Preference-Based Assessments

HIV Pre-Exposure Prophylaxis, Condoms, or Both? Insights on Risk Compensation Through a Discrete Choice Experiment and Latent Class Analysis Among Men Who Have Sex With Men

Rayner Kay Jin Tan, PhD,* Yi Wang, PhD,* Kiesha Prem, PhD, Jack Harrison-Quintana, MA, Alvin Kuo Jing Teo, MPH, Nashwinder Kaur, BSc, Alex R. Cook, PhD, Mark I-Cheng Chen, PhD, Chen Seong Wong, MBBS

A B S T R A C T

Objectives: We considered how decision making around human immunodeficiency virus (HIV) pre-exposure prophylaxis (PrEP) among gay, bisexual, and other men who have sex with men (GBMSM) is made in the context of one's perceived risk of HIV acquisition and the availability of condoms.

Methods: We recruited 648 GBMSM aged 18 years old and residing in Singapore through Grindr. Participants were given information on PrEP and participated in a discrete choice experiment requiring them to choose between 2 baskets of PrEP attributes and compare the chosen "PrEP only" option to default options of "condoms only" or "PrEP with condoms." Generalized multinomial logit model was used to examine the scaling effect and preference heterogeneity. Latent class analysis was conducted to examine preference heterogeneity in the sample.

Results: Latent class analysis revealed 3 classes of GBMSM: PrEP conservatives (53.9%), moderates (31.1%), and liberals (14.9%). PrEP conservatives were more likely to report greater utility when using condoms only compared with PrEP only, as well as PrEP with condoms, compared with PrEP only, and more likely to report the lowest utility for PrEP as perceived HIV risk increased. PrEP liberals were more likely to report greatest utilities for PrEP only compared with condoms only, as well as PrEP only compared with PrEP with condoms. The utility for PrEP was not affected by perceived risk of HIV or sexually transmitted infections when risks were low.

Conclusion: This study provides some evidence for risk compensation among a class of GBMSM who already perceived themselves to be good candidates for PrEP before the discrete choice experiment.

Keywords: gay men, HIV, HIV/AIDS, HIV prevention, Singapore.

VALUE HEALTH. 2021; 24(5):714–723

Introduction

Gay, bisexual, and other men who have sex with men (GBMSM) are disproportionately affected by human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) in many settings. HIV pre-exposure prophylaxis (PrEP) is a promising means of HIV prevention among GBMSM, with several large trials underlining its efficacy in greatly reducing the risk of HIV acquisition for both daily and on-demand modalities.[1,2] Past studies have established the effectiveness of PrEP through pragmatic, community-based trials and yearly population-level indicators of PrEP uptake and HIV incidence.[3-5]

Although there is unequivocal evidence for the effectiveness of PrEP for HIV prevention among GBMSM, concerns around risk compensation and the normative aspects of PrEP have surfaced. Specifically, policymakers have expressed fears around reduced

condom use, and thus the concomitant rise in other STIs.[6] The evidence, however, remains mixed in the literature. A systematic review and meta-analysis of earlier studies of oral PrEP among at-risk populations for HIV acquisition found no evidence for any increase in sexual risk behaviors or compensation,[7] but a more recent meta-analysis of open-label studies found that PrEP use was associated with increased condomless sex and incidence of STIs, although these increases were most prominent in GBMSM who reported such behaviors at baseline.[8] Another recently published systematic review found a high burden of other STIs among individuals who were initiating PrEP, or who have been taking PrEP.[9]

Several issues complicate the measurement of risk compensation in existing studies. First, most studies measure behavioral indicators that serve as proxy measures for risk compensation instead of measuring changes in perceptions of risk that

*The first two authors contributed equally to this work.

eventually lead to changes in one's sexual risk behavior, which would align more closely to the theoretical bases for risk compensation.[10] Second, trial designs that measure how changes in risk perceptions lead to changes in sexual risk behaviors would not be possible owing to ethical issues.[11,12]

Health preference research, and particularly quantitative preference data, have offered healthcare decision makers a means of assessing trade-offs and informing reimbursement and pricing decisions.[13] Although discrete choice experiments (DCEs) have been used largely in such research, this study presents a potentially novel means of measuring individual preferences to use PrEP vis-à-vis condoms based on changes in one's perceived risk for HIV and other STIs through a DCE. This article presents results of a DCE among GBMSM in Singapore, in which participants are provided a series of choice tasks that consider one's potential risk of HIV and other STI acquisition, while offering varying attributes for PrEP access and follow-up care that would be relevant for decision making when accessing PrEP.

PrEP was first introduced in Singapore in 2016 by several government-run clinics and general practitioners. A study among 1098 GBMSM conducted in 2017 on Grindr, a geosocial networking smartphone application, had found that about 15.0% of GBMSM surveyed had ever taken PrEP, although many participants had obtained PrEP overseas owing to the high cost of PrEP in Singapore, which remains unsubsidized by the government.[14] Singapore provides a compelling setting to explore such considerations, as its small geographical area, standardized compulsory sexual education programs for all school students, and intense community-based sexual health promotion efforts around condom use and distribution in the GBMSM community allow us to standardize several assumptions regarding perceptions around condom use efficacy and access to healthcare services that may arise in other more heterogeneous settings. Participants are also asked to compare these considerations for accessing PrEP in lieu of, or accompanied by, condom use. We then sought to identify how these preferences may vary across groups of GBMSM through latent class analysis.

