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Use of Gay Chatlines and Online Dating Platforms as Potential Mediators or Moderators in the Relationship Between Loneliness, Self-Rated Attractiveness and Human Immunodeficiency Virus Acquisition Risk Among Gay, Bisexual, and Other Men Who Have Sex With Men in Vancouver, Canada

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Background: Gay, bisexual, and other men who have sex with men (gbMSM) remain disproportionately affected by human immunodeficiency virus (HIV). Interaction between psychosocial factors likely plays a role in HIV acquisition risk. We aimed to analyze the association of loneliness and self-rated attractiveness with HIV acquisition risk, and determine whether these associations were mediated by gay telephone chatlines or online dating platforms.

Methods: This cross-sectional study included HIV-negative gbMSM 16 years or older enrolled into the Momentum Health Study from February 2012 to February 2015. Loneliness, self-rated attractiveness (exposures) and use of gay chatlines or online dating platforms (mediators) were assessed through self-interviews. Human immunodeficiency virus acquisition risk (outcome) was assessed by the HIV Incidence Risk Index. Weighted logistic regression modeled the association and moderation effect between exposures and outcome. Mediation models estimated 3-way direct effect among exposures, mediators, and outcome.

Results: Of 542 gbMSM, those who were lonely (adjusted odds ratio [aOR], 1.54; 95% confidence intervals [CI], 1.04–2.28) and attractive (aOR, 1.69; 95% CI, 1.04–2.76) had increased odds for HIV acquisition

risk. Our moderation analysis demonstrated a heightened joint effect among lonely and attractive participants (aOR, 1.70; 95% CI, 1.08–2.65). Use of gay telephone chatlines or online dating platforms mediated 30.5% of the association between loneliness and HIV acquisition risk, but did not mediate attractiveness and HIV acquisition risk.

Conclusions: Our findings suggest that the provision of interventions focusing on mental health support and safer sex practices through gay telephone chatlines or online dating platforms is promising to help alleviate the HIV burden among gbMSM.

Globally, gay, bisexual, and other men who have sex with men (gbMSM) continue to face a disproportionate burden of human immunodeficiency virus (HIV).¹ In Canada, for instance, gbMSM represented 2% to 3% of the population but accounted for 39.7% of new HIV infections in 2019.^{2,3} Although advances in antiretroviral therapy (ART) have led to a dramatic decrease in HIV incidence, morbidity, and improvements in life expectancy,⁴ control of the HIV transmission among gbMSM has been slower

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than the general population. This reality may indicate the presence of ongoing factors that facilitate HIV transmission risk among gbMSM,⁵ which may inform potential population-specific interventions and programs.

As a result of stigma and discrimination, the prevalence of mental health conditions, including loneliness, is higher among gbMSM and other minority populations.⁶ Loneliