

Supplementary Information

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Supplementary Note 1: Intervention summary

Intervention

The Intervention was named “Safe Fun Battle” and was designed to encourage a positive attitude toward consistent condom use and HIV/STI testing among MSM dating apps users. The content was developed together with local organizations offering community support and STIs testing services to the MSM population. By incorporating real-life examples collected from the qualitative interviews (first stage of the study) and sharings from front-line workers, the intervention aims to improve participants' perceived self-efficacy and decision-making skills concerning condom use and negotiation and HIV/STI testing in real-life contexts.

Game

3 sets of tailored scenarios were selected as the background of the games. In each of the storylines, participants were exposed to various situations illustrating the potential consequences of meeting sexual partners through dating apps and also risks to sexual health during sexual encounters. They have to make virtual decisions in each of the contexts and each action will lead to a different ending for the stories. Supplemented with graphics of fictional characters designed for this project, the dialogues were all pre-recorded by voice-over professionals to increase the realism.

- **酒店事件 The Hotel Room**

The player hook-up with his match on dating apps in a hotel room. The player penetrated the match with his penis condomlessly instead of using his fingers as they consented. After being exposed, he has to interact with his match in order to continue this sexual encounter:

- Starts a conversation on whether to use a condom
- Try to convince his match to go bareback using negative results from STIs check-ups
- Try to persuade his match to have anal sex without a condom as he is the only sex partner
- Being assumed that it is the insertive party's responsibility to prepare condoms
- Decide on alternative sexual activities when a condom is not available

- **藥愛體驗 When Sex Encounters Drugs**

On a dating apps interface, the player received a new message from a user with the ice cream and snowflakes symbols on his profile. The player has to decide how to respond to the following conditions about chemsex:

- Whether to try using drugs at sex
- Being invited to go for a sexual encounter at a hotel
- Whether to use more than one type of drug at the same time
- Was informed that this would be a chemsex encounter only when he has arrived at the venue
- Decide whether to use a condom during chemsex
- Decide whether to use a condom with a person who is on PrEP
- Whether to trust the other person's claim in being on PrEP
- Realized that a camera was set up in the room without his consent

- **桑拿奇遇 Cruising at the Sauna**

In a gay sauna, the story begins with the player being invited to enter a room where it was too dark to identify whether it is safe. Below are some of the situations where the player has to make decisions to react and control the flow:

- Whether to use a condom for oral sex
- Being dragged into the room and forced to have sex
- The condom was being removed nonconsensually during anal sex
- Being invited to group sex
- Being invited to have condomless sex with people who are on PrEP
- To try out the receptive role at anal sex
- Having insufficient lubrication during anal sex
- Encountered an ex-partner and was threatened that the intimate images/videos taken previously will be circulated if they don't have sex with him now

Depending on the choices the player made, there are 11 endings to the stories. They were related to the content of the information pages. In some of the endings, the players would end up having condomless sex and be exposed to risks of STIs transmission. Sexual violence happened in several endings where the Players were forced to engage in sexual activities unwillingly or have their intimate parts photo-recorded without their consent. Two of the endings were related to the use of PrEP and PEP where players would be directed to the respective information pages to read more about the two treatments. There are also neutral endings where the players made informed and safe decisions under every condition. They were then presented with general reminders for safe dating apps usage, tips in condom negotiation or the power to reject unwanted invitations and ways to be assertive with their choices.

Information pages

The information pages contain a wide range of information that would be useful for MSM dating apps users in Hong Kong, especially those who are sexually active. Primarily focusing on the practice of safer sex, the information flows with condom and lubricant usage, the introduction of different Sexually Transmitted Infections (STIs) and how to get tested. General information about PrEP and PEP and how to access them in Hong Kong were also included. In addition, participants were also presented with information related to chemsex, sexual violence and image-based sexual violence.

● 安全套知多啲 The Good Condom Guide

Using a condom at sex is one of the ways to lower the risks of contracting STIs. On this page, we described ways to increase the proper usage of condoms. First, the pros and points to note of the three common condom materials (latex/polyurethane & polyisoprene) were outlined. For example, polyurethane condoms are thinner which may enhance sensitivity. But it requires extra lubrication to prevent breakage. Second, we detailed how sizes of condoms are presented by different manufacturers (diameter/ nominal width) and how to find the best fit by measuring the circumferences of penises. Lastly, the steps to use a condom properly were laid out. Specifically, we emphasized ensuring the condom was rolled on the right way round with pictures illustrating what the right and wrong sides of a condom would look like.

Other than penetrative sex, we also suggested using a condom or dental dam during oral sex or rimming to further reduce the risks of direct contact with another person's genital areas or bodily fluids.

● 潤滑劑知多啲 Let's Get Lubed

Applying lubrication during sex is one of the ways to enhance safer sex. Especially for anal sex where there's limited to no natural secretion produced by the rectum. Having sufficient lubrication also prevents tears in the

skin that might increase the risks of STIs transmissions. The four broad categories of lubes were described, namely water-based, silicone-based, hybrid (water & silicone) and oil-based. Their features point to note, and whether it is safe to be applied to condoms and sex toys were presented. For example, silicon-based lubes are more long-lasting, and safe to use with condoms, but should be avoided from applying to sex toys made of silicone.

Features of the other types of lubrications, such as warming, flavoured, and edible were also listed on the page. To better control the degree of slipperiness, we have suggested first applying a certain amount to their palms or fingers instead of onto the genital areas directly. Especially, if they are sharing the lubricants with someone else, this would help prevent contamination.

- **性病知多啲 Let's talk STIs**

How STIs could be transmitted was illustrated on this page. The common causes included having high risks bodily fluids (for example pre-ejaculatory fluid, semen, vaginal secretions and blood) that are contagious in contact with the genital areas, especially where the tissues are torn or damaged and by direct skin-to-skin contact.

Some of the common STIs and their symptoms were listed, including HIV/AIDS, Syphilis, Gonorrhoea, Chlamydia, Herpes, Genital warts and HPV and Pubic lice. And the difference between Human Immunodeficiency Virus (HIV) and Acquired immunodeficiency syndrome (AIDS) was particularly highlighted - HIV target a type of white blood cell called CD4 T cell and weakens the immune system. Only if left untreated, the immune system became severely impaired and enters the most advanced stage of HIV infection, AIDS. On the contrary, people living with HIV can also lead long and healthy lives. The Undetectable = Untransmittable (U=U) concept was also introduced. By taking antiretroviral therapy (ART) daily as prescribed, people with HIV who achieve and maintain an undetectable viral load cannot transmit the virus to others sexually.

We recommended screening for STIs after any condomless sexual activities. A list of organizations offering free STIs testing was presented on the page.

- **ChemFun 知多啲 A Different Kinda Party: Chemsex 101**

On this page, basic information about chemsex was offered. Participants were introduced to its definition, why is it appealing to some people and that this practice is still illegal in Hong Kong. General information on how to practice chemsex safely was presented. We reminded participants to be aware of how different drugs work in the body, how they should be used, the safe dosage, the immediate effect, and the side effects/negative impacts on health. Some possible safety precautions were also emphasized to reduce harm. Other than negotiating about the use of safer sex measures before the encounter and performing regular STIs check-ups, a guide to handling the emergency situation when someone overdosed and became unconscious was included. Organizations offering support to MSM chemsex users were listed on the page.

- **PrEP 知多啲 Get Prepared with PrEP**

Pre-Exposure Prophylaxis (PrEP) is one of the ways to prevent HIV infection. It is suitable for people without HIV and was recommended to those who are more likely to be exposed to HIV. On this page, we presented how PrEP works and who is suitable for a prescription. Other than being HIV-negative, people considering PrEP should also be free from significant kidney impairment. Oral PrEP should be intake on a daily basis or be instructed for the on-demand (2-1-1) dosing. Other than the guidelines for intake of PrEP, we have also outlined the possible side effects during the course.

PrEP is currently not available in the local health care system, therefore we have listed information of agencies offering consultation and prescription in Hong Kong and overseas, including their prices and websites.

- **PEP 知多啲 PEP the Emergency Saver**

When exposed to HIV, persons can seek Post-Exposure Prophylaxis (PEP) within 72 hours after potential exposure. On this page, we described situations where PEP might be useful in lower the risks of HIV transmission

and emphasized the need to adhere to a 28-day course in order to obtain efficacy. The potential side effects were also mentioned.

In Hong Kong, only the Accident & Emergency rooms at public hospitals and several private hospitals/clinics offer prescriptions for PEP. Prices and agencies providing the services were listed on the page. As PEP only provide protection against HIV infection, it is recommended to get tested for STIs if the person had condomless sex.

- **性暴力知多啲 It Can Also Happen to Men: Understanding Sexual Violence**

The fact that sexual violence could happen to different genders, even males, is presented on this page. A more comprehensive definition that any sexual act without freely given consent is considered sexual violence was provided. Examples of sexually abusive actions that commonly happened among MSM were given. The perceived difficulties for men and MSM to seek help after being sexually assaulted were highlighted. And thus, we have listed several local organizations providing crisis support to MSM victims of sexual violence.

- **影像性暴力知多啲 Image Matters: Understanding Image-Based Sexual Violence**

Behaviours that were considered image-based sexual violence were identified on this page. And specifically, how these might happen among MSM were introduced. For example, having explicit images taken or distributed nonconsensually and having one's picture sexually photoshopped. Tips on how to prevent being secretly filmed during a sexual encounter and how to communicate with partners about the privacy of intimate images to avoid sextortion after a break-up were provided.

A list of local organizations providing crisis support to MSM victims of sexual violence was stated.

- **支援機構知多啲 You're not alone**

A list of supporting organizations in Hong Kong and their services was presented on this page. Ranging from sexual health information, STIs testing, and community support to crisis support for sexual violence incidents and chemsex users. Their social media and hotline for contact were included to allow easier access to help when needed.

Control

The control group offered information and educational content about sexual orientations which is not relevant to the intervention component on dating apps and safer sex.

Information pages

Participants were asked to go through three information pages targeted at providing an expanded description of what is sexual orientation, the discrimination against sexual orientations and disclosing one's sexual orientation (coming out).

- **性傾向知多啲 It's A Spectrum: Understanding Sexual Orientations**

Unlike the traditional view of sexual orientation where a person must be attracted to the same gender physically, spiritually, and emotionally, this page gives alternative illustrations of how attraction could be understood as separate continuums.

[The Genderbread Person](#) model describes gender using 4 different elements, it broke out "Attraction" into two perspectives. People could be attracted to the same or different gender and gender types romantically and sexually. And they can also experience being attracted to none or more than one of the categories.

The Kinsey Scale was also presented on this page. Although the Scale itself has several limitations, this pioneering research has suggested that most people are not attracted to only one gender.

By demonstrating different conceptualizations of sexual orientation, we highlighted that the definition of it could be different across individuals. The discussion on gender and sexualities are expanding every day and we should not limit ourselves to a single framework. Broader terminologies such as “Men who have Sex with Men, MSM” and “Women who have Sex with Women, WSW” was also introduced to illustrate the changes in labels people could now use to present their sexualities.

- **性傾向歧視知多啲 The Discrimination**

Local studies have shown individuals have been discriminated against because of one’s identity as LGBT+ in different ways, such as being harassed or rejected for a working opportunity. Although currently there’s no discrimination law focusing on sexual orientation in Hong Kong, over 65.9% of respondents from a previous Public Opinion Research agreed that a related ordinance should be enacted.

Different types of discrimination and how the discriminative behaviours might be applied in the context of sexual orientations were listed on this page. For example, if an individual was rejected for a job because the employer wants to hire who is not homosexual, it could be a form of direct discrimination. And if a person was humiliated because of their sexual orientation, for example, a female staff who wears trousers all the time was being questioned about her sexual orientation and if she would be interested in other female colleagues, it could be a form of harassment.

- **出櫃知多啲 Am I Ready to Come Out?**

Exploring one’s sexual orientation could be a long journey and according to the Cass Identity Model, it is likely for people to undergo 6 different stages: Confusion, Comparison, Tolerance, Acceptance, Pride and Integration. And at each stage, some of us may find it helpful to share our feelings and thoughts with people we trust.

Preparing oneself to come out (disclosing one’s sexual orientation to others) is crucial. But it is also important to note that the one being informed also deserves time to digest the news and give a proper response. We presented a story of what might happen in the coming out process on this page. The character’s exploration of his sexual orientation and the struggle to reveal his identity to his parents were illustrated. Many people expect parents to be furious if they were told their children are not heterosexual. But in the story, the parents were shocked in the beginning and took a period of time to wrap their heads around the fact that their son is gay. The parents appreciated being informed and ended up finding ways to restore the family’s harmony.