Methods

Study Design and Participants

This study follows a qualitative study on the acceptability of PrEP and a cross-sectional study on PrEP use among GBMSM in Singapore.[14,15] This study was conducted as a web-based survey hosted on Sawtooth Software (Sawtooth Software, Inc, Provo, UT), and disseminated by Grindr. Grindr is a popular application (app) for smartphones and tablets that was designed to allow GBMSM to connect with other individuals through the geolocation capabilities of individual devices. To be eligible for the survey, participants had to be at least 18 years old, identify as a cisgender or transgender male, identify as nonheterosexual, be HIV-negative, and be a Singapore citizen, resident, or a foreign national residing in Singapore for more than a year at the point of the survey. Ethics approval was obtained from the National University of Singapore institutional review board (reference S-17-335) before data collection.

Procedures

From April 14 to May 17, 2019, all users of Grindr located in Singapore received an invitation to participate in this survey. This invitation was sent out 6 times across the study period. On accepting the invitation to participate, Grindr users were directed to an external web page hosted by Sawtooth Software, Inc.

Participants gave their consent online and took an average of 7.7 minutes to complete the survey, and of 891 eligible participants who began the survey, 648 (73%) participants completed the DCE. Multiple responses from the same device were not allowed. As we did not offer monetary incentives to participants, we kept the survey instrument succinct to achieve a high completion rate. We were not able to employ quota sampling procedures or construct weights for the present sample as no prior data exists on the population-level characteristics of the GBMSM community in Singapore.

Selection of Attributes for DCE

Several preliminary studies informed the selection of attributes for the DCE.[14,15] From these studies, 2 key concerns around PrEP access emerged: first, access to PrEP medication, and second, follow-up care visits while taking PrEP. Attributes identified for PrEP medication included the cost and location of accessing the medication, whereas attributes for follow-up care visits included the cost, location, and frequency per visit. Preliminary research also revealed how one's decision to use PrEP vis-à-vis other already available options, such as condoms, was influenced by one's perceived risk of acquiring HIV or other STIs as a result of one's sexual activity in general, or in situations associated with higher risk of HIV and other STI acquisition. Therefore, 2 additional attributes of perceived HIV risk and perceived STI risk per sexual act while on PrEP were included in the DCE. The attributes and levels used are summarized in Table 1.

DCE Design

Before the DCE proper, participants reported their age, sex, sexual orientation, nationality, residence status, HIV status, ethnicity, highest level of educational attainment, and gross personal income. After receiving information on the efficacy of daily PrEP, participants then reported their self-perceived candidature for PrEP. The DCE contained 7 attributes, 5 of which were described in choice tasks by 4 response levels, and 1 attribute each had 5 and 3 levels, yielding a total of $(5 \times 4 \times 4 \times 4 \times 4 \times 4 \times 3)$ 15 360 potential combinations. The DCE questionnaire was designed using Sawtooth version 9.6.1, and a 2-stage design was used. For each task, participants selected the preferred choices

Table 1. DCE attributes and levels.

Attributes	Levels
Drug cost (per mo)	S$50/S$100/S$200/S$350
Drug access	Online (pick-up with agent or delivery to home)/ anonymous Test site/GP clinic/DSTI/Hospital
Follow-up tests for HIV/STI/ liver function	3-monthly/6-monthly/ yearly
Follow-up test cost (per visit)	S$50/S$100/S$150/S$200
Follow-up location/ prescription provider	Anonymous test site/GP clinic/STI/hospital
STI infection	0%/5%/10%/20% per encounter
HIV infection	0%/1%/5%/10% per encounter

DCE indicates discrete choice experiment; DSTI, department of sexually transmitted infections control clinic; GP, general practitioner; HIV, human immunodeficiency virus; S$, Singapore dollar; STI, sexually transmitted infections.

Figure 1. Screenshots of choice tasks in discrete choice experiment.

Task 1

We now want you to think about how much you might be willing to pay for, and how you would like to access PrEP medication and related testing services.

Also, at the same time, we want you to consider how much risk you might be of acquiring HIV and other sexually transmitted illnesses (STI) per sexual act while on PrEP.

Imagine that these were your only 2 options to choose from, which option would you prefer? Please select your preferred option before answering the question at the bottom of the page.

(1 of 4)

PrEP medication • Get at: Anonymous test sites • Cost per month: $50 **Follow-up tests** • At: GP clinics • Every: 12 months • Cost: $150 **Risks per sexual encounter** • HIV infection: 0% • STI infection: 20%	**PrEP medication** • Get at: GP clinics • Cost per month: $350 **Follow-up tests** • At: Polyclinic or hospital • Every: 3 months • Cost: $100 **Risks per sexual encounter** • HIV infection: 1% • STI infection: 5%
Select	Select

PrEP only versus Condoms only

Now that you have selected your preferred PrEP option above, we want to compare your preferred option with a condoms-only option*

Would you prefer to **use PrEP only** or **use condoms only**, based on your preferred PrEP option above?

*This assumes that using condoms lowers risk of HIV/STI infection to 0%

PrEP only	Condoms only

Task 2

Thank you for your input on the previous 4 questions.

We are now have 4 more questions before the end of the survey; the format will be the same, but the question at the bottom of the page will be different.

We now want you to think about how much you might be willing to pay for, and how you would like to access PrEP medication and related testing services.

Also, at the same time, we want you to consider how much risk you might be of acquiring HIV and other sexually transmitted illnesses (STI) per sexual act while on PrEP.

Imagine that these were your only 2 options to choose from, which option would you prefer? Please select your preferred option before answering the question at the bottom of the page.

(1 of 4)

PrEP medication • Get at: Anonymous test sites • Cost per month: $50 **Follow-up tests** • At: GP clinics • Every: 12 months • Cost: $150 **Risks per sexual encounter** • HIV infection: 0% • STI infection: 20%	**PrEP medication** • Get at: GP clinics • Cost per month: $350 **Follow-up tests** • At: Polyclinic or hospital • Every: 3 months • Cost: $100 **Risks per sexual encounter** • HIV infection: 1% • STI infection: 5%
Select	Select

PrEP only versus PrEP + condoms

Now that you have selected your preferred PrEP option above, we want to compare your preferred option with an option to add on condoms*.

