ORIGINAL PAPER

HIV Testing Among a Representative Community Sample of Gay, Bisexual, and Other Men Who Have Sex with Men in Vancouver, Canada

Heather L. Armstrong[1,2] · Lu Wang[1] · Julia Zhu[1] · Nathan J. Lachowsky[1,3] · Kiffer G. Card[1,4] · Jason Wong[5] · Jody Jollimore[6] · Joshua Edward[7] · Eric A. Roth[8] · Robert S. Hogg[1,4] · David M. Moore[1,2]

Abstract

Earlier HIV diagnosis allows for improved treatment outcomes and secondary prevention. It is recommended that all individuals know their HIV status and that those at higher risk test more frequently. Using a representative community sample of gay, bisexual, and other men who have sex with men (GBMSM), we aimed to: (1) determine the proportion of GBMSM who have tested in the past 2 years, (2) determine reasons for testing and never having tested, and (3) explore correlates of testing. Of 535 eligible participants, 80.0% reported having had an HIV test in the past 2 years, most commonly as part of a regular testing schedule. The most common reason for not testing was low perceived HIV risk. Bisexual and older GBMSM, as well as those who lived outside of Vancouver, were less likely to have tested in the past 2 years. Rapid point-of-care testing may help improve testing rates and was shown to effectively engage some hard-to-reach GBMSM (e.g., those who had not tested for other STIs) in this sample.

Keywords HIV testing · Gay and bisexual men · Point-of-care testing · Motivation

Introduction

The first step of the UNAIDS 90-90-90 targets is to ensure that 90% of those living with HIV are diagnosed [1] and HIV testing guidelines in British Columbia (BC), Canada developed in 2014, recommend that all individuals be tested for HIV [2]. These guidelines further recommend that populations with a higher burden of HIV such as gay, bisexual, and other men who have sex with men (GBMSM) test every year. In Vancouver, it is estimated that 23.4% of GBMSM are living with HIV [3] and in 2015, GBMSM accounted for 67% of new HIV diagnoses in the city [4]. Early detection of HIV increases response to highly active antiretroviral therapy (HAART) and decreases morbidity and mortality [5, 6]. Further, people who are unaware of their infection may be more likely to pass it on to others as it is estimated that more than half of new infections are transmitted by individuals unaware of their status [7].

Despite the known benefits of testing, there are still individuals who have never been tested and many who delay testing or test less often than recommended. Past surveillance among GBMSM in Vancouver conducted in 2008–2009 found that 32% of self-reported HIV-negative GBMSM had

✉ Heather L. Armstrong
harmstrong@cfenet.ubc.ca

1   British Columbia Centre for Excellence in HIV/AIDS, 505-1200 Burrard St., Vancouver, BC V6Z 2C7, Canada

2   Department of Medicine, University of British Columbia, Vancouver, Canada

3   School of Public Health and Social Policy, University of Victoria, Victoria, Canada

4   Faculty of Health Sciences, Simon Fraser University, Burnaby, Canada

5   British Columbia Centre for Disease Control, Vancouver, Canada

6   Community-Based Research Centre for Gay Men's Health, Vancouver, Canada

7   Health Initiative for Men, Vancouver, Canada

8   Department of Anthropology, University of Victoria, Victoria, Canada

not tested for HIV in the past 2 years [8]. While some may not test for personal reasons (e.g., perceived low-risk, fear of knowing the result), structural and practical reasons may also affect testing behaviour [5, 9]. Standard HIV tests often require multiple visits to the doctor or clinic, first for testing and then to receive the results, and it may take several weeks for these results to be determined. Further, family physicians are usually not equipped to perform blood draws and need to refer out to laboratory testing services. Sexual health clinics, which may be better able to accommodate this testing, are less common but may be inaccessible to those who live outside major centres or those uncomfortable visiting designated HIV/STI testing sites, especially those targeting gay men, for fear of stigma or lack of anonymity [5].

Rapid point-of-care testing (POCT) was designed to remove some of these structural and practical barriers. Rapid testing uses a finger prick blood sample, eliminating the need for a venous blood draw. Further, results are available within minutes of testing, eliminating the need for multiple trips to potentially various locations. Acceptability of POCT was high among a community sample of 258 anonymous HIV testers [10] and in one study of GBMSM who had never tested for HIV, intentions of using a rapid POCT if available were high, even among those who said they were "somewhat unlikely" to test for HIV [9]. However, POCT is potentially more expensive than standard testing and slightly less sensitive and specific than current laboratory-based HIV tests, thus POCT should be used selectively for appropriate settings and populations [11].

In order to better understand recent changes in the HIV testing environment for GBMSM in Metro Vancouver, we conducted a cross-sectional analysis of participants enrolled in a study examining attitudes towards HIV treatment and HIV risk behavior. There were four main objectives to this analysis. First, we sought to identify the proportion of GBMSM who had tested for HIV in the past 2 years, previously tested but not in the last 2 years, and who had never tested. Second, we wished to describe men's reasons for testing or not testing. Third, we aimed to identify factors associated with testing in the last 2 years. Finally, among those who had tested, we wanted to examine uptake of POCT as well as factors associated with last test as POCT versus not.

Methods

Participants in this study were enrolled in the larger Momentum Health Study, a biobehavioural study of GBMSM in Vancouver, Canada. Eligibility criteria included being 16 years of age or older, identifying as a man (including trans men), having had sex (i.e., broadly defined as any sexual contact) with a man in the past 6 months, living in Metro Vancouver, and being able to complete the study in English.

Respondent-driven sampling (RDS) was used to recruit the sample and full study methodology has been published elsewhere [3]. Purposefully chosen "seed" participants were selected to target hidden and hard-to-reach populations [12]. Upon completing the survey, seed participants were given up to six recruitment vouchers to distribute among their networks. Likewise, subsequent participants were also given vouchers to distribute, thus allowing recruitment to proceed in waves. Participants received a $50 honourarium and an additional $10 for each additional participant they successfully recruited into the study. Recruitment occurred between February 2012 and February 2014. All participants provided written informed consent.

All study visits took place in the downtown study office. Upon providing written informed consent, participants completed a computer-assisted self-interview (CASI) assessing demographics, sexual behaviour and risk including self-reported HIV prevention strategies (e.g., condom use during anal sex, strategic positioning defined as engaging in anal sex in lower risk positions based on HIV serostatus (i.e., insertive HIV-negative partner and receptive HIV-positive partner), anal sex avoidance, serosorting defined as having condomless sex with only people of the same HIV status, viral load sorting defined as having condomless sex only with HIV-positive partners who have low viral loads or are on HIV treatment, withdrawal, and asking partner's HIV status before sex), health service utilization, and experiences with testing for HIV and sexually transmitted infections (STIs). Reasons for testing and not testing were assessed using a measure previously used in HIV surveillance in Canada [13]. Validated psychosocial measures including the Hospital Anxiety and Depression Scale (HADS; [14]) and the HIV Treatment Optimism-Skepticism Scale [15] were also included. As part of the larger study, participants also met with a study nurse for clinical assessment and HIV/STI testing (see [3] for full study testing procedures). All study procedures were approved by the research ethics boards of the University of British Columbia, the University of Victoria, and Simon Fraser University.

Analyses were limited to HIV-negative participants as determined by biological HIV testing at baseline, as well as those who had been recently diagnosed with HIV within the past 2 years. Prior to HIV testing, participants were asked if they had ever received an HIV test. Participants who answered 'no' were given a list of 23 possible reasons people may give for not testing (e.g., "I am at low risk for HIV infection", "I could not deal with knowing I was infected", "I don't have a doctor") and asked to select all that apply. Participants were also given an "other" option with an open text field so they could provide their own response if desired; open text fields were then re-coded if appropriate to existing responses or else classified as "other". Participants who answered 'yes', they had previously tested for HIV, were

given a list of 12 possible reasons for having been tested (e.g., "I get tested regularly and this was a regular test", "I tested after starting a new relationship", "I had symptoms or illness that I thought might be related to HIV"), as well as an open field "other" option, and asked to select all that apply [13]. They were also asked, "Was your most recent test a 'Rapid Test' for HIV (were you able to receive the results immediately?)".

In order to determine factors associated with HIV testing in the past 2 years versus not in the past 2 years/never and, among testers, factors associated with uptake of POCT at last test (vs. standard HIV testing), we generated univariable and multivariable logistic regression models using backward selection. A 2 year testing window was chosen to be consistent with past HIV surveillance conducted among GBMSM in Vancouver and Canada [8, 13]. Variables of interest with p-value < 0.2 in univariable modelling were included for consideration in the multivariable modelling. The final models were selected based on AIC and Type III p-values, with the least significant variable dropped until minimum AIC was attained [16], in order to balance the trade-off between goodness of fit and model complexity and to adjust for potential confounding effects of other variables in the model [17, 18]. All analyses used RDS weighting via RDSAT version 7.1.46 [19] that was imported into SAS Version 9.4 (SAS Corporation Cary, NC), which was used to conduct all analyses.

Results

719 GBMSM participated in the larger Momentum Health Study, including 119 seed participants (see [20] for more detailed description of seeds vs. study recruits). After excluding participants who had been diagnosed with HIV more than 2 years before their study visit (n = 184), we were left with an analytical sample of 535 (520 HIV-negative, 15 recently diagnosed HIV-positive). Median age of the sample was 30 years (Q1,Q3: 24,39). The majority (66.7%) self-identified as White; other races/ethnicities included Asian (11.7%), Indigenous (7.3%), Latino (9.8%), and other (4.5%). Most identified as gay (81.3%); 13.4% identified as bisexual and 5.3% as other (e.g., queer). Most participants also lived in the city of Vancouver, 41.5% lived downtown and 37.2% lived elsewhere in the city; the remaining 21.3% lived in the greater Metro Vancouver area. The majority (71.4%) reported an annual income < $30,000 Canadian dollars and 10.2% reported an annual income ≥ $60,000. The median number of male anal sex partners in the past 6 months was 3 (Q1,Q3: 1–6) and about one-third (31.1%) reported any condomless anal sex with at least one serodiscordant or unknown status partner during this time.

Reasons for Testing and Not Testing

Four out of five participants in this sample reported having had an HIV test in the past 2 years (n = 448, 80.0%). A further 10.7% of participants reported that they had tested, but not in the past 2 years, and 9.3% indicated that they had never had an HIV test. Among participants who had ever had an HIV test (n = 496, 90.7%), the most common reason for testing was that it was part of a regular routine (53.2%). Other reasons included testing after a risk event (20.9%) and after starting a new relationship (18.7%). Among participants who had never tested for HIV (n = 39, 9.3%), the most common reasons for not testing were considering oneself to be at low risk (69.3%) and wanting to test but just not having done it yet (59.7%). Please see Table 1 for a complete list of reasons for ever or never having testing.

HIV Testing in the Past 2 Years

In the multivariable model of likelihood of not having tested in the past 2 years or never testing for HIV versus testing in the past 2 years, men who had not tested were more likely to identify as bisexual (vs. gay; aOR = 9.65, 95% CI: 3.02, 30.85), identify an other race/ethnicity (vs. White; aOR = 3.59, 95% CI: 1.12, 11.52), live outside the city of Vancouver (vs. downtown, aOR = 2.23, 95% CI: 1.14, 4.37), and be 45 years of age or older (vs. < 30, aOR = 2.37, 95% CI: 1.15, 4.89). Men who had not tested in the past 2 years also reported fewer male anal sex partners (aOR = 0.89, 95% CI: 0.82, 0.97), were less likely to have ever tested for other STIs (aOR = 0.15, 95% CI: 0.07, 0.32), were more likely to consider themselves as having a "very unlikely" lifetime risk of acquiring HIV (vs. "unlikely"; aOR = 0.48, 95% CI: 0.26, 0.87), and were less likely to have recently used the HIV prevention strategies of viral load sorting (i.e., using condoms selectively with serodiscordant partners based on HIV-positive partners' viral load; aOR = 0.06, 95% CI: 0.004, 0.92) and asking their partners' HIV status (aOR = 0.49, 95% CI: 0.29, 0.83). Gay men who had disclosed their sexual orientation to others (i.e., considered themselves "out") were also less likely to have tested than gay men who were not "out" (aOR = 2.78, 95% CI: 1.01, 7.68). Men who had not tested were less likely to report any condomless anal sex with an HIV serodiscordant or unknown status partner in the past 6 months in the univariable analysis (OR = 0.44, 95% CI: 0.26, 0.74), but this was not selected for inclusion in the final multivariable model. For complete results see Table 2.

