $p=0.000$ ), MSM/WM (35.1% vs 18.1%,  $p=0.000$ ), had recently tested for STIs (44.3% vs 39.9%,  $p=0.045$ ) and were not local residents (87.3% vs 91.9%  $p=0.001$ ).

The number, kit type and previous testing history for STI and HIV varied by type of venue; 72.3% of all kits were dispensed in public venues and a further 13.3% dispensed at the university. A higher proportion of kits dispensed in targeted venues were HIVST (45.1% vs 25.0% in all other venues combined,  $p=0.000$ ). A higher proportion of interactions in targeted venues were in people that reported recent STI or HIV testing 61.9% and 58.4%, respectively, compared with other sites which ranged from 26.2% to 46.9% for STIs and 15.9% to 38.7% for HIV testing (online supplemental file 4).

Nine hundred and fifty-eight (50.7%) STISS were returned (40.4% in BH and 58.7% in BNSSG) lower than the proportion of postal kits returned for the same time period (65% for both BH and the BNSSG). Fifty-seven (6.0%) and 24 (2.5%) samples tested positive for chlamydia and gonorrhoea, respectively, four samples tested positive for HIV and were in people known to be HIV positive (table 2). Three samples tested positive for syphilis antibodies.

### Acceptability and user experience

Two hundred and eight (8%) users completed the questionnaire (111 BH and 97 BNSSG). Compared with Vendlive data, a higher

**Table 1** Characteristics of people using the vending machine and completing the survey (based on interactions with complete data and may include repeat users)

	HIV ST		STISS		P value		SW		BH		P value		Survey		Total	
	n=647	%	n=1889	%			n=1395	%	n=1141	%			n=208	%	n=2536	%
Age group (years)					<0.000						<0.000					
<18*	15	(2.3)	29	(1.5)			44	(3.2)	0	(0)			0	(0)	44	(1.7)
18–25	255	(39.4)	929	(49.2)			566	(40.6)	618	(54.2)			83	(39.9)	1184	(46.7)
26–35	173	(26.7)	569	(30.1)			464	(33.3)	278	(24.4)			56	(26.9)	742	(29.3)
36–45	111	(17.2)	235	(12.4)			207	(14.8)	139	(12.2)			33	(15.9)	346	(13.6)
46–55	65	(10.1)	83	(4.4)			75	(5.4)	73	(6.4)			25	(12.0)	148	(5.8)
56+	28	(4.3)	44	(2.3)			39	(2.8)	33	(2.9)			11	(5.3)	72	(2.8)
Gender					<0.000						<0.000					
Male (incl trans-male)	425	(65.7)	984	(52.1)			813	(58.3)	596	(52.2)			100	(48.1)	1409	(55.6)
Female (incl trans-female)	203	(31.4)	827	(43.8)			540	(38.7)	490	(42.9)			101	(48.6)	1030	(40.6)
Other†	19	(2.9)	78	(4.1)			42	(3.0)	55	(4.8)			7	(3.4)	97	(3.8)
Sexual partners‡					<0.000						<0.000					
MSW	198	(30.6)	642	(34.0)			522	(37.4)	318	(27.9)			43	(20.7)	840	(33.1)
MSM/WM	227	(35.1)	342	(18.1)			291	(20.9)	278	(24.4)			52	(25.0)	569	(22.4)
WSM/WM	187	(28.9)	785	(41.6)			521	(37.4)	451	(39.5)			88	(42.3)	972	(38.3)
WSW	16	(2.5)	42	(2.2)			19	(1.4)	39	(3.4)			11	(5.3)	58	(2.3)
Other§	19	(2.9)	78	(4.1)			42	(3.0)	55	(4.8)			7	(3.4)	97	(3.8)
Previous HIV test					<0.000						<0.000					
≤3 months	83	(12.8)	228	(12.1)			152	(10.9)	159	(13.9)			34	(16.3)	311	(12.3)
3–12 months	138	(21.3)	358	(19.0)			261	(18.7)	235	(20.6)			49	(23.6)	496	(19.6)
>12 months ago¶	191	(29.5)	498	(26.4)			435	(31.2)	254	(22.3)			57	(27.4)	689	(27.2)
Never	235	(36.3)	805	(42.6)			547	(39.2)	493	(43.2)			68	(32.7)	1040	(41.0)
Previous STI test					<0.000						<0.000					
≤3 months	125	(19.3)	273	(14.5)			208	(14.9)	190	(16.7)			45	(21.6)	398	(15.7)
3–12 months	162	(25.0)	480	(25.4)			350	(25.1)	292	(25.6)			50	(24.0)	642	(25.3)
>12 months ago¶	178	(27.5)	636	(33.7)			494	(35.4)	320	(28.0)			70	(33.7)	814	(32.1)
Never	182	(28.1)	500	(26.5)			343	(24.6)	339	(29.7)			43	(20.7)	682	(26.9)
Residence					<0.000						<0.000					
In area	565	(87.3)	1736	(91.9)			1311	(94.0)	990	(86.8)			.	.	2301	(90.7)
Out of area	82	(12.7)	153	(8.1)			84	(6.0)	151	(13.2)			.	.	235	(9.3)
Time of interaction					<0.000						<0.000					
Weekday 09:00 am to 17:00 pm	348	(53.8)	1068	(56.5)			745	(53.4)	671	(58.8)			.	.	1416	(55.8)
Weekday all other times	178	(27.5)	496	(26.3)			389	(27.9)	285	(25.0)			.	.	674	(26.6)
Weekend	121	(18.7)	325	(17.2)			261	(18.7)	185	(16.2)			.	.	446	(17.6)
Kit type					<0.000						<0.000					
HIV	.	.	.	.			328	(23.5)	319	(28.0)			.	.	647	(25.5)
STI	.	.	.	.			1067	(76.5)	822	(72.0)			.	.	1889	(74.5)