Coming out could mean differently to everyone, but it is not a must to reveal one’s sexual identity and orientation in all contexts. The fact that no one should be forced to come out was emphasized. It should only be done when an individual finds it necessary, and do it with a suitable target at places they found safe and comfortable.

Supplementary Table 1: Baseline characteristics and study outcomes of the study participants and dropouts

	Overall (n=480)	Non-dropouts (n=387)	Dropouts (n=93)
Baseline socio-demographic characteristics			
<i>Age, mean (SD)^a</i>	28.69 (7.43)	29.02 (7.50)	27.30 (6.98)
<i>Sexual orientation</i>			
Homosexual	401 (83.54%)	323 (83.46%)	78 (83.87%)
Bisexual and others	79 (16.46%)	64 (16.54%)	15 (16.13%)
<i>Relationship status</i>			
In a relationship/married	237 (49.38%)	191 (49.35%)	46 (49.46%)
Single	243 (50.63%)	196 (50.65%)	47 (50.54%)
<i>Educational level</i>			
Bachelor's degree or above	417 (86.88%)	337 (87.08%)	80 (86.02%)
Less than a bachelor's degree	63 (13.13%)	50 (12.92%)	13 (13.98%)
<i>Employment status</i>			
Employed full-time	287 (59.79%)	236 (60.98%)	51 (54.84%)
Not employed full-time	193 (40.21%)	151 (39.02%)	42 (45.16%)
<i>Monthly personal income (HK \$)</i>			
≥20,000	213 (44.38%)	178 (45.99%)	35 (37.63%)
<20,000	267 (55.63%)	209 (54.01%)	58 (62.37%)
Characteristics of dating app usage			
<i>Duration of using dating apps</i>			
More than 1 year	358 (74.58%)	295 (76.23%)	63 (67.74%)
Less than 1 year	122 (25.42%)	92 (23.77%)	30 (32.26%)
<i>Frequency of using dating apps</i>			
Every day	213 (44.38%)	167 (43.15%)	46 (49.46%)
Not every day	267 (55.63%)	220 (56.85%)	47 (50.54%)
Primary outcome			
<i>Had condomless sex in the last 3 months</i>			
Yes	205 (42.71%)	167 (43.15%)	38 (40.86%)
No	275 (57.29%)	220 (56.85%)	55 (59.14%)
Secondary outcomes			
<i>Had chemsex in the last 3 months^b</i>			
Yes	50 (10.42%)	34 (8.79%)	16 (17.20%)
No	430 (89.58%)	353 (91.21%)	77 (82.80%)
<i>Had group sex in the last 3 months</i>			
Yes	82 (17.08%)	61 (15.76%)	21 (22.58%)
No	398 (82.92%)	326 (84.24%)	72 (77.42%)
<i>Underwent HIV testing in the last 3 months</i>			
Yes	170 (35.42%)	136 (35.14%)	34 (36.56%)
No	310 (64.58%)	251 (64.86%)	59 (63.44%)
<i>Underwent other STI testing in the last 3 months</i>			
Yes	92 (19.17%)	76 (19.64%)	16 (17.20%)
No	388 (80.83%)	311 (80.36%)	77 (82.80%)
<i>Number of sex partners with condomless anal sex in the last 3 months^c, mean (SD)</i>	0.95 (2.18)	0.86 (1.91)	1.30 (3.06)

<i>Condom Self-Efficacy Scale total score, mean (SD)</i>	56.08 (10.40)	56.37 (10.11)	54.90 (11.55)
<i>Multidimensional Condom Attitudes Scale total score, mean (SD)</i>	115.85 (21.47)	115.57 (21.65)	117.05 (20.78)

Note: The percentages of participants represented in certain columns of this study may not sum exactly to 100.00% due to the rounding of figures.

^a $p=0.045$, by independent t-test

^b $p=0.023$, by Fisher's exact test

^c The outcome was not registered in the study protocol.