Rapid Testing at Last HIV Test

Among participants who had ever had an HIV test and who responded to questions about rapid testing (n = 462/496, 93.1%), nearly half (45.4%) reported that their most recent

Table 1 Reasons for ever or never having tested for HIV

Reasons for testing (n = 496)	n	Crude%	RDS%	Reasons for never testing (n = 39)	n	Crude%	RDS%
I get tested regularly and this was a regular test	312	62.9	53.2	I am at low risk for HIV infection	20	51.3	69.3
I was getting tested after an event or exposure that might have put me at risk	132	26.6	20.9	I want to be tested I just have not done it yet	17	43.6	59.7
I tested after starting a new relationship	107	21.6	18.7	I have not had sex with an infected person	15	38.5	63.6
I was being tested for another STI	92	18.5	13.7	I always have safer sex	15	38.5	100.0
I was encouraged to get tested by friends/family/partner	52	10.5	10.4	I think I am HIV-negative	12	30.8	100.0
A health care worker recommended that I get tested for HIV	29	5.8	6.2	It could affect my relationships	8	20.5	44.9
I found out that a sex partner was or might be HIV positive	28	5.6	5.1	I do not want to know	7	17.9	25.5
I had symptoms or illness that I thought might be related to HIV	21	4.2	3.3	I am worried about the impact on my sex life	7	17.9	45.5
No reason	18	3.6	3.2	I never thought about it	7	17.9	0.0
I saw an ad/poster/article about HIV	13	2.6	2.5	I am afraid of needles	6	15.4	0.0
Tested as part of other medical procedure	11	2.2	1.6	I do not have a doctor	5	12.8	0.0
I was notified by public health that I could have been exposed to HIV	4	0.8	0.1	I could not deal with knowing I was infected	5	12.8	29.2
Had been a while/never tested before	3	0.6	2.0	I am healthy so I do not need to be tested	4	10.3	0.0
Other reasons	12	2.4	2.9	I do not know where to get an HIV test	4	10.3	0.0
				I am worried about being discriminated against	4	10.3	35.1
				It could affect my career or insurance	2	5.1	26.0
				If I tested positive nothing can be done	1	2.6	0.0
				I do not think I can get HIV	1	2.6	0.0
				I think I am HIV-positive	1	2.6	0.0
				I do not think the test is always right	1	2.6	0.0
				I am afraid of having my name reported	1	2.6	0.0
				I could not get an appointment for HIV testing when I wanted one	1	2.6	0.0
				It does not matter if I am infected because of my age	0	0.0	0.0
				Other reasons	2	5.1	29.7

STI sexually transmitted infection

test had been a POCT. Univariable and multivariable results are presented in Table 3. Rapid testing was less likely among GBMSM who are Asian or Latino (vs. White; aOR = 0.34, 95% CI: 0.15, 0.77 and aOR = 0.36, 95% CI: 0.14, 0.89, respectively), 45 years of age or over (vs. < 30; aOR = 0.27, 95% CI: 0.13, 0.56), and who lived in Vancouver but outside of downtown (aOR = 0.49, 95% CI: 0.28, 0.87) or in Metro Vancouver (vs. downtown; aOR = 0.34, 95% CI: 0.18, 0.64). Rapid testing was also less likely among GBMSM who had ever tested for STIs (aOR = 0.22, 95% CI: 0.08, 0.64) as well as among those who tested at a doctor, hospital, or walk-in clinic (aOR = 0.13, 95% CI: 0.08, 0.23) or another location (aOR = 0.30, 95% CI: 0.15, 0.62) compared with those who tested at a sexual health clinic. Rapid testing was more likely among those who usually received medical care at hospital emergency rooms (vs.

elsewhere; aOR = 4.87, 95% CI: 2.03, 11.67). Rapid testing was also more likely among GBMSM who used viral load sorting as an HIV prevention strategy (aOR = 2.84, 95% CI: 1.29, 6.28) but less likely among those who reported avoiding anal sex as an HIV prevention strategy (aOR = 0.60, 95% CI: 0.37, 0.996). Rapid testing was not associated with any condomless anal sex with an HIV serodiscordant or unknown status partner in the past 6 months (OR = 1.21, 95% CI: 0.81, 1.80).

Discussion

While 80% of GBMSM in this sample had tested for HIV within the past 2 years, one in ten had not tested in the past 2 years and a further one in ten had never tested. For

Table 2 Univariable and multivariable analyses of likelihood of no recent (> 2 years) or never testing for HIV versus recent testing (past 2 years)