\*Only available for SW sites.

†Other—machine users 87 non-binary, 10 other; survey participants 7 non-binary.

‡Sexual partners not stated for 7 survey respondents.

§Other—machine user 51 non-binary bisexual, 36 non-binary other sexual partner, 2 other gender bisexual, 8 other gender other sexual partner; survey participants—3 non-binary bisexual, 3 non-binary sex with men, 1 non-binary sex with woman.

¶Survey data combines last test 1–3 years and more than 3 years.

BH, Brighton and Hove; MSM, men-who-have-sex-with men only; MSM/WM, men-who-have-sex-with men only or women and men; STI, sexually transmitted infection; STISS, STI self-sample kits; WSMWM, women-who-have-sex-with-men or with men and women; WSW, women-who-have-sex-with women only.

proportion of questionnaire responders were aged 46 years and older (17.3% vs 8.6%), female (48.6% vs 40.6%), WSM/WM (16.8% vs 9.7%) and tested for STIs (45.6% vs 41.0%) and HIV (39.9% vs 31.9%) within the last 12 months. Most respondents (82.7%, n=172) were white, 7.7% (15) were mixed and 4.3% (9) were of black African or black Caribbean ethnicity.

Convenience (55.3%, n=115), desire for instant access (51.9%, n=108) and increased privacy and confidentiality (33.7%, n=70) were the the most common reasons for using the

machines. One hundred and sixteen (55.8%) and 76 (38.0%) respondents said they would have accessed testing from clinics or online, respectively, if the machines were not available and a further 56 (26.9%) stated they would not have tested. (Table 3)

91.8% (n=191) of users stated that the machines were user friendly and 97.1% (n=202) would recommend the machine to others. Respondents agreed that the machines were convenient (86.5%, n=180), easy to find (64.9%, n=135) and could be used without any assistance (66.3%, n=138). Safety and privacy

**Table 2** Testing outcomes for all returned vending machine kits

	BNSSG, n (%)		BH, n (%)		Overall, n (%)	
	n=626		n=332		n=958	
STI kits dispensed	1067		822		1889	
STI kits returned	626	(58.7)	332	(40.4)	958	(50.7)
HIV positive*	0	(0)	4†	(1.2)	4	(0.4)
Chlamydia positive*	43	(6.9)	14	(4.2)	57	(6.0)
Gonorrhoea positive*	20	(3.2)	4	(1.2)	24	(2.5)
Syphilis positive*	1‡	(0.2)	2‡	(0.6)	3	(0.3)

\*Denominator returned.  
†Known positives.  
‡Antibodies detected.  
BH, Brighton and Hove; BNSSG, Bristol, North Somerset and South Gloucestershire; STI, sexually transmitted infection.

concerns while using the machine were reported by 42% and 66% of questionnaire respondents (table 3). A lower proportion of respondents from BH agreed with these statements.

## DISCUSSION

This paper is the first to explore the experience of STI and HIV test kit dispensing machines in non-targeted and targeted venues and provides evidence of the high uptake and acceptability of vending machines in public settings.

The lower return rates and positivity compared with postal kits suggest users may have a lower overall risk of infection or take kits opportunistically to use later.

Machines were convenient and easy to access and use and the use among people who would have otherwise accessed testing via sexual health clinics could potentially shift the demand for testing among low-risk individuals away from sexual health clinics. However, concerns about privacy and safety while using

**Table 3** Summary of survey results

	BH results		BNSSG results		Survey results	
	n=111	%	n=97	%	n=208	%
Motivations for use	Why did you choose to use the machine?*					
	41	(36.9)	29	(29.9)	70	(33.7)
	13	(11.7)	13	(13.4)	26	(12.5)
	24	(21.6)	8	(8.2)	32	(15.4)
	1	(0.9)	1	(1.0)	2	(1.0)
	49	(44.1)	59	(60.8)	108	(51.9)
	70	(63.1)	45	(46.4)	115	(55.3)
	4	(3.6)	6	(6.2)	10	(4.8)
	Where would you test if it wasn't for the machine?*					
	63	(56.8)	53	(54.6)	116	(55.8)
	28	(25.2)	51	(52.6)	79	(38.)
	15	(13.5)	19	(19.6)	34	(16.3)
	7	(6.3)	4	(4.1)	11	(5.3)
	38	(34.2)	18	(18.6)	56	(26.9)
Machine experience	User friendliness					
	76	(68.5)	70	(72.2)	146	(70.2)
	26	(23.4)	19	(19.6)	45	(21.6)
	7	(6.3)	6	(6.2)	13	(6.3)
	0	(0)	2	(2.1)	2	(1.0)
	2	(1.8)	0	(0)	2	(1.0)
	When using the machine I found...*					
	91	(82.0)	89	(91.8)	180	(86.5)
	58	(52.3)	77	(79.4)	135	(64.9)
	53	(47.7)	85	(87.6)	138	(66.3)
	37	(33.3)	84	(86.6)	121	(58.2)
	18	(16.2)	50	(51.5)	68	(32.7)
	I would recommend this service to a friend...					
	105	(94.6)	97	(100.)	202	(97.1)
	6	(5.4)	0	(0)	6	(2.9)

Additional questionnaire responses in online supplemental material 5.

\*denotes multichoice question so answer may not equal 100%

the machines may have discouraged people who would otherwise not access any testing.

Differences in the number of kits dispensed, user characteristics and user experience between BNSSG and BH indicate potential differences in barriers to testing and choice of machine locations in these two areas.

Published literature on the use of machines has focused on HIVST which has been shown to be effective in increasing HIV testing uptake in MSM.<sup>10</sup> However, machines dispensing only HIV kits pose a significant missed opportunity for STI testing with users not testing or seeking STI testing elsewhere simultaneously.<sup>10,18</sup> Demand for SH screening has increased following the COVID-19 pandemic, and despite expansion of digital options for testing, a large proportion of people still seek face-to-face consultation.<sup>1</sup> However, capacity within SHS are increasingly constrained and the emergence of new infections such as Mpox and challenges such as multi-drug-resistant organisms has highlighted the need for sexual health services to prioritise provision of care to vulnerable individuals and those with complex needs.<sup>19</sup> Given that HIV and other STIs have the same mode of transmission, it is practical to offer testing for both at the same time to allow early diagnosis and treatment.<sup>20</sup> The provision of HIV and STI kits via vending machine offers a mechanism to replace conventional methods of testing for some people and subsequently reduce this demand from other parts of the sexual health service.

Previous studies of machines have been targeted to MSM populations, for reasons related to high-risk behaviour.<sup>11</sup> However, reaching other population groups with a high risk of infections, such as young MSW and WSM (15–24 years olds) and people from black communities who experience barriers to testing, is crucial in reducing the HIV and STI burden. Main barriers to testing include factors such as geography and distance to services, stigma, low perceived risk among individuals and healthcare professionals and fear of positive status.<sup>21–24</sup> Self-sampling for STIs have been found to be acceptable to these population groups as they offer users privacy reducing feelings of stigma and shame as well as overcome structural barriers that stop people from accessing testing through face-to-face services.<sup>9,25</sup> The ability to access the testing via the machines without the need for a smartphone, internet access or phone credit may overcome barriers encountered with postal testing.

The willingness of black communities to use machines to access HIV testing has been described, and the introduction of STI and HIV testing kits dispensing machines could overcome the barriers encountered following the roll out of postal kits to distribute self-sampling kits.<sup>26</sup> The placement of machines in public settings also has the potential to increase the awareness and normalisation of STI and HIV testing encouraging wider engagement with sexual health services and linkage to care.<sup>27,28</sup>

This paper has several strengths; this is the first study to evaluate STI and HIV test kit machines in public settings in two locations within England. The inclusion of the questionnaire provides insights into the user experience, previous testing history and motivations for using the service. The implementation of the intervention across two locations provides evidence of uptake and acceptability across multiple geographies and demographics. The main limitation of the study is the differences in demographics of questionnaire respondents to people using the machines which may mean that findings are not generalisable. Information on ethnicity was limited to survey participants only (as ethnicity is not collected on Vendlive and is poorly completed on returned test kits). Future research is needed to determine the acceptability and overall uptake of testing among people

from black communities. The study only includes the views and experiences of people who used the machine, and further research is needed to understand the experience of people that decided against machine use and wider public perception. Additionally, the self-recruitment of questionnaire respondents may have resulted in self-selection bias with greater participation among users with a positive experience. Due to the nature of the data collected in Vendlive and within the kits, it is not possible to report the number of repeat users or testing history of individuals with positive results. Finally, it was not possible to determine whether individuals with reactive HIV self-testing results attended for confirmatory testing or to access prevention services.

## CONCLUSION

This is the first study to demonstrate that vending machines in public settings are an acceptable and effective means of accessing populations of in-frequent or never testers in the general population and can act as a horizontal intervention to tackle both HIV and STI. Machines were valued for their convenience and instant access and could be used for the delivery of other sexual health services, such as contraception and pre-exposure prophylaxis in both higher and lower income settings. However, further research is needed to understand the requirements to assure privacy and safety while using the machines along with the feasibility and impact on sexual health service provision to ensure sustainability and continuity. Additionally, an economic evaluation is needed to ascertain whether vending machines represent a cost-effective option to reduce the demand on clinics increasing their capacity to provide timely care to individuals with complex needs.

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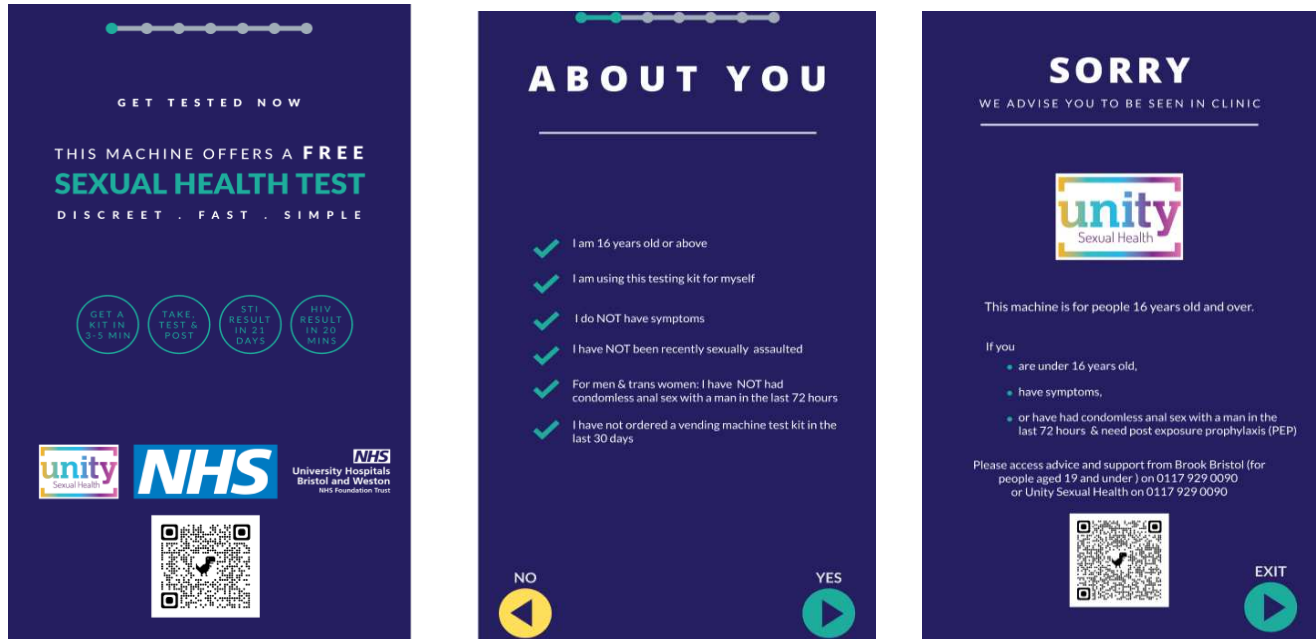
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#### REFERENCES