Supplementary Table 2: Between-group difference of change of all study outcomes

	Occurrence or Mean (95%CI)		Between-group difference of change	
	Intervention	Control	OR or β (95% CI)	p-value
<i>Had condomless anal sex in the last 3 months</i>				
Baseline	43.75%	41.67%		
3-month follow-up	31.40%	43.69%	0.54 (0.36 to 0.82)	0.003
6-month follow-up	29.89%	39.90%	0.59 (0.37 to 0.93)	0.025
<i>Had chemsex in the last 3 months</i>				
Baseline	8.33%	12.50%		
3-month follow-up	4.35%	9.46%	0.68 (0.31 to 1.52)	0.352
6-month follow-up	5.43%	10.34%	0.78 (0.37 to 1.66)	0.523
<i>Had group sex in the last 3 months</i>				
Baseline	14.17%	20.00%		
3-month follow-up	16.43%	20.72%	1.14 (0.67 to 1.94)	0.631
6-month follow-up	14.13%	20.69%	0.96 (0.53 to 1.73)	0.881
<i>Underwent HIV testing in the last 3 months</i>				
Baseline	30.83%	40.00%		
3-month follow-up	36.23%	33.78%	1.67 (1.04 to 2.68)	0.035
6-month follow-up	35.33%	31.53%	1.77 (1.08 to 2.93)	0.025
<i>Underwent other STI testing in the last 3 months</i>				
Baseline	17.08%	21.25%		
3-month follow-up	21.74%	18.02%	1.66 (0.95 to 2.89)	0.076
6-month follow-up	22.28%	22.17%	1.32 (0.77 to 2.27)	0.319
<i>Number of sex partners with condomless anal sex in the last 3 months</i>				
Baseline	1.05 (0.77 to 1.32)	0.85 (0.57 to 1.12)		
3-month follow-up	0.88 (0.45 to 1.31)	1.16 (0.73 to 1.58)	-0.48 (-0.94 to -0.02)	0.041
6-month follow-up	0.78 (0.52 to 1.05)	0.91 (0.66 to 1.17)	-0.33 (-0.62 to -0.04)	0.024
<i>Condom Self-Efficacy Scale (CSES) total score</i>				
Baseline	56.13 (54.80 to 57.45)	56.04 (54.72 to 57.36)		
3-month follow-up	58.80 (57.49 to 60.11)	55.34 (54.06 to 56.62)	3.38 (1.65 to 5.10)	<0.001
6-month follow-up	58.60 (57.09 to 60.10)	55.29 (53.83 to 56.74)	3.22 (1.15 to 5.30)	0.002
<i>CSES Consistent Use Subscale</i>				
Baseline	12.20 (11.88 to 12.52)	12.23 (11.91 to 12.55)		
3-month follow-up	12.64 (12.31 to 12.97)	12.03 (11.71 to 12.35)	0.64 (0.16 to 1.11)	0.008
6-month follow-up	12.55 (12.19 to 12.91)	11.99 (11.65 to 12.34)	0.59 (0.06 to 1.11)	0.028
<i>CSES Correct Use Subscale</i>				
Baseline	24.37 (23.76 to 24.98)	24.13 (23.52 to 24.75)		
3-month follow-up	25.51 (24.92 to 26.10)	23.95 (23.37 to 24.53)	1.32 (0.50 to 2.14)	0.002
6-month follow-up	25.49 (24.84 to 26.15)	23.82 (23.18 to 24.45)	1.44 (0.51 to 2.38)	0.003