	Not recent/never (n = 87)			Tested past 2 years (n = 448)			Univariable		Multivariable	
	n	RDS%	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Sexual identity										
Gay	66	65.9	52.1, 79.7	389	84.7	79.4, 90.1	Ref		Ref	
Bisexual	15	29.2	15.4, 43.0	31	10.0	5.2, 14.7	**3.77**	**2.23, 6.37**	**9.65**	**3.02, 30.85**
Other	6	4.9	0.7, 9.0	28	5.3	2.4, 8.2	1.18	0.44, 3.13	1.96	0.60, 6.42
Race/ethnicity										
White	67	77.3	65.1, 89.5	329	66.8	60.0, 73.6	Ref		Ref	
Asian	9	6.9	0.8, 13.0	53	11.8	7.9, 15.7	0.51	0.23, 1.13	0.54	0.18, 1.65
Indigenous	2	4.2	0.0, 10.1	29	8.7	4.1, 13.3	0.42	0.15, 1.14	0.29	0.08, 1.04
Latino	3	2.6	0.0, 5.8	22	9.7	4.5, 14.9	**0.23**	**0.07, 0.79**	0.47	0.09, 2.39
Other	6	9.0	0.0, 19.1	15	3.0	1.1, 4.9	**2.58**	**1.09, 6.12**	**3.59**	**1.12, 11.52**
Born in Canada										
No	14	19.6	7.4, 31.8	117	31.4	24.9, 38.0	Ref		Ref	
Yes	73	80.4	68.2, 92.6	331	68.6	62.0, 75.1	**1.88**	**1.12, 3.15**	1.92	0.89, 4.13
Neighborhood										
Downtown	30	34.0	20.8, 47.2	200	47.7	40.9, 54.5	Ref		Ref	
Vancouver, Not Downtown	30	32.1	19.7, 44.4	158	31.7	25.6, 37.8	1.42	0.85, 2.36	1.36	0.73, 2.55
Outside City	27	33.9	20.9, 47.0	90	20.6	15.4, 25.9	**2.30**	**1.37, 3.87**	**2.23**	**1.14, 4.37**
Age group (years)										
< 30	43	47.5	33.9, 61.0	224	48.7	41.9, 55.5	Ref		Ref	
30–44	22	26.7	14.0, 39.3	151	36.0	29.5, 42.5	0.76	0.46, 1.25	1.07	0.55, 2.10
45 +	22	25.9	13.4, 38.4	73	15.3	10.5, 20.1	**1.74**	**1.02, 2.97**	**2.37**	**1.15, 4.89**
# of male anal sex partners, p6m (median, *adjusted median, and adjusted IQR) (Continuous)*	2	*2*	*1, 3*	3	*3*	*1, 9*	**0.85**	**0.79, 0.92**	**0.89**	**0.82, 0.97**
# of female sex partners, p6m										
0	74	78.3	65.4, 91.1	417	91.4	87.1, 95.7	Ref		Not selected	
1 +	13	21.7	8.9, 34.6	31	8.6	4.3, 12.9	**2.94**	**1.67, 5.18**		
Condomless anal sex with opposite/unknown status partner, p6m										
No	64	80.5	70.6, 90.5	273	64.4	57.9, 70.9	Ref		Not selected	
Yes	18	19.5	9.5, 29.4	168	35.6	29.1, 42.1	**0.44**	**0.26, 0.74**		
Anal sex position preference										
Bottom	29	31.8	19.1, 44.6	147	31.1	24.8, 37.4	Ref		Not selected	
Versatile	21	20.5	10.5, 30.5	115	24.9	19.0, 30.8	0.80	0.45, 1.45		
Top	30	36.0	23.0, 48.9	169	41.0	34.3, 47.7	0.86	0.51, 1.42		
No anal sex	7	11.7	0.7, 22.8	17	3.0	1.3, 4.7	**3.82**	**1.61, 9.02**		

Table 2 (continued)

	Not recent/never (n = 87)			Tested past 2 years (n = 448)			Univariable		Multivariable	
	n	RDS%	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Seropositioning prevention strategy, p6m										
No	68	83.2	74.3, 92.1	321	73.9	68.2, 79.6	Ref		Not selected	
Yes	19	16.8	7.9, 25.7	123	26.1	20.4, 31.8	0.57	0.33, 0.99		
Viral load sorting prevention strategy, p6m										
No	86	99.5	98.5, 100.0	389	89.7	86.0, 93.4	Ref		Ref	
Yes	1	0.5	0.0, 1.5	55	10.3	6.6, 14.0	0.04	0.003, 0.64	0.06	0.004, 0.92
Withdrawal prevention strategy, p6m										
No	69	85.3	77.6, 93.0	314	72.5	66.4, 78.7	Ref		Not selected	
Yes	18	14.7	7.0, 22.4	130	27.5	21.3, 33.6	0.46	0.26, 0.81		
Ask HIV status of partners as prevention strategy, p6m										
No	41	49.9	36.2, 63.6	152	36.1	29.4, 42.7	Ref		Ref	
Yes	46	50.1	36.4, 63.8	292	63.9	57.3, 70.6	0.57	0.37, 0.86	0.49	0.29, 0.83
Tested for STIs, ever										
No	27	30.6	18.3, 42.8	20	8.6	3.7, 13.5	Ref		Ref	
Yes	57	69.4	57.2, 81.7	423	91.4	86.5, 96.3	0.21	0.13, 0.37	0.15	0.07, 0.32
Had an anal pap, past 1 year										
No	81	97.3	94.0, 100.0	366	88.0	83.7, 92.3	Ref		Not selected	
Yes	3	2.7	0.0, 6.0	61	12.0	7.7, 16.3	0.21	0.06, 0.68		
Being out[a]										
No	22	35.1	21.2, 48.9	90	26.8	20.4, 33.3	Ref		Ref	
Yes	65	64.9	51.1, 78.8	358	73.2	66.7, 79.6	0.68	0.43, 1.06	2.78	1.01, 7.68
Any injection drug use (including steroids)										
No	84	98.0	94.7, 100.0	413	92.2	88.0, 96.4	Ref		Not selected	
Yes	3	2.0	0.0, 5.3	35	7.8	3.6, 12.0	0.24	0.06, 0.96		
Told family doctor that you have male sex partners										
No	20	26.2	13.4, 39.0	52	14.8	9.8, 19.9	Ref		Not selected	
Yes	26	33.7	20.6, 46.7	205	39.4	33.0, 45.9	0.48	0.27, 0.85		
N/A (no family Dr)	41	40.1	27.1, 53.1	186	45.7	38.8, 52.6	0.50	0.29, 0.86		
Usually receives medical care somewhere other than doctor's office, walk-in clinic, health centre, or ER										
No	80	94.0	88.8, 99.2	384	86.6	81.9, 91.3	Ref		Ref	
Yes	7	6.0	0.8, 11.2	64	13.4	8.7, 18.1	0.41	0.18, 0.95	0.47	0.17, 1.29
HAD depression score										
Normal/mild	84	93.8	84.1, 100.0	422	95.5	93.3, 97.8	Ref		Not selected	
Moderate/severe	2	6.2	0.0, 15.9	23	4.5	2.2, 6.7	1.41	0.57, 3.50		

Table 2 (continued)

	Not recent/never (n = 87)			Tested past 2 years (n = 448)			Univariable		Multivariable	
	n	RDS%	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Frequency of asking about partners' HIV statuses										
< 50%	49	52.6	38.8, 66.4	169	41.6	34.9, 48.4	Ref		Not selected	
≥ 50%	38	47.4	33.6, 61.2	279	58.4	51.6, 65.1	0.64	0.42, 0.98		
Perceived risk of acquiring or transmitting HIV										
Very unlikely (≤10%)	45	56.8	43.7, 70.0	182	42.2	35.5, 48.9	Ref		Ref	
Unlikely (11–39%)	33	31.6	19.8, 43.4	197	41.5	35.0, 48.1	0.57	0.36, 0.90	0.48	0.26, 0.87
Likely (≥40%)	9	11.6	3.6, 19.6	69	16.3	10.8, 21.7	0.53	0.27, 1.03	1.05	0.45, 2.49

Bold text signifies a statistically significant result

p6m past 6 months, *IQR* interquartile range

[a]Only asked to gay identified participants; OR/aORs for continuous variables are calculated by 1 unit increase

HIV-negative GBMSM who are at low risk for HIV, including those who are in sexually exclusive relationships with HIV-negative or virally suppressed HIV-positive partners [21], regular HIV testing may not be necessary if no risk events have occurred. In this study, 20.3% of participants who had not tested in the past 2 years reported being in monogamous or married relationships (although it should be noted that not all married relationships are monogamous). And although our data collection period preceded the release of new testing guidelines in BC in 2014, these data suggest that some men who are at higher risk of HIV acquisition are not testing as frequently as recommended [2]. Given the implementation of new guidelines that GBMSM should test annually, and that those at highest risk should test more frequently [2], it remains to be seen if testing rates and frequency increase in the future. Additionally, since data collection for this study occurred, new prevention technologies specifically pre-exposure prophylaxis (PrEP) which was approved for use in Canada in 2016, have shifted traditional definitions of high-risk sex. While no participants in this study reported being on PrEP at time of data collection, recent increases in PrEP uptake will likely have corresponding increases in frequency and prevalence of HIV testing, as testing is required every 3 months as per PrEP dispensing guidelines [22].

Among those who had ever tested, the majority reported testing as part of an established routine. However, among those who had never tested, reported reasons for not testing centred around a theme of perceived low risk or non-exposure (e.g., "I am at low risk for HIV infection", "I have not had sex with an infected person", and "I always have safer sex"). This is potentially problematic as people tend to overestimate the likelihood of positive personal outcomes and underestimate their actual risk of negative outcomes, a cognitive bias known as the "Optimism Bias" [23]. This bias has been found among GBMSM asked to estimate their perceived risk of HIV. In a sample of 629 GBMSM attending commercial sex venues, most men (78%) did not perceive their risk of HIV to be significant enough to be candidates for pre-exposure prophylaxis (PrEP); however, 80.3% of men objectively met sufficient risk criteria [24]. In the present study, 19.5% of GBMSM reporting condomless anal sex with a serodiscordant or unknown status partner had not tested in the past 2 years and no participants reported use of PrEP. Further, in the present analyses, 44.5% of GBMSM reported asking their partner's HIV status less than half the time so men may be unaware of potential exposure events. Another frequently reported reason for not testing was "I want to be tested, I just have not done it yet" and men who endorse this reason may be a key target population for increased testing efforts. Given these men's existing endorsement of testing, and in line with the Transtheoretical Model of Health Behaviour Change [25], increased visibility

Table 3 Factors associated with point-of-care versus standard testing at last HIV test

	Standard Test (n = 250)			POCT (n = 212)			Univariable		Multivariable	
	n	RDS %	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Sexual identity										
Gay	209	79.6	71.6, 87.5	189	88.4	81.8, 95.0	Ref		Not selected	
Bisexual	22	14.4	6.8, 21.3	13	7.9	1.8, 14.0	0.51	0.27, 0.94		
Other	19	6.4	2.0, 10.8	10	3.7	0.8, 6.6	0.52	0.22, 1.26		
Race/ethnicity										
White	187	63.6	54.5, 72.7	158	75.4	66.8, 84.0	Ref		Ref	
Asian	31	13.8	8.0, 19.6	21	7.3	3.3, 11.3	0.45	0.24, 0.85	0.34	0.15, 0.77
Indigenous	15	7.7	1.9, 13.5	11	6.4	0.9, 11.9	0.70	0.34, 1.45	0.58	0.23, 1.45
Latino	10	10.5	3.3, 17.6	10	5.6	0.1, 11.0	0.45	0.22, 0.93	0.36	0.14, 0.89
Other	7	4.4	0.0, 8.8	12	5.3	1.5, 9.0	1.01	0.43, 2.38	1.39	0.45, 4.27
Neighborhood										
Downtown	98	40.5	31.9, 49.2	102	51.0	40.8, 61.2	Ref		Ref	
Vancouver, not downtown	94	33.8	25.7, 41.9	69	28.2	19.5, 36.9	0.66	0.43, 1.02	0.49	0.28, 0.87
Outside city	58	25.7	17.9, 33.4	41	20.8	13.0, 28.7	0.65	0.40, 1.04	0.34	0.18, 0.64
Age group (years)										
< 30	113	43.5	34.8, 52.1	113	50.7	40.5, 60.9	Ref		Ref	
30–44	81	33.1	24.9, 41.3	72	37.8	27.9, 47.7	0.98	0.65, 1.47	0.88	0.51, 1.51
45 +	56	23.4	16.0, 30.8	27	11.5	5.1, 17.9	0.42	0.24, 0.73	0.27	0.13, 0.56
Current relationship status										
Married/monogamous	38	14.4	8.5, 20.2	34	16.2	8.3, 24.1	Ref		Ref	
Open/partially open	62	26.4	18.7, 34.1	41	15.9	9.0, 22.7	0.53	0.29, 0.998	0.60	0.27, 1.33
No regular partner	150	59.2	50.7, 67.7	137	67.9	58.5, 77.4	1.02	0.60, 1.71	1.13	0.56, 2.28
# of male anal sex partners, p6m (*median, adjusted median, and adjusted IQR*) (Continuous)	2	2	1, 5	4	4	1, 9	1.02	1.01, 1.04	Not selected	
Condomless Anal Sex with Opposite/unknown Status Partner, p6m										
No	166	69.8	61.9, 77.8	127	65.7	56.3, 75.1	Ref		Not selected	
Yes	73	30.2	22.2, 38.1	81	34.3	24.9, 43.7	1.21	0.81, 1.80		
# of female sex partners, p6m										
0	230	86.7	79.1, 94.4	197	93.4	89.2, 97.6	Ref		Not selected	
1 +	20	13.3	5.6, 20.9	15	6.6	2.4, 10.8	0.46	0.24, 0.89		