- Stephanie J Migchelsen QE, Harb AK, Daahir U, *et al.* *Katy Sinka, Hamish Mohammed Sexually transmitted infections and screening for chlamydia in England, 2022*. UK Health Security Agency, 2023.
- Brown JR, Reid D, Howarth AR, *et al.* Sexual behaviour, STI and HIV testing and testing need among gay, Bisexual and other men who have sex with men recruited for online surveys pre/post-COVID-19 restrictions in the UK. *Sex Transm Infect* 2023;99:467–73.
- Hughes G, Field N. The epidemiology of sexually transmitted infections in the UK: impact of behavior, services and interventions. *Future Microbiol* 2015;10:35–51.
- Footman A, Dagama D, Smith CH, *et al.* A systematic review of new approaches to sexually transmitted infection screening framed in the capability, opportunity, motivation, and behavior model of implementation science. *Sex Transm Dis* 2021;48:S58–65.
- Spence T, Kander I, Walsh J, *et al.* Perceptions and experiences of Internet-based testing for sexually transmitted infections. *Systematic Review and Synthesis of Qualitative Research J Med Internet Res* 2020;22.
- Sumray K, Lloyd KC, Estcourt CS, *et al.* Access to, usage and clinic outcomes of, online postal sexually transmitted infection services: a Scoping review. *Sex Transm Infect* 2022;98:528–35.
- NICE. Reducing sexually transmitted infections. *NICE Guideline* 2022.
- Ivancic L, Glavan LJM, Vuksic VB. A literature review of Digital transformation in Healthcare. 2020 43rd International Convention on Information, Communication and Electronic Technology (MIPRO); Opatija, Croatia.2020
- Gibbs J, Solomon D, Jackson L, *et al.* Measuring and evaluating sexual health in the era of Digital health: challenges and opportunities. *Sex Health* 2022;19:336–45.
- Vera JH, Soni S, Pollard A, *et al.* Acceptability and feasibility of using Digital vending machines to deliver HIV self-tests to men who have sex with men. *Sex Transm Infect* 2019;95:557–61.
- Kaneko N, Sherriff N, Takaku M, *et al.* Increasing access to HIV testing for men who have sex with men in Japan using Digital vending machine technology. *Int J STD AIDS* 2022;33:680–6.
- Raffe S, Pollard A, Vera JH, *et al.* HIV self-tests for men who have sex with men, accessed via a Digital vending machine: a qualitative study of acceptability. *Int J STD AIDS* 2020;31:420–5.
- Summary profile of local authority sexual health: Bristol. *UK Health Security Agency* 2023.
- Summary of local authority sexual Health. In: *South Gloucestershire*. London: UK Health Security Agency, 2023.
- Summary profile of local authority sexual health:: In: *North Somerset*. UK Health Security Agency, 2023.
- Summary profile of local authority sexual Health. In: *Brighton and Hove*. UK Health Security Agency, 2023.
- Yardley L, Ainsworth B, Arden-Close E, *et al.* The person-based approach to enhancing the acceptability and feasibility of interventions. *Pilot Feasibility Stud* 2015;1:37.
- Ong JJ, Fu H, Baggaley RC, *et al.* Missed opportunities for sexually transmitted infections testing for HIV pre-exposure prophylaxis users: a systematic review. *J Int AIDS Soc* 2021;24:e25673.
- Medland NA, Taylor R, Saunders J, *et al.* Why sexual health clinics are important in the 2020s. *Sex Health* 2022;19:329–35.
- Saleem K, Ting EL, Loh AJW, *et al.* Missed opportunities for HIV testing among those who accessed sexually transmitted infection (STI) services, tested for Stis and diagnosed with Stis: a systematic review and meta-analysis. *J Int AIDS Soc* 2023;26:e26049.
- Burns FM, Johnson AM, Nazroo J, *et al.* Missed opportunities for earlier HIV diagnosis within primary and secondary Healthcare settings in the UK. *AIDS* 2008;22:115–22.
- McDonagh LK, Saunders JM, Cassell J, *et al.* Application of the COM-B model to barriers and Facilitators to Chlamydia testing in general practice for young people and primary care practitioners: a systematic review. *Implement Sci* 2018;13:130.
- Rade DA, Crawford G, Lobo R, *et al.* Sexual health help-seeking behavior among migrants from sub-Saharan Africa and South East Asia living in high income countries: A systematic review. *Int J Environ Res Public Health* 2018;15.
- Jackson L, Al-Janabi H, Roberts T, *et al.* Exploring young people's preferences for STI screening in the UK: A qualitative study and discrete choice experiment. *Social Science & Medicine* 2021;279:113945.
- Vialard F, Anand A, Leung Soo C, *et al.* Self-sampling strategies (with/without Digital innovations) in populations at risk of *Chlamydia Trachomatis* and *Neisseria Gonorrhoeae*: a systematic review and meta-analyses. *Sex Transm Infect* 2023;99:420–8.
- Lee MJ, Onyango D, Hamza H, *et al.* Surveying testing preferences in black, Latin American, and other minorities for the Co-design of Digital vending machines for HIV self-testing. *Int J STD AIDS* 2020;31:158–65.
- Tanton C, Geary RS, Clifton S, *et al.* Sexual health clinic attendance and non-attendance in Britain: findings from the third national survey of sexual attitudes and lifestyles (Natsal-3). *Sex Transm Infect* 2018;94:268–76.
- Fernández-Balbuena S, de la Fuente L, Hoyos J, *et al.* Highly visible street-based HIV rapid testing: is it an attractive option for a previously untested population? A cross-sectional study. *Sex Transm Infect* 2014;90:112–8.

## 1. Machine interface

BNSSG: first page, consent page and page if users do not meet criteria to use the service



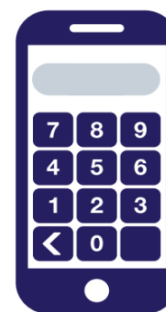
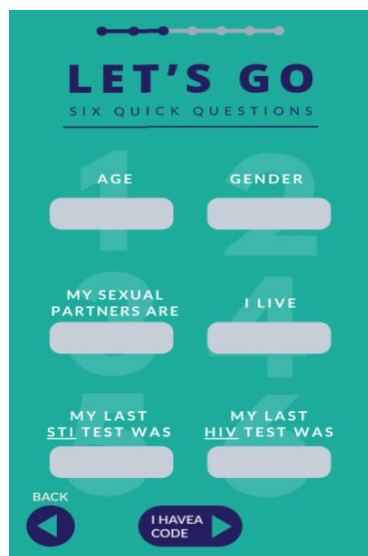
Brighton and Hove: first page, consent page and page if users do not meet criteria to use the service







BNSSG and BH: 6 questions and choice page

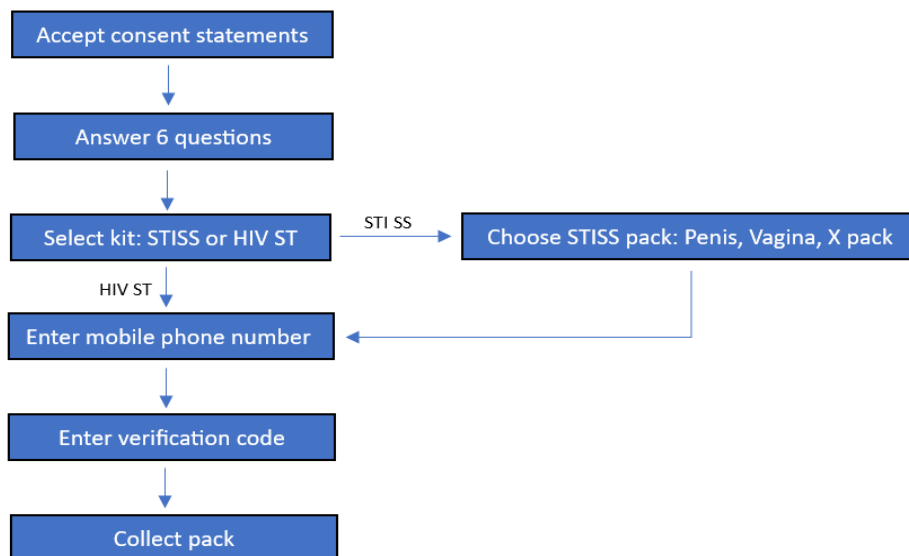


WE'LL TEXT YOU A CODE TO ENTER ON THE NEXT SCREEN  
**DON'T WORRY** WE DON'T STORE YOUR NUMBER





## 2. A. Process flow chart



*A mobile phone number to be used only once over a period of 28 days, preventing the same user (identified by their mobile phone number) from obtaining several HIV self-test kits and potentially selling them for profit.*

## 2B. Stock management

The arrangements for monitoring and restocking the machines varied by site based on the agreement between the SH service and the venue. In BH the machines were monitored by venue staff who checked regularly (daily to weekly) and called the local SHS when running low for new stock to be dropped off.

In BNSSG, for three venues stock was held on site with venue staff responsible for checking stock levels within the machines and restocking as required, staff were then responsible for contacting the SHS when the stockpile was running low, and kit was either posted or hand delivered to the venue.