Would you prefer to **use PrEP only** or **use PrEP+condoms**, based on your preferred PrEP option above?

*This assumes that using condoms lowers risk of HIV/STI infection to 0%

PrEP only	PrEP + condoms

HIV indicates human immunodeficiency virus; PrEP, pre-exposure prophylaxis.

Table 2. Summary statistics.

	Participants with consistent answers (%)	Participants with inconsistent answers (%)	P value
Total no.	416	232	
Age, y			
≤24	76 (18.3)	51 (22.0)	.433
24-40	247 (59.4)	136 (58.6)	
>40	93 (22.4)	45 (19.4)	
Sex			
Cisgender male	388 (92.3)	212 (91.4)	.378
Others	28 (6.7)	20 (8.6)	
Sexual orientation			
Gay	324 (77.9)	174 (75.0)	.404
Others	92 (22.1)	58 (25.0)	
Ethnicity			
Chinese	287 (69.0)	147 (63.4)	.044
Malay	35 (8.4)	36 (15.5)	
Indian	24 (5.8)	15 (6.5)	
Others	70 (16.8)	34 (14.7)	
Educational attainment			
A-level equivalent and below	53 (12.7)	32 (13.8)	.455
Diploma, bachelor, and professional certificate	290 (69.7)	168 (72.4)	
Postgraduate degree	73 (17.6)	32 (13.8)	
Income per month			
S$0-S$1999	90 (21.6)	60 (25.9)	.074
S$2000-S$3999	115 (27.6)	76 (32.8)	
≥S$4000	211 (50.7)	96 (41.4)	
Candidature for PrEP			
Yes	268 (64.4)	137 (59.1)	.176
No or not sure	148 (35.6)	95 (30.9)	

PrEP indicates pre-exposure prophylaxis; S$, Singapore dollar.

from 2 PrEP profiles first, and then were asked to choose between the preferred PrEP profile ("PrEP only") and the "default" option. Two default options were considered: "condoms only" and "PrEP with condoms." For condoms only, participants were asked to choose between the preferred PrEP only option selected in stage 1 only, or the default option of condoms only. For PrEP with condoms scenarios, participants were asked to choose between the preferred PrEP only option selected in stage 1, or the preferred PrEP option selected in stage 1 plus the use of condoms. For each task, only one default option was used. We excluded an opt-out option (ie, neither condoms nor PrEP) to build on past research on risk compensation, and specifically, the trade-off between condoms and PrEP.

The following steps were taken to incorporate the 2 default options. First, the default option condoms only was used. The questionnaires were generated with 20 blocks and 4 tasks in each block. Balanced overlap was selected as the random task generation method. Second, for each block, they were structured with 2 sections of 4 tasks to give a total of 8 tasks. The same 4 tasks repeated for each section, and the default option differed in both sections with condoms only and PrEP with condoms for the first and second sections, respectively. For example, in each block, the

first stage of task 1 and the first stage of task 5 are the same, but the default options differed. Simulation was conducted using Sawtooth to guarantee all the parameters can be identified.

Because our survey was self-administered online, and as DCE questions are relatively complicated compared to typical survey questions, we took certain steps to ensure that the quality of responses was not compromised. Our repeated task design may serve as quality control and help identify the participants who did not understand the DCE questions. For participants that gave inconsistent answers, such as selecting different PrEP profiles in task 1 and task 5, we assumed that these participants did not understand the DCE questions or the task at hand and were excluded from analysis. Participants were informed about the different default options before the first 4 tasks, as well as before the remaining 4 tasks. The questionnaires were piloted by getting feedback on the survey from 15 participants recruited from the researchers' personal network, who were purposively selected to represent varying educational attainment levels and age groups prior to dissemination. This was to ensure that the questions would be easily understood by a diverse group of GBMSM in Singapore. Additional instructions were given to explain certain attributes prior to the DCE (eg, what perceived risk of HIV and

Table 3. Results of conditional logit model for PrEP preferences (n = 416).

	Coefficient	95% CI	*P* value	WTP	95% CI
Condoms	−0.75	(−1.05 to −0.45)	<.001	−147.0	(−202.9 to −89.5)
PrEP with condoms	0.94	(0.84-1.05)	<.001	184.2	(159.1-215.0)
Places to purchase PrEP					
Online	0.11	(−0.09 to 0.30)	.280	21.0	(−19.4 to 64.1)
Anonymous test sites	0.30	(0.11-0.50)	.002	59.3	(21.7-99.6)
General Practitioner	−0.15	(−0.35 to 0.05)	.146	−28.9	(−70.8 to 12.2)
Department of sexually transmitted infections control clinic	0.13	(−0.06 to 0.33)	.185	25.6	(−11.8 to 66.0)
Government hospitals and clinics	-	-	-	-	-
PrEP cost	−0.51	(−0.57 to −0.45)	<.001	-	-
Places for follow-up test					
Anonymous test sites	0.21	(0.05-0.38)	.011	41.4	(10.5-72.6)
General practitioner	0.21	(0.04-0.38)	.016	40.4	(8.8-75.0)
Department of sexually transmitted infections control clinic	0.18	(0.01-0.35)	.034	35.7	(2.0-69.6)
Government hospitals and clinics	-	-	-	-	-
Follow-up cost	−0.08	(−0.19 to 0.04)	.193	-	-
Duration between 2 consecutive follow-up visits					
3 months	-	-	-	-	-
6 months	0.09	(−0.05 to 0.22)	.229	16.6	(−10.2 to 42.5)
12 months	0.12	(−0.02 to 0.27)	.087	24.1	(−3.9 to 53.6)
Risk of acquiring HIV					
0%	-	-	-	-	-
1%	−0.27	(−0.44 to −0.11)	.001	−52.7	(−86.8 to −20.0)
5%	−0.77	(−0.93 to −0.60)	<.001	−149.8	(−183.4 to −118.5)
10%	−1.30	(−1.50 to −1.12)	<.001	−254.4	(−294.2 to −216.7)
Risk of acquiring STI					
0%	-	-	-	-	-
5%	−0.23	(−0.39 to −0.06)	.006	−44.0	(−74.5 to −13.7)
10%	−0.25	(−0.42 to −0.07)	.006	−47.9	(−82.2 to −16.3)
20%	−0.40	(−0.58 to −0.23)	<.001	−78.6	(−116.6 to −45.0)
Pseudo R-squared	0.1491				