Table 3 (continued)

	Standard Test (n = 250)			POCT (n = 212)			Univariable		Multivariable	
	n	RDS %	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Anal sex position preference										
Bottom	81	31.3	23.1, 39.5	69	29.5	20.2, 38.8	Ref		Ref	
Versatile	51	17.2	11.2, 23.1	63	33.7	23.6, 43.8	2.08	1.26, 3.44	1.69	0.90, 3.18
Top	104	44.9	36.2, 53.7	73	34.1	24.7, 43.4	0.80	0.51, 1.26	0.78	0.44, 1.38
No anal sex	14	6.6	1.9, 11.3	7	2.8	0.1, 5.4	0.44	0.16, 1.21	0.41	0.11, 1.46
Always using condoms as a prevention practice, p6m										
No	85	33.8	25.7, 41.9	90	40.6	30.7, 50.4	Ref		Not selected	
Yes	165	66.2	58.1, 74.3	119	59.4	49.6, 69.3	0.75	0.51, 1.09		
Viral load sorting prevention practice, p6m										
No	228	94.3	91.4, 97.1	181	86.2	79.1, 93.4	Ref		Ref	
Yes	22	5.7	2.9, 8.6	28	13.8	6.6, 20.9	2.63	1.36, 5.09	2.84	1.29, 6.28
Avoiding anal sex as a prevention practice, p6m										
No	111	51.1	42.4, 59.8	114	61.7	52.1, 71.2	Ref		Ref	
Yes	139	48.9	40.2, 57.6	95	38.3	28.8, 47.9	0.65	0.45, 0.95	0.60	0.37, 0.996
Tested for STIs, ever										
No	10	5.4	0.5, 10.2	10	9.3	1.9, 16.8	Ref		Ref	
Yes	237	94.6	89.8, 99.5	200	90.7	83.2, 98.1	0.55	0.27, 1.14	0.22	0.08, 0.64
Location of most recent HIV test										
Sexual health clinic	93	32.3	24.8, 39.8	158	65.8	55.3, 76.3	Ref		Ref	
Doctor/hospital/walk-in clinic	120	51.1	42.4, 59.8	28	23.9	13.8, 34.0	0.23	0.15, 0.35	0.13	0.08, 0.23
Other	37	16.6	9.8, 23.4	26	10.3	4.2, 16.4	0.30	0.17, 0.55	0.30	0.15, 0.62
Being out[a]										
No	56	28.8	20.2, 37.4	36	25.1	15.5, 34.6	Ref		Ref	
Yes	194	71.2	62.6, 79.8	176	74.9	65.4, 84.5	1.21	0.80, 1.83	0.78	0.44, 1.35
Has a family doctor										
No	98	40.3	31.5, 49.1	100	50.4	40.2, 60.7	Ref		Not selected	
Yes	152	59.7	50.9, 68.5	111	49.6	39.3, 59.8	0.66	0.46, 0.96		
Told family doctor that you have male sex partners										
No	32	17.0	10.0, 24.0	26	16.4	8.2, 24.6	Ref		Not selected	
Yes	118	42.2	33.8, 50.6	83	33.0	23.7, 42.3	0.81	0.47, 1.40		
N/A (no family Dr)	98	40.7	31.8, 49.6	100	50.7	40.4, 60.9	1.29	0.76, 2.19		
Usually receives medical care at family doctor's office										
No	114	45.5	36.7, 54.3	114	56.4	46.3, 66.5	Ref		Not selected	
Yes	136	54.5	45.7, 63.3	98	43.6	33.5, 53.7	0.65	0.45, 0.93		

Table 3 (continued)

	Standard Test (n = 250)			POCT (n = 212)			Univariable		Multivariable	
	n	RDS %	95% CI	n	RDS %	95% CI	OR	95% CI	aOR	95% CI
Usually receives medical care at emergency room										
No	240	94.8	90.4, 99.3	199	89.2	81.3, 97.0	Ref		Ref	
Yes	10	5.2	0.7, 9.6	13	10.8	3.0, 18.7	**2.24**	**1.10, 4.54**	**4.87**	**2.03, 11.67**
HAART treatment optimism (median, adjusted median, and adjusted IQR) (Continuous)	24	24	21, 26	24	24	21, 28	1.03	0.99, 1.07	Not selected	
Stigma score (median, adjusted median, and adjusted IQR) (Continuous)	18	18	17, 20	18	18	16, 19	**0.93**	**0.88, 0.99**	0.92	0.85, 1.00

Bold text signifies a statistically significant result

p6m = past 6 months; IQR = interquartile range

[a] Only asked to gay identified participants; OR/aORs for continuous variables are calculated by 1 unit increase

and access to testing sites, potentially coupled with education about the importance of being tested, may effectively encourage them to take action.