For one site in BNSSG, the SHS took responsibility for monitoring the stock levels within the machine remotely (via vendlive) and restocking the machine as required.

### 3. Questionnaire

**I have read the patient information sheet and consent to my data being used in the study.**

- Yes

**What is your age?**

- 18-25
- 26-35
- 36-45
- 46-55
- 55+ years

**What is your gender?**

- Male (including trans-male)
- Female (including trans-female)
- Non-binary
- Other [blank space]
- Prefer not to say

**What is your ethnicity?**

- White (includes: English, Welsh, Scottish, Northern Irish, Gypsy, Any other White background)
- Mixed or multiple ethnic groups (includes: White and Black Caribbean, White and Black African, White and Asian, Any other Mixed or Multiple ethnic background)
- Asian or Asian British (includes: Indian, Pakistani, Bangladeshi, Chinese, Any other Asian background)
- Black, African, Caribbean or Black British (includes: African, Caribbean, Any other Black, African or Caribbean background)
- Other ethnic group (includes: Arab, Any other ethnic group)

**Is English your first language? If no, please state your first language.**

- Yes
- No [blank space]

**I have sex with...**

- Men (including trans men)
- Women (including trans women)
- Men and women
- Prefer not to say

**Do any of the following apply to you?**

- Visual impairment
- Hearing impairment
- Long standing physical health condition
- Long standing mental health condition
- Learning disability
- Problematic drug/alcohol use
- None of the above

**Please describe your housing situation.**

- Securely housed
- Insecurely housed
- Street homeless
- Prefer not to say

**When was your last HIV test?**

- Less than 3 months
- 3-6 months
- 6-12 months
- 1-3 years
- More than 3 years
- Never

**When was your last STI test?**

- Less than 3 months
- 3-6 months
- 6-12 months
- 1-3 years
- More than 3 years
- Never

**Where did you hear about the vending machine? (you may choose more than one answer)**

- Word of mouth
- Advice from GP/healthcare professional
- Saw it in person
- Social media
- Other [blank space]

**What services have you used to check your sexual health before? (you may choose more than one answer)**

- Ordered online
- Sexual health clinic
- GP
- Pharmacy
- School/college/university
- Vending machine
- I've never tested
- Other [blank space]

**Why did you choose to get a kit from the vending machine?**

- Feels more confidential / private than a sexual health clinic
- I did not want a test kit coming through the post to my home
- I did not want to visit a sexual health clinic
- I don't have internet access
- I wanted instant access
- It was more convenient
- Other [Blank space]

**If the machine wasn't here, how would you test for HIV/STIs?**

- Sexual health clinic
- GP
- Postal service kit
- Pharmacy
- Other [blank space]
- I wouldn't have tested

**Which location did you use the vending machine in?**

- Multichoice for locations depending on BH or BNSSG

**What do think about the location of the vending machine?**

- It was in a convenient location
- It was easy to locate
- I could access the machine without any assistance
- I had no concerns about my safety when I used the machine
- I had no concerns about privacy when I used the machine

**How would you rate the user-friendliness of the vending machine?**

- Very good
- Good
- Average
- Poor
- Very poor

**Would you recommend this service to your friends?**

- Yes
- No

**Is there anything else you'd like to tell us about your experience of using the vending machine?**

[Blank space]

**\*BH only\***

**Please enter your email address to receive your £10 high street voucher.**

[enter email address]

**I am interested in receiving more information regarding the short interview on my views on the vending machines in exchange for a £20 high street voucher.**

- Yes
- No

**I would like to find out more about the results of this study and consent to being contacted with a copy of the results. I will enter my email address below to be contacted for this.**