CI indicates confidence interval; PrEP, pre-exposure prophylaxis; STI, sexually transmitted illness; WTP, willingness to pay.

other STIs per sexual act meant in the context of the choices made) and changes to the layout of the DCE were made in response to such feedback. Screenshots of the choice tasks may be found in Figure 1.

Analytic Plan

Quantitative data analysis was carried out using the statistical software R 3.6.1 with the following 3 steps. First, conditional logit models were used to understand participants' overall preference for PrEP, the condoms only option, and the PrEP with condoms option. Logistic regression was then used to understand participants' preferences for PrEP with condoms in more detail. The response data from the second section of the DCE, that is, from task 5 to task 8 in each block, were used. The independent variables include the attributes of the PrEP profile in consideration and the participants' demographics. The demographic variables

include: age, gender, sex orientation, ethnicity, education, income. Participants' perception about whether they are suitable candidates for PrEP was also included. The dependent variable is 1 if participants chose PrEP with condoms and 0 otherwise. Second, generalized multinomial logit model was used to examine the scaling effect and preference heterogeneity.[16] Given that the results from the generalized multinomial logit model did not show a statistically significant scaling effect, we proceeded with latent class analysis without considering scale. Third, latent class model was used to examine the preference heterogeneity by categorizing participants into different groups.[17] Variables predicting the class membership include participants' age, sex orientation, ethnicity, education, income, and participants' perception about whether they are suitable candidates for PrEP. Data were dummy-coded for analysis. Although a mixed logit model would have provided better fit for our data, we opted to present our findings through a latent class model so that the findings would be more easily

Table 4. Results of estimation using generalized multinomial logistic regression (n=416).

	Coefficient	95% CI	P value	WTP	95% CI
Condoms	−0.84	(−1.58 to −0.11)	.024	−91.2	(−157.3 to −8.2)
PrEP with condoms	2.16	(1.74-2.58)	<.001	232.7	(179.2-297.6)
Places to purchase PrEP					
Online	0.14	(−0.16 to 0.45)	.363	15.2	(−18.4 to 52.3)
Anonymous test sites	0.42	(0.10-0.75)	.011	45.6	(10.0-88.8)
General practitioner	−0.28	(−0.58 to 0.03)	.072	−29.9	(−65.9 to 4.8)
Department of sexually transmitted infections control clinic	0.17	(−0.14 to 0.48)	.282	18.5	(−16.0 to 50.3)
Government hospitals and clinics	-	-	-	-	-
PrEP cost	−0.93	(−1.08 to −0.77)	<.001	-	-
Places for follow-up test					
Anonymous test sites	0.35	(0.09-0.62)	.009	38.2	(8.2-69.4)
General practitioner	0.27	(0.001-0.54)	.049	29.2	(−1.8 to 62.1)
Department of sexually transmitted infections clinic	0.27	(−0.001 to 0.55)	.051	29.5	(0.1-61.1)
Government hospitals and clinics	-	-	-	-	-
Follow-up cost	−0.14	(−0.33 to 0.05)	.149	-	-
Duration between 2 consecutive follow-up visits					
3 months	-	-	-	-	-
6 months	0.09	(−0.13 to 0.30)	.430	9.4	(−14.7 to 33.0)
12 months	0.16	(−0.07 to 0.39)	.167	17.3	(−8.6 to 44.5)
Risk of acquiring HIV					
0%	-	-	-	-	-
1%	−0.62	(−0.91 to −0.34)	<.001	−67.2	(−99.5 to −37.6)
5%	−1.50	(−1.79 to −1.21)	<.001	−162.0	(−197.4 to −131.7)
10%	−2.43	(−2.81 to −2.05)	<.001	−261.4	(−302.7 to −225.9)
Risk of acquiring STI					
0%	-	-	-	-	-
5%	−0.57	(−0.84 to −0.30)	.006	−61.7	(−93.4 to −31.8)
10%	−0.41	(−0.70 to −0.12)	.005	−44.3	(−75.6 to −11.8)
20%	−0.83	(−1.14 to −0.53)	<.001	−89.7	(−122.9 to −55.9)
SD					
Condom	6.93	(5.24-8.62)	<.001		
PrEP with condoms	5.34	(4.05-6.63)	<.001		
Places to purchase PrEP					
Online	0.002	(−0.43 to 0.43)	.993		
Anonymous test sites	0.66	(0.26-1.06)	.001		
General practitioner	0.04	(−0.36 to 0.45)	.827		
Department of sexually transmitted infections control clinic	0.74	(0.14-1.33)	.015		
Government hospitals and clinics	-	-	-		
PrEP cost	0.54	(−0.03 to −0.11)	.063		
Places for follow-up test					
Anonymous test sites	0.17	(−0.25 to 0.59)	.427		
General practitioner	0.20	(−0.42 to 0.82)	.529		
Department of sexually transmitted infections control clinic	0.66	(0.17-1.13)	.007		
Government hospitals and clinics	-	-	-		
Follow-up cost	0.58	(0.36-0.81)	<.001		
Duration between 2 consecutive follow-up visits					
3 months	-	-	-		