CSES Communication Subscale				
Baseline	19.55 (19.01 to 20.09)	19.68 (19.14 to 20.22)		
3-month follow-up	20.68 (20.14 to 21.22)	19.37 (18.84 to 19.90)	1.43 (0.71 to 2.16)	<0.001
6-month follow-up	20.61 (20.00 to 21.23)	19.48 (18.89 to 20.07)	1.26 (0.36 to 2.16)	0.006
Multidimensional Condom Attitudes Scale (MCAS) total score				
Baseline	115.93 (113.20 to 118.66)	115.78 (113.05 to 118.51)		
3-month follow-up	120.46 (117.80 to 123.11)	116.69 (114.09 to 119.29)	3.62 (0.37 to 6.86)	0.029
6-month follow-up	124.42 (121.37 to 127.47)	115.77 (112.82 to 118.72)	8.50 (4.38 to 12.61)	<0.001
MCAS reliability and effectiveness				
Baseline	30.98 (30.45 to 31.51)	31.07 (30.55 to 31.60)		
3-month follow-up	30.77 (30.21 to 31.33)	31.13 (30.59 to 31.67)	-0.27 (-0.98 to 0.44)	0.458
6-month follow-up	30.90 (30.26 to 31.55)	30.59 (29.96 to 31.21)	0.41 (-0.46 to 1.27)	0.355
MCAS excitement				
Baseline	7.16 (6.81 to 7.51)	6.65 (6.31 to 7.00)		
3-month follow-up	7.51 (7.14 to 7.88)	6.88 (6.52 to 7.24)	0.12 (-0.37 to 0.61)	0.627
6-month follow-up	7.98 (7.60 to 8.36)	7.16 (6.80 to 7.53)	0.31 (-0.25 to 0.87)	0.276
MCAS displeasure				
Baseline	7.80 (7.38 to 8.22)	7.50 (7.08 to 7.92)		
3-month follow-up	8.30 (7.88 to 8.71)	7.75 (7.35 to 8.16)	0.24 (-0.31 to 0.80)	0.390
6-month follow-up	8.96 (8.53 to 9.39)	8.00 (7.58 to 8.41)	0.67 (0.03 to 1.30)	0.041
MCAS identity stigma				
Baseline	27.80 (26.96 to 28.65)	28.06 (27.21 to 28.91)		
3-month follow-up	28.90 (28.09 to 29.71)	28.11 (27.31 to 28.90)	1.05 (-0.00004 to 2.09)	0.050
6-month follow-up	29.72 (28.79 to 30.65)	27.64 (26.74 to 28.53)	2.34 (1.07 to 3.60)	<0.001
MCAS embarrassment about negotiation				
Baseline	21.20 (20.48 to 21.92)	21.14 (20.43 to 21.86)		
3-month follow-up	22.31 (21.60 to 23.01)	20.98 (20.29 to 21.67)	1.27 (0.35 to 2.19)	0.007
6-month follow-up	22.77 (22.02 to 23.51)	20.84 (20.12 to 21.56)	1.87 (0.84 to 2.91)	<0.001
MCAS embarrassment about purchase				
Baseline	20.98 (19.82 to 22.15)	21.35 (20.18 to 22.52)		
3-month follow-up	22.71 (21.53 to 23.89)	21.85 (20.69 to 23.00)	1.23 (-0.18 to 2.63)	0.087
6-month follow-up	24.21 (22.96 to 25.46)	21.62 (20.40 to 22.83)	2.96 (1.41 to 4.51)	<0.001

Supplementary Table 3: Mixed effects models for comparison of psychological study outcomes in all subscales