- Yes
- No

## 4. Characteristics of people using the vending machine by venue type

	General		University		Healthcare		Targetted		Occupational	
	n=1834	%	n=337	%	n=150	%	n=113	%	n=102	%
<b>Age Group</b>										
< 18*	61	(3.3)	0	(0)	4	(2.7)	0	(0)	0	(0)
18 - 25	761	(41.5)	290	(86.1)	58	(38.7)	24	(21.2)	30	(29.4)
26 - 35	584	(31.8)	37	(11.0)	46	(30.7)	41	(36.3)	34	(33.3)
36 - 45	264	(14.4)	9	(2.7)	22	(14.7)	27	(23.9)	24	(23.5)
46 - 55	111	(6.1)	0	(0)	9	(6.0)	15	(13.3)	13	(12.7)
56+	53	(2.9)	1	(0.3)	11	(7.3)	6	(5.3)	1	(1.0)
<b>Gender</b>										
Male (incl trans-male)	1035	(56.4)	150	(44.5)	83	(55.3)	85	(75.2)	56	(54.9)
Female (incl trans-female)	733	(40.0)	171	(50.7)	63	(42.)	19	(16.8)	44	(43.1)
Other <sup>§</sup>	66	(3.6)	16	(4.7)	4	(2.7)	9	(8.0)	2	(2.0)
<b>Sexual Partners</b>										
MSW	621	(33.9)	119	(35.3)	51	(34.0)	20	(17.7)	29	(28.4)
MSM/WM	414	(22.6)	31	(9.2)	32	(21.3)	65	(57.5)	27	(26.5)
WSM/WM	703	(38.3)	155	(50.0)	58	(38.7)	16	(14.2)	40	(39.2)
WSW	30	(1.6)	16	(4.7)	30	(20.0)	3	(2.7)	4	(3.9)
Other <sup>#</sup>	66	(3.6)	16	(4.7)	4	(2.7)	9	(8.0)	2	(2.0)
<b>Previous HIV</b>										
≤ 3 months	202	(11.0)	34	(10.1)	25	(16.7)	30	(26.5)	20	(19.6)
3 -12 months	381	(20.8)	43	(12.8)	22	(14.7)	36	(31.9)	14	(13.7)
> 12 months ago	536	(29.2)	56	(16.6)	31	(20.7)	26	(23.0)	40	(39.2)
Never	715	(39.0)	204	(60.5)	72	(48.0)	21	(18.6)	28	(27.5)
<b>Previous STI</b>										
≤ 3 months	267	(14.6)	53	(15.7)	29	(19.3)	32	(28.3)	17	(16.7)
3 -12 months	497	(27.1)	57	(16.9)	23	(15.3)	38	(33.6)	27	(26.5)
> 12 months ago	621	(33.9)	70	(20.8)	53	(35.3)	23	(20.4)	47	(46.1)
Never	449	(24.5)	157	(46.6)	45	(30.0)	20	(17.7)	11	(10.8)
<b>Residence</b>										
In area	1700	(92.7)	310	(92.0)	135	(90.0)	79	(69.9)	77	(75.5)
Out of area	134	(7.3)	27	(8.0)	15	(10.0)	34	(30.1)	25	(24.5)
<b>Test Kit</b>										
HIV Self Test	453	(24.7)	84	(24.9)	43	(28.7)	51	(45.1)	22	(21.6)

STI Self Sample	1409	(76.8)	253	(75.1)	107	(71.3)	62	(54.9)	80	(78.4)
<b>Time of Interaction</b>										
Weekday 9am - 5pm	1028	(56.1)	144	(42.7)	133	(88.7)	33	(29.2)	78	(76.5)
Weekday All other times	458	(25.0)	144	(42.7)	15	(10.0)	33	(29.2)	24	(23.5)
Weekend	348	(19.0)	49	(14.5)	2	(1.3)	47	(41.6)	0	(0)

\* only collected in SW venues

§other - 87 non-binary, 10 other

# other - 51 non-binary bisexual, 36 non-binary other sexual partner, 2 other gender bisexual, 8 other gender other sexual partner



## 5. Additional survey responses

	Survey results	
	n=208	%
<b>First Language</b>		
English	180	(86.5)
Not English	28	(13.5)
<b>Health status*</b>		
Visual impairment	11	(5.3)
Hearing impairment	4	(1.9)
Long standing physical health condition	15	(7.2)
Long standing mental health condition	30	(14.4)
Learning disability	18	(8.7)
<b>Housing status</b>		
Securely housed	190	(91.3)
Insecurely housed	15	(7.2)
Street homeless	0	(0)
Prefer not to say	3	(1.4)
<b>Previous testing locations*</b>		
Ordered online	81	(38.9)
Sexual health clinic	132	(63.5)
GP	47	(22.6)
Pharmacy	10	(4.8)
School/college/university	19	(9.1)
Vending machine	21	(10.1)
Never tested	36	(17.3)
Other	2	(1.0)
<b>How did you hear about the machine?*</b>		
Word of mouth	31	(14.9)
Advice from GP or HCP	17	(8.2)
Saw it in person	87	(41.8)
Social media	32	(15.4)
Other	48	(23.1)

\* multichoice answer so may not equal 100%

Not English first language. Spanish = 7, Italian = 4, French/German = 3, Arabic, Bulgarian, Cantonese, Greek, Hungarian, Romanian, Swedish, Welsh = 1

HCP – Health care professional