The results of this study indicate significant disparities between those who have tested in the past 2 years and those who have not or have never tested. While number of recent male anal sex partners was positively associated with likelihood of having had an HIV test in the past 2 years, condomless anal sex with an unknown status or serodiscordant partner in the past 6 months was not significantly associated with HIV testing in the final multivariable model. However, we also found a positive association between having tested in the past 2 years and reporting use of viral load sorting as an HIV prevention strategy (i.e., having condomless anal sex with serodiscordant partners only when the HIV-positive partner's viral load is low). Thus, in practice, GBMSM may be managing risk by only engaging in what has been traditionally considered a high-risk behaviour when that risk has been minimized or completely eliminated [21]. Given that those who are sufficiently informed and able to negotiate condom use based on viral load also report more recent testing, they may be more engaged in health care and have had more opportunities to have learned about viral load and Treatment as Prevention strategies, as well as to increase their overall health literacy. This may be partially supported by the finding that those who reported having ever tested for any STI were also more likely to report having tested for HIV in the past 2 years (among those who had tested in the past 2 years, 91.4% had also ever tested for an STI compared with 69.4% among non-testers). Future analyses will also need to take into consideration an individual's use of PrEP as an additional HIV-prevention strategy.

Bisexual men, men who self-identified as an "other" ethnic or racial minority, those 45 years of age or older, and those who lived outside the city of Vancouver were significantly less likely to have tested in the past 2 years. Each of these factors, while each potentially associated with differing risk profiles, may also be associated with decreased connection to the gay community, either socially, or physically, or both [26–28]. Without this connection, messaging from targeted testing interventions may not be seen and access to welcoming and safe health services and support may be limited or completely unavailable. Further, public health campaigns to increase HIV testing may target GBMSM in general. Thus, increasing the inclusivity of the message (e.g., including racial minority and older individuals in media campaigns) and targeted messaging that is cognizant of within community differences and sensitive to subcultures may help increase testing among these individuals. This is consistent with a recent study of perceptions of HIV testing campaigns among Black/African-American and Hispanic/Latino GBMSM in New York City [29] which called for the use of non-stereotypical messages and images related to

race and sexuality, the use of non-gay identified images, and for testing campaigns to be maximally inclusive and visible.

Rapid POCT was used at their most recent testing episode by nearly half of the participants in this study who reported a previous HIV test. Encouragingly, this method was successfully able to engage some generally hard-to-reach subpopulations of GBMSM including those who had never tested for other STIs and those who usually received medical care at hospital emergency. Unsurprisingly, access to POCT via sexual health clinics and living downtown, where most gay community resources in Vancouver are located, predicted uptake. For the most part, these clinics are the only venues which receive public funding for POCT in Vancouver. This suggests that increasing the visibility and availability of POCT at other potential testing venues, including family doctors and in more suburban and rural areas, may encourage more individuals to test, thus improving rates of diagnosis and treatment outcomes. Likewise, mobile or online POCT could effectively engage individuals in more remote areas. Indeed, in a rural Canadian setting, rapid POCT was highly desired and acceptable, suggesting uptake would be high if offered [10]. However, appropriate implementation of POCT is also necessary as the rate of false positive is higher than conventional laboratory testing, they are more expensive, and are less reliable to detect early infection [11]. Thus, even if POCT is more readily available, individuals seeking testing should be aware of the benefits and limitations of each testing method and clinicians should screen patients to determine the most appropriate way to test.

There are strengths and limitations of this work that should be noted. RDS is notable for its ability to reach men who would otherwise not be included in traditional recruitment strategies such as venue-based sampling from gay bars or sexual health clinics. Further, the use of weighted analyses allows for the calculation of population point estimates which may be more representative of the sampled population. Our study is limited by our operationalization of HIV testing to be within the past 2 years. While this is consistent with past surveillance in this population and location [8, 13], it is a longer period than the new guidelines recommend [2]. As such, our study cannot distinguish individuals who are not testing as frequently as recommended, but who have still tested between 1 and 2 years ago, and who may be an important target population for increased testing frequency. With respect to reasons for testing and not testing, participants were presented with a list of predefined options, thus they may have responded differently upon reflection than if they had been asked about their motivation prior to testing. Finally, in 2012–2014 there was limited availability of publically funded POCT outside of downtown Vancouver, where 41.5% of our sample lived. Thus, these individuals may have had greater access to POCT and were subsequently significantly more likely to have had a rapid test at last testing.

Given that the majority of GLBT services are centralized in downtown Vancouver, even those who do not live in this area may visit frequently; however, this result should still be interpreted with caution.

Conclusion

As the first step toward reaching the UNAIDS global 90-90-90 targets, HIV testing is necessary for diagnosis so that individuals living with HIV are aware and can begin appropriate treatment. Among HIV-negative individuals, testing also provides an opportunity for education and discussion with health care professionals about novel combination prevention techniques, including pre-exposure prophylaxis. Because of the importance of diagnosis and treatment, both at the individual and population levels, all individuals who are sexually active and/or at risk should be tested for HIV and further efforts should be made to engage GBMSM, particularly bisexual and older men, and those living outside of the city of Vancouver, in testing. Expansion of rapid testing may be one suitable option as this effectively engaged some hard-to-reach GBMSM in this sample and notably, one Vancouver area gay men's health clinic (Health Initiative for Men, http://checkhimout.ca) has begun to offer rapid testing services at satellite sites outside of the city. Increased awareness among less connected GBMSM and further access to rapid testing at appropriate sites and for appropriate high-risk patients may improve diagnoses and subsequent treatment outcomes.