	Intervention group					Control group					Between-group difference at each time point		Group × Time Effect <i>p</i> -value ^a
	Mean (95% CI)	Within-group change from T0 Mean (95% CI)	<i>p</i> -value	Within-group change from T1 Mean (95% CI)	<i>p</i> -value	Mean (95% CI)	Within-group change from T0 Mean (95% CI)	<i>p</i> -value	Within-group change from T1 Mean (95% CI)	<i>p</i> -value	Mean (95% CI)	<i>p</i> -value	
CSES Consistent Use Subscale													
Baseline (T0)	12.20 (11.88 to 12.52)					12.23 (11.91 to 12.55)					-0.03 (-0.49 to 0.43)	0.900	0.021
3-month follow-up (T1)	12.64 (12.31 to 12.97)	0.44 (0.03 to 0.85)	0.033			12.03 (11.71 to 12.35)	-0.20 (-0.60 to 0.21)	0.721			0.61 (0.15 to 1.07)	0.010	
6-month follow-up (T2)	12.55 (12.19 to 12.91)	0.35 (-0.11 to 0.81)	0.205	-0.09 (-0.50 to 0.32)	1.000	11.99 (11.65 to 12.34)	-0.24 (-0.68 to 0.21)	0.597	-0.04 (-0.43 to 0.35)	1.000	0.56 (0.06 to 1.06)	0.028	
CSES Correct Use Subscale													
Baseline	24.37 (23.76 to 24.98)					24.13 (23.52 to 24.75)					0.24 (-0.63 to 1.10)	0.591	0.003
3-month follow-up	25.51 (24.92 to 26.10)	1.14 (0.42 to 1.86)	<0.001			23.95 (23.37 to 24.53)	-0.18 (-0.89 to 0.52)	1.000			1.56 (0.73 to 2.39)	<0.001	
6-month follow-up	25.49 (24.84 to 26.15)	1.12 (0.30 to 1.95)	0.003	-0.01 (-0.68 to 0.65)	1.000	23.82 (23.18 to 24.45)	-0.32 (-1.11 to 0.48)	1.000	-0.13 (-0.77 to 0.50)	1.000	1.68 (0.76 to 2.59)	<0.001	
CSES Communication Subscale													
Baseline	19.55 (19.01 to 20.09)					19.68 (19.14 to 20.22)					-0.12 (-0.89 to 0.64)	0.748	<0.001
3-month follow-up	20.68 (20.14 to 21.22)	1.12 (0.49 to 1.76)	<0.001			19.37 (18.84 to 19.90)	-0.31 (-0.93 to 0.31)	0.690			1.31 (0.55 to 2.07)	<0.001	
6-month follow-up	20.61 (20.00 to 21.23)	1.06 (0.27 to 1.85)	0.004	-0.07 (-0.75 to 0.62)	1.000	19.48 (18.89 to 20.07)	-0.20 (-0.96 to 0.56)	1.000	0.11 (-0.54 to 0.76)	1.000	1.13 (0.28 to 1.99)	0.009	
MCAS reliability and effectiveness													
Baseline	30.98 (30.45 to 31.51)					31.07 (30.55 to 31.60)					-0.09 (-0.84 to 0.66)	0.810	0.198
3-month follow-up	30.77 (30.21 to 31.33)	-0.21 (-0.84 to 0.41)	1.000			31.13 (30.59 to 31.67)	0.05 (-0.55 to 0.66)	1.000			-0.36 (-1.14 to 0.42)	0.363	
6-month follow-up	30.90 (30.26 to 31.55)	-0.08 (-0.84 to 0.68)	1.000	0.13 (-0.52 to 0.79)	1.000	30.59 (29.96 to 31.21)	-0.49 (-1.22 to 0.24)	0.330	-0.54 (-1.17 to 0.08)	0.114	0.32 (-0.58 to 1.21)	0.489	
MCAS excitement													
Baseline	7.16 (6.81 to 7.51)					6.65 (6.31 to 7.00)					0.50 (0.01 to 1.00)	0.045	0.536
3-month follow-up	7.51 (7.14 to 7.88)	0.35 (-0.08 to 0.78)	0.154			6.88 (6.52 to 7.24)	0.23 (-0.19 to 0.64)	0.570			0.63 (0.11 to 1.14)	0.018	
6-month follow-up	7.98 (7.60 to 8.36)	0.82 (0.33 to 1.31)	<0.001	0.47 (0.06 to 0.88)	0.017	7.16 (6.80 to 7.53)	0.51 (0.03 to 0.99)	0.031	0.28 (-0.11 to 0.67)	0.247	0.82 (0.29 to 1.34)	0.003	
MCAS displeasure													
Baseline	7.80 (7.38 to 8.22)					7.50 (7.08 to 7.92)					0.30 (-0.29 to 0.89)	0.317	0.114
3-month follow-up	8.30 (7.88 to 8.71)	0.50 (0.01 to 0.98)	0.044			7.75 (7.35 to 8.16)	0.25 (-0.22 to 0.73)	0.600			0.54 (-0.04 to 1.12)	0.066	