Table 4. Continued

	Coefficient	95% CI	*P* value	WTP	95% CI
6 months	0.11	(−0.19 to 0.41)	.461		
12 months	0.16	(−0.13 to 0.45)	.291		
Risk of acquiring HIV					
0%	-	-	-		
1%	0.05	(−0.33 to −0.43)	.796		
5%	0.03	(−0.30 to 0.35)	.880		
10%	0.27	(−0.16 to 0.70)	.212		
Risk of acquiring STI					
0%	-	-	-		
5%	0.08	(−0.21 to −0.38)	.572		
10%	0.13	(−0.22 to −0.47)	.476		
20%	0.67	(0.13-1.20)	.015		
Scale parameters					
tau	0.01	(−0.02 to 0.03)	.439		
gamma	61.45	(−92.6 to 215.5)	.434		

CI indicates confidence interval; HIV, human immunodeficiency virus; PrEP, pre-exposure prophylaxis; SD, standard deviation; STI, sexually transmitted infections; WTP, willingness to pay.

translatable through differentiated models of care, and interpreted by policymakers in the context of the evidence that already exists on risk compensation in the context of PrEP use. We hypothesized that the target population prefers lower cost, more anonymity, longer duration between follow-up visits, and lower HIV and other STI risk. Diagnostic assessments of the responses may be found in Appendix Tables 1 to 7 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023.

Results

Table 2 summarizes the demographic characteristics for all participants, compared with participants who had consistent answers across both sets of DCE choice tasks. Both sets of participants were similar across all sociodemographic attributes.

Table 3 summarizes the results of the conditional logit model for PrEP preferences. Results indicate that participants preferred purchasing PrEP at available anonymous testing sites (relative utility, 0.30; *P* = .002, 95% confidence interval [CI], 0.11-0.50) compared with government-run hospitals. Relative utility of PrEP also decreased with every 100 dollars increase in monthly PrEP price (relative utility, −0.51; *P* < .001; 95% CI, −0.57 to −0.45). Participants also exhibited stronger preferences for having their follow-up care visits at anonymous testing sites (relative utility, 0.21; *P* = .011; 95% CI, 0.05-0.38), privately-owned general practitioner clinics (relative utility, 0.21; *P* = .016; 95% CI, 0.04-0.38), and the specialist sexual health clinic in Singapore (relative utility, 0.18; *P* = .034; 95% CI, 0.01-0.35), compared with government-run hospitals, and a yearly visit (relative utility, 0.12; *P* = 0.087; 95% CI, −0.02 to 0.27), compared with quarterly visits.

Participants' utility for PrEP decreases as the perceived HIV acquisition risk increases when only PrEP is used. As the perceived HIV acquisition risk when only PrEP is used are 1%, 5%, and 10%, compared with 0% of HIV acquisition risk at the baseline, the utility of PrEP decreases by −0.27 (*P* = .001; 95% CI, −0.44 to −0.11), −0.77 (*P* < .001; 95% CI, −0.93 to −0.60), and −1.30 (*P* < .001; 95% CI, −1.50 to −1.12), respectively. This indicates that

there is a lower utility for PrEP as the HIV acquisition risk when only PrEP is used becomes higher. A similar trend was exhibited with perceived risk of other STI when only PrEP is used. As the perceived STI acquisition risk when only PrEP is used are 5%, 10%, and 20%, compared with 0% of STI acquisition risk at the baseline, the utility of PrEP decreases by −0.23 (*P* = .006; 95% CI, −0.39 to −0.06), −0.25 (*P* = .006; 95% CI, −0.42 to −0.07), and −0.40 (*P* < .001; 95% CI, −0.58 to −0.23). Comparing "PrEP only" and "condoms only" options, participants reported a lower utility of using only condoms at −0.75 (*P* < .001; 95% CI, −1.05 to −0.45), given the reference basket. When using PrEP, participants' utility on average increases by 0.94 (*P* < .001; 95% CI, 0.84-1.05) if condoms can be added on.

Appendix Table 9 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023 summarizes the logit model on preferences for PrEP with condoms. Compared with perceived HIV acquisition risk being 0%, a HIV acquisition risk of 1%, 5%, and 10% make people more likely to add on condom. The choice of "PrEP with condoms" was not affected by one's perceived risk of STI acquisition. In terms of participants' demographics, participants with postgraduate degree are more likely to add on condom.

Table 4 shows the results from generalized multinomial logit regression. The main conclusions about the overall preferences remained similar compared to the results from conditional logit model. However, the results suggest heterogeneous preferences among the participants. The heterogeneity was mainly from the heterogeneous preferences at the individual level (ie, the standard deviations of the preferences were significant). The results suggest no scaling effect in our study as the scaling parameters were insignificant. Participants showed heterogeneous preferences on condom. No heterogeneous effect was detected for the preferences on the perceived risk of acquiring HIV.