Compliance with Ethical Standards

Conflict of interest The authors have no conflicts of interest to declare.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All study procedures received ethical approval from the research ethics boards of the University of British Columbia, the University of Victoria, and Simon Fraser University.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Joint United Nations Programme on HIV/AIDS (UNAIDS). 90-90-90: an ambitious treatment target to help end the AIDS epidemic. 2014. http://www.unaids.org/sites/default/files/media_asset/90-90-90_en.pdf.
2. Office of the Provincial Health Officer. HIV Testing guidelines for the province of British Columbia. 2014. http://www.bccdc.ca/resource-gallery/Documents/Communicable-Disease-Manual/Chapter%205%20-%20STI/HIVTestingGuidelinesJune2015.pdf.
3. Moore DM, Cui Z, Lachowsky N, et al. HIV community viral load and factors associated with elevated viremia among a community-based sample of men who have sex with men in Vancouver, Canada. J Acquir Immune Defic Syndr. 2016;72(1):87–95.
4. BC Centre for Disease Control. HIV in British Columbia: annual surveillance report 2015. 2017. http://www.bccdc.ca/search?k=hiv%20annual%20report.
5. Deblonde J, De Koker P, Hamers FF, Luchters S, Temmerman M. Barriers to HIV testing in Europe: a systematic review. Eur J Public Health. 2010;20(4):422–32.
6. Mugavero MJ, Amico KR, Westfall AO, et al. Early retention in HIV care and viral load suppression: implications for a test and treat approach to HIV prevention. J Acquir Immune Defic Syndr. 2012;59(1):86–93.
7. Marks G, Crepaz N, Janssen RS. Estimating sexual transmission of HIV from persons aware and unaware that they are infected with the virus in the USA. AIDS. 2006;20(10):1447–50.
8. Moore DM, Kanters S, Michelow W, et al. Implications for HIV prevention programs from a serobehavioural survey of men who have sex with men in Vancouver, British Columbia: the ManCount study. Can J Pub Health. 2012;103(2):142–6.
9. MacKellar DA, Hou SI, Whalen CC, et al. Reasons for not HIV testing, testing intentions, and potential use of an over-the-counter rapid HIV test in an internet sample of men who have sex with men who have never tested for HIV. Sex Transm Dis. 2011;38(5):419–28.
10. Lewis NM, Gahagan JC, Stein C. Preferences for rapid point-of-care HIV testing in Nova Scotia, Canada. Sex Health. 2013;10:124–32.
11. Broeckaert L, Challacombe L. Rapid point-of-care HIV testing: a review of the evidence. 2015. http://www.catie.ca/en/pif/spring-2015/rapid-point-care-hiv-testing-review-evidence.
12. Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. Soc Probl. 1997;44:174–99.
13. Public Health Agency of Canada. M-Track: enhanced surveillance of HIV, sexually transmitted and blood-borne infections and associated risk behaviours among men who have sex with men in Canada. Phase 1 report. Centre for communicable diseases and infection control, infectious disease prevention and control branch, Public Health Agency of Canada.
14. Snaith RP. The hospital anxiety and depression scale. Health Qual Life Outcomes. 2003;1(1):29.
15. Van de Ven P, Crawford J, Kippax S, Knox S, Prestage G. A scale of optimism-scepticism in the context of HIV treatments. AIDS Care. 2000;12(2):171–6.
16. Lima VD, Geller J, Bangsberg DR, et al. The effect of adherence on the association between depressive symptoms and mortality among HIV-infected individuals first initiating HAART. AIDS. 2007;21:1175–83.
17. Card KG, Lachowsky NJ, Cui Z, et al. Exploring the role of sex-seeking apps and websites in the social and sexual lives of gay, bisexual and other men who have sex with men: a cross-secitional study. Sex Health. 2016;14(3):229–37.
18. Dohoo IR, Martin SW, Stryhn H. Methods in epidemiologic research. VER Inc; 2012.
19. Voltz E, Wejnert C, Cameron C, Spiller M, Barash V, Degani I, Heckathorn D. Respondent-driven sampling analysis tool (RDSAT) (Version 71). Ithaca: Cornell University; 2012.
20. Lachowsky NJ, Sorge JT, Raymond HF, Cui Z, Sereda P, Rich A, Roth EA, Hogg RS, Moore DM. Does size really matter? A sensitivity analysis of number of seeds in a respondent-driven sampling study of gay, bisexual and other men who have sex with men in Vancouver, Canada. BMC Med Res Methodol. 2016;16(1):157.
21. Rodger AJ, Cambiano V, Bruun T, et al. Sexual activity without condoms and risk of HIV transmission in serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. JAMA. 2016;316(2):171–81.
22. British Columbia Centre for Excellence in HIV/AIDS. Guidance for the use of pre-exposure prophylaxis (PrEP) for the prevention of HIV acquisition in British Columbia. Vancouver: The Centre; 2017.
23. Sharot T, Riccardi AM, Raio CM, Phelps EA. Neural mechanisms mediating optimism bias. Nature. 2007;450(7166):102–5.
24. Gallagher T, Link L, Ramos M, Bottger E, Aberg J, Daskalakis D. Self-perception of HIV risk and candidacy for pre-exposure prophylaxis among men who have sex with men testing for HIV at commercial sex venues in New York City. LGBT Health. 2014;1(3):218–24.
25. Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. Am J Public Health. 1997;12(1):38–48.
26. Lewis NM, Bauer GR, Coleman TA, et al. Community cleavages: gay and bisexual men's perceptions of gay and mainstream community acceptance in the post-AIDS, post-rights era. J Homosex. 2015;62(9):1201–27.
27. McLaren S. The relationship between living alone and depressive symptoms among older gay men: the moderating role of sense of belonging with gay friends. Int Psychogeriatr. 2016;28(11):1895–901.
28. Power J, Brown R, Schofield MJ, et al. Social connectedness among lesbian, gay, bisexual, and transgender parents living in metropolitan and regional and rural areas of Australia and New Zealand. J Community Psychol. 2014;42(7):869–89.
29. Drumhiller K, Murray A, Gaul Z, et al. "We deserve better!" perceptions of HIV testing campaigns among Black and Latino MSM in New York City. Arch Sex Behav. 2018;47:289.