6-month follow-up	8.96 (8.53 to 9.39)	1.16 (0.60 to 1.72)	<0.001	0.67 (0.18 to 1.16)	0.003	8.00 (7.58 to 8.41)	0.50 (-0.05 to 1.04)	0.085	0.24 (-0.22 to 0.71)	0.636	0.97 (0.37 to 1.57)	0.002	
MCAS identity stigma													
Baseline	27.80 (26.96 to 28.65)					28.06 (27.21 to 28.91)					-0.25 (-1.45 to 0.94)	0.677	0.001
3-month follow-up	28.90 (28.09 to 29.71)	1.10 (0.18 to 2.01)	0.013			28.11 (27.31 to 28.90)	0.05 (-0.84 to 0.94)	1.000			0.79 (-0.35 to 1.93)	0.173	
6-month follow-up	29.72 (28.79 to 30.65)	1.91 (0.80 to 3.03)	<0.001	0.82 (-0.11 to 1.75)	0.103	27.64 (26.74 to 28.53)	-0.42 (-1.50 to 0.65)	1.000	-0.47 (-1.36 to 0.41)	0.597	2.08 (0.79 to 3.37)	0.002	
MCAS embarrassment about negotiation													
Baseline	21.20 (20.48 to 21.92)					21.14 (20.43 to 21.86)					0.06 (-0.96 to 1.07)	0.910	0.002
3-month follow-up	22.31 (21.60 to 23.01)	1.11 (0.30 to 1.91)	0.003			20.98 (20.29 to 21.67)	-0.17 (-0.95 to 0.62)	1.000			1.33 (0.34 to 2.32)	0.008	
6-month follow-up	22.77 (22.02 to 23.51)	1.57 (0.66 to 2.48)	<0.001	0.46 (-0.22 to 1.15)	0.312	20.84 (20.12 to 21.56)	-0.30 (-1.19 to 0.58)	1.000	-0.14 (-0.79 to 0.51)	1.000	1.93 (0.90 to 2.97)	<0.001	
MCAS embarrassment about purchase													
Baseline	20.98 (19.82 to 22.15)					21.35 (20.18 to 22.52)					-0.37 (-2.01 to 1.28)	0.662	0.001
3-month follow-up	22.71 (21.53 to 23.89)	1.73 (0.49 to 2.96)	0.003			21.85 (20.69 to 23.00)	0.50 (-0.70 to 1.70)	0.958			0.86 (-0.79 to 2.51)	0.306	
6-month follow-up	24.21 (22.96 to 25.46)	3.23 (1.87 to 4.59)	<0.001	1.50 (0.42 to 2.59)	0.003	21.62 (20.40 to 22.83)	0.27 (-1.05 to 1.58)	1.000	-0.23 (-1.26 to 0.80)	1.000	2.60 (0.85 to 4.34)	0.004	

^a *p*-values were obtained by linear mixed-effects models.

Supplementary Note 2: Original full abstract

Title

Web-based interactive intervention in promoting safer sex among men who have sex with men: a randomized controlled trial with mediation analysis

Abstract

Background Men who have sex with men (MSM) who use dating applications (apps) have higher rates of engaging in condomless anal sex than those who do not. This study aimed to evaluate the effectiveness of an interactive web-based intervention in promoting safer sex among this population.

Methods The study was a two-armed, assessor-blinded, randomized, parallel-group trial with a 6-month follow-up period. The intervention was guided by the theory of planned behavior and co-designed by researchers, healthcare providers, and prior participants. The primary outcome was the frequency of condomless anal sex in the past three months. Secondary outcomes included five other behavioral outcomes (frequency of group sex, chemsex, HIV testing, other STI testing, and the number of sex partners with whom participants had condomless anal sex in the last three months) and two psychological outcomes (self-efficacy and attitudes toward condom use). All study outcomes were measured at baseline, 3-month (T1), and 6-month follow-up (T2). This trial was registered on ISRCTN (ISRCTN16681863) on 28 April 2020.

Findings From 30 November 2020 to 19 October 2021, a total of 480 MSM were enrolled and randomly assigned to the intervention group (n=240) and control group (n=240). Participants in the intervention group had significantly reduced condomless anal sex in the past three months than the control group at both follow-up time points (T1: OR=0.59, 95%CI 0.40 to 0.88, $p=0.009$; T2: OR=0.64, 95%CI 0.42 to 0.98, $p=0.040$; overall time-by-group interaction: $p=0.010$). Additionally, the number of sex partners with condomless anal sex in the last three months revealed a significant overall time-by-group interaction ($p=0.043$), and there was a statistically significant decrease from baseline to the 6-month follow-up within the intervention group (mean difference=-0.26, $p=0.039$). Moreover, participants in the intervention group showed significant improvements in condom use self-efficacy and attitude than the control group ($p<0.001$ for both overall time-by-group interactions), with both factors serving as mediators.

Conclusion The web-based interactive intervention can significantly reduce condomless anal sex behaviors by enhancing self-efficacy and attitudes regarding condom use among MSM dating app users, with significant effects sustained at both three and six months. It is recommended that similar studies be widely implemented in other Asian contexts with similar cultures.