A 3-class model was the most appropriate based on BIC criteria (Appendix Table 10 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023) and concordance to previous qualitative data generated for the study.[15] These classes

Figure 2. Willingness to pay (latent class analysis).
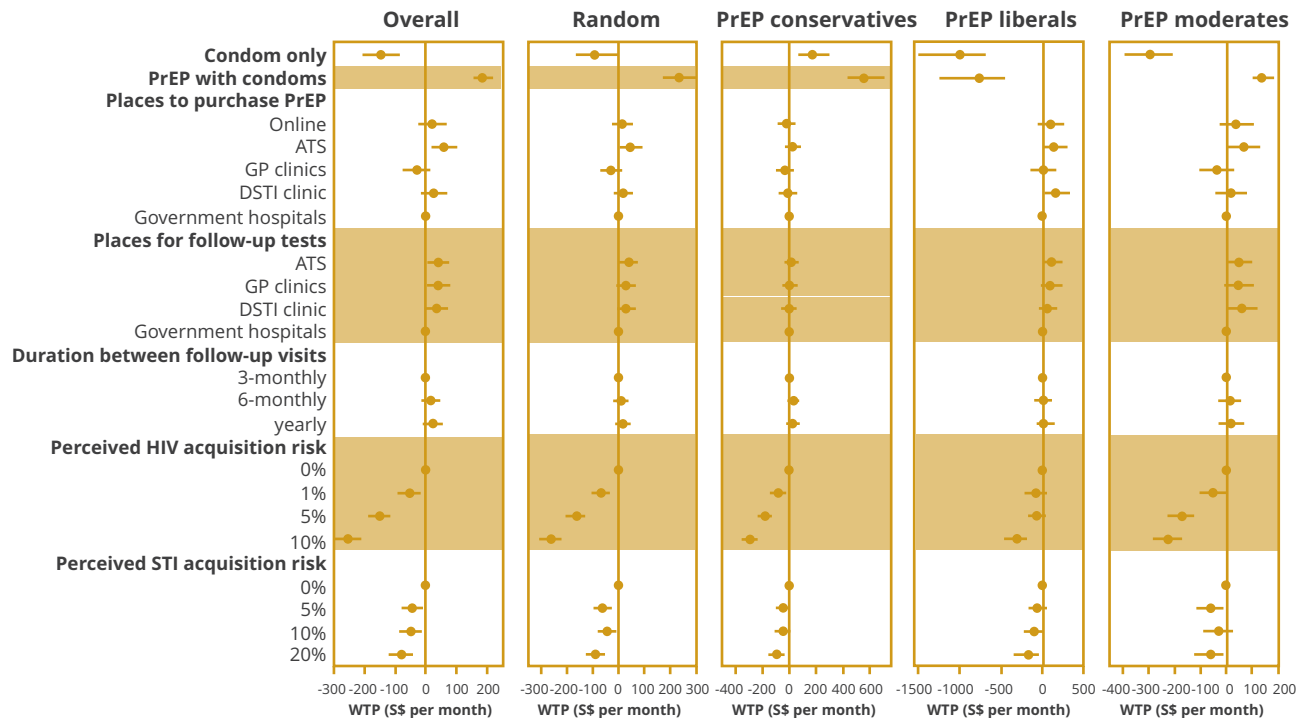
ATS indicates anonymous testing site; GP, general practitioners; DSTI, department of sexually transmitted infections control clinic; PrEP, pre-exposure prophylaxis; STI, sexually transmitted infections.

were labelled post hoc as PrEP conservatives, PrEP liberals, and PrEP moderates (Appendix Table 11 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023). Figure 2 summarizes the results on willingness to pay (latent classes: Appendix Table 12 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023). The willingness to pay was generated using the coefficients of PrEP cost as the base. The confidence intervals for willingness to pay were generated using the Krinsky and Robb method.[18] Appendix Figure 1 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023 summarizes the latent class models generated for participants.

PrEP conservatives were more likely to report greater utility when using condoms only instead of PrEP only, as well as PrEP with condoms compared with PrEP only. They did not care about the places to purchase PrEP and to get follow-up examinations. These participants were most sensitive to PrEP cost and did not care about follow-up cost. They were also most sensitive to HIV risk. Their utility for PrEP also decreased with the increasing perceived risk for STI acquisition.

PrEP liberals were more likely to report the greatest utilities for PrEP use only compared with condom use only, as well as PrEP use only compared to PrEP with condoms. PrEP liberals were more likely to report greater utilities for accessing PrEP through the ATS or the specialist sexual health clinic and get follow-up visits done at the ATS. These participants were less sensitive to PrEP cost compared with PrEP conservatives. When the risk of HIV infection was low (eg, 1% and 5%, these participants' utility for PrEP was not affected). As the risk of HIV infection became higher and reach to 10%, their utility for PrEP decreased. They also cared about the risk of STI acquisition.

PrEP moderates preferred PrEP only compared with condoms only, but were slightly more likely to prefer having PrEP with condoms rather than PrEP alone. PrEP moderates preferred to access PrEP at ATS and get follow-up visits at ATS and special sexual health clinic. Their level of price sensitivity to PrEP was similar to PrEP liberals. Their utility for PrEP decreased as the perceived risk of HIV infection increased. They also care about STI infections; however, the disutility remained similar as the risk of STI infection increased. The average class probabilities for PrEP conservatives, PrEP liberals, and PrEP moderates were 54.0%, 14.9%, and 31.1%, respectively. Appendix Table 11 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023 summarizes the demographic attributes associated with membership by class, whereas Appendix Figure 1 in the Supplementary Material found at https://doi.org/10.1016/j.jval.2020.11.023 summarizes participant demographics by predicted class membership.

Discussion

First, this study found that accessing PrEP at the anonymous testing site (compared with government-run hospitals and clinics) and follow-up care visits at nongovernment hospital settings with a longer follow-up time of once a year (compared with quarterly visits) were valued by potential users and could encourage PrEP use, as would lower prices. These findings corroborate findings from prior studies in Singapore,[14,15] which suggest that anonymity of sexual health services and cost-related issues were the main barriers to accessing PrEP among GBMSM.

Second, this study also found that utility for PrEP use decreased with increasing perceived risk of HIV and other STI acquisition per sexual act while using PrEP for participants in general, however this inverse relationship exhibited a steeper curve for perceived risk of HIV acquisition compared with that of perceived STI acquisition risk, likely due to greater perceptions of HIV severity and susceptibility in GBMSM.[19] Furthermore, this study found that when asked if they preferred PrEP with condoms versus a PrEP only option, participants reported greater utility in doing so only with increasing perceived risk of HIV acquisition, but not with an increasing risk of STI acquisition. Overall, across both sets of choice experiments, participants reported a greater utility for condoms as their perceived risk of HIV acquisition increased.

Although the trends were identified across GBMSM sampled, in general, they assume homogeneity across GBMSM who may be different in terms of their sexual behaviors and perceived risks of HIV and other STI acquisition. Latent class analysis thus allowed us to identify how these PrEP and condom-related preferences varied across different subgroups of GBMSM. PrEP conservatives preferred condom use only or PrEP with condoms compared with PrEP use only and reported greatest sensitivity to changes in perceived HIV risk. They were also less likely to consider themselves as candidates for PrEP compared with the other 2 classes. The second class held more liberal views on PrEP and preferred PrEP use only compared with condoms only or PrEP with condoms. They were also relatively likely to consider themselves as candidates for PrEP use. PrEP moderates were in the middle between PrEP conservatives and PrEP liberals. They showed similar preferences for PrEP purchasing site, follow-up site, and price sensitivity as PrEP liberals. Their utility for PrEP decreased consistently with higher HIV infection risk, which was similar to PrEP conservatives, although the magnitude was smaller.

We identified several strengths of this study in the context of existing research. Although past studies have discussed risk compensation in the context of STI acquisition and changes in sexual risk behavior through measures and indicators of behavior change, this study attempts to advance our understanding of risk compensation by providing evidence for how changing perceived risks of HIV and other STI acquisition are associated with varying preferences for PrEP vis-à-vis condom use. This choice experiment design thus advances our understanding of risk compensation in the context of PrEP use among GBMSM, as trial designs assessing risk compensation are not ethically viable.[11] Furthermore, it addresses several concerns brought forth by other scholars that highlight issues around ascertaining if changes in attitudes or risk perceptions preceded behavior change.[20]

We are mindful of several key limitations in this study. First, sampling participants through Grindr may bias the sample towards being more sexually active than GBMSM in general, as GBMSM who use geosocial networking smartphone apps are expected to exhibit more sexual risk behaviors and are more receptive to PrEP than other GBMSM in general.[21] Given that baseline sexual risk behaviors were not explicitly collected in the survey, the findings around PrEP preference in this study might be less generalizable to the preferences of GBMSM in general. Nevertheless, although our findings may not reflect the wider GBMSM population in Singapore, recent studies have shown how GBMSM who use the internet and geosocial networking smartphone apps may, in general, be engaged in behaviors that are associated with greater risks for HIV and other STIs, but are also testing more frequently and recently than general GBMSM,[22,23] potentially allowing our findings to be more generalizable to internet-using and app-using GBMSM in other settings as well. Second, we recognize that while risk compensation would involve changing perceptions of risk that precede any increase in sexual risk behavioral intentions and eventual behavior, our choice experiment design was only able to emulate these conditions imperfectly. Specifically, the choice experiment design had asked participants to imagine their perceived risk of HIV and other STI acquisition, but this rational approach to imagining one's risk discounts the situational factors that may underpin decision making during sexual encounters, which include considerations around sexual arousal, condom use negotiation, trust, and familiarity with partners.[24-26] Furthermore, any reported utilities of PrEP only vis-à-vis condom only or PrEP with condoms would only capture preferences to do so, and not actual behaviors. Finally, the present study was not designed to explore interaction effects between attributes, which may be explored in future studies to further deepen our understanding of consumer preferences on PrEP.

Conclusion

Overall, this study advances our understanding for risk compensation beyond prior studies that use behavioral indicators by showing how one's utility for condom use in lieu of PrEP, or utility for PrEP with condoms, was associated with changes in one's perception of HIV or STI acquisition risk. Additionally, these changes were largely seen in participants who already reported being good candidates for PrEP, corroborating existing evidence that risk compensation may be most prominent in GBMSM who were already at risk of HIV. The findings of this study provide a framework for the implementation and scale-up of PrEP in Singapore and also provide further insight into whether PrEP may lead to risk compensation among GBMSM, thus placing them at greater risk for other STIs. This is a novel application of a DCE to address this topic. Specifically, given that risk compensation would be expected to occur among GBMSM who were already presumed to be at risk for HIV, we recommend that PrEP should continue to be scaled up to benefit the wider GBMSM community to reduce the risk of HIV acquisition overall and to enable those at risk of HIV and other STIs to be better engaged in long-term follow-up and treatment through PrEP-associated clinical care.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.jval.2020.11.023.

Article and Author Information

Author Affiliations: Saw Swee Hock School of Public Health, National University of Singapore and National University Health System, Singapore, Singapore (Tan, Wang, Prem, Teo, Cook, Chen); Department of Infectious Disease Epidemiology, Faculty of Epidemiology and Population Health, London School of Hygiene & Tropical Medicine, London, England, UK (Prem); Grindr for Equality, Los Angeles, CA, USA (Harrison-Quintana); National Centre for Infectious Diseases, Singapore, Singapore (Kaur, Chen, Wong); Yong Loo Lin School of Medicine, National University of Singapore, Singapore (Wong).

Correspondence: Rayner Kay Jin Tan, PhD, Saw Swee Hock School of Public Health, National University of Singapore and National University Health System, 12 Science Dr 2, Tahir Foundation Building #09-01, Singapore 117549, Singapore. Email: rayner.tan@u.nus.edu

REFERENCES

1. Molina JM, Capitant C, Spire B, et al. On-demand preexposure prophylaxis in men at high risk for HIV-1 infection. *N Engl J Med*. 2015;373(23):2237–2246.
2. Grant RM, Lama JR, Anderson PL, et al. Preexposure chemoprophylaxis for HIV prevention in men who have sex with men. *N Engl J Med*. 2010;363(27):2587–2599.
3. McCormack S, Dunn DT, Desai M, et al. Pre-exposure prophylaxis to prevent the acquisition of HIV-1 infection (PROUD): effectiveness results from the pilot phase of a pragmatic open-label randomised trial. *Lancet*. 2016;387(10013):53–60.
4. Grulich AE, Guy R, Amin J, et al. Population-level effectiveness of rapid, targeted, high-coverage roll-out of HIV pre-exposure prophylaxis in men who have sex with men: the EPIC-NSW prospective cohort study. *Lancet HIV*. 2018;5(11):e629–e637.
5. Scheer S, Hsu L, Schwarcz S, et al. Trends in the San Francisco human immunodeficiency virus epidemic in the "getting to zero" era. *Clini Infect Dis*. 2017;66(7):1027–1034.
6. Jansen MPM, Tromp N, Baltussen R. PrEP: why we are waiting. *Lancet HIV*. 2016;3(1):e11–e12.
7. Fonner VA, Dalglish SL, Kennedy CE, et al. Effectiveness and safety of oral HIV preexposure prophylaxis for all populations. *AIDS (London, England)*. 2016;30(12):1973–1983.
8. Traeger MW, Schroeder SE, Wright EJ, et al. Effects of pre-exposure prophylaxis for the prevention of human immunodeficiency virus infection on sexual risk behavior in men who have sex with men: a systematic review and meta-analysis. *Clini Infect Dis*. 2018;67(5):676–686.
9. Ong JJ, Baggaley RC, Wi TE, et al. Global epidemiologic characteristics of sexually transmitted infections among individuals using preexposure prophylaxis for the prevention of HIV infection: a systematic review and meta-analysis. *JAMA Network Open*. 2019;2(12). e1917134–e1917134.
10. Rojas Castro D, Fugon L, Bourgeois-Fisson E, Le Gall JM, Barbier F, Spire B. The "Swiss statement": who knows about it? How do they know? What are its effects on people living with HIV/AIDS? *AIDS Care*. 2012;24(8):1013–1019.
11. Underhill K. Study designs for identifying risk compensation behavior among users of biomedical HIV prevention technologies: balancing methodological rigor and research ethics. *Soc Sci Med*. 2013;94:115–123.
12. Blumenthal J, Haubrich RH. Will risk compensation accompany pre-exposure prophylaxis for HIV? *Virtual Mentor*. 2014;16(11):909–915.
13. Marsh K, van Til JA, Molsen-David E, et al. Health preference research in Europe: a review of its use in marketing authorization, reimbursement, and pricing decisions: report of the ISPOR stated preference research special interest group. *Value in Health*. 2020;23(7):831–841.
14. Tan RKJ, Teo AKJ, Kaur N, Harrison-Quintana J, Chen MI, Wong CS. Cost and anonymity as factors for the effective implementation of pre-exposure prophylaxis: an observational study among gay, bisexual and other men who have sex with men in Singapore. *Sexual Health*. 2018;15(6):533–541.
15. Wong CS, Kumar PA, Wong CM, et al. Acceptability of HIV pre-exposure prophylaxis (PrEP) and opinions on PrEP service delivery among men who have sex with men in singapore: a qualitative study. *AIDS Educ Preven*. 2019;31(2):152–162.
16. Fiebig DG, Keane MP, Louviere J, Wasi N. The generalized multinomial logit model: accounting for scale and coefficient heterogeneity. *Marketing Science*. 2010;29(3):393–421.
17. Sarrias M, Daziano R. Multinomial logit models with continuous and discrete individual heterogeneity in R: the gmnl package. *J Stat Softw*. 2017;79(2):46.
18. Hole AR. A comparison of approaches to estimating confidence intervals for willingness to pay measures. *Health Econ*. 2007;16(8):827–840.
19. Holt M, Bernard D, Race K. Gay mens perceptions of sexually transmissible infections and their experiences of diagnosis: part of the way of life to feeling dirty and ashamed. *J Sexual Health*. 2010;7(4):411–416.
20. Holt M, Murphy DA. Individual versus community-level risk compensation following preexposure prophylaxis of HIV. *Am J Public Health*. 2017;107(10):1568–1571.
21. Hoenigl M, Little SJ, Grelotti D, et al. Grindr users take more risks, but are more open to human immunodeficiency virus (HIV) pre-exposure prophylaxis: could this dating app provide a platform for HIV prevention outreach? *Clin Infect Dis*. 2020;71(7):e135–e140.
22. Noble M, Jones AM, Bowles K, DiNenno EA, Tregear SJ. HIV testing among internet-using MSM in the United States: systematic review. *AIDS Behav*. 2017;21(2):561–575.
23. Wang H, Zhang L, Zhou Y, et al. The use of geosocial networking smartphone applications and the risk of sexually transmitted infections among men who have sex with men: a systematic review and meta-analysis. *BMC Public Health*. 2018;18(1):1178.
24. Siegler AJ, Voux Ad, Phaswana-Mafuya N, et al. Elements of condom-use decision making among South African men who have sex with men. *J Int Assoc Provid AIDS Care*. 2014;13(5):414–423.
25. Calabrese SK, Reisen CA, Zea MC, Poppen PJ, Bianchi FT. The pleasure principle: the effect of perceived pleasure loss associated with condoms on unprotected anal intercourse among immigrant Latino men who have sex with men. *AIDS Patient Care STDs*. 2012;26(7):430–435.
26. Ariely D, Loewenstein G. The heat of the moment: the effect of sexual arousal on sexual decision making. *J Behav Decis Mak*. 2006;19(2):87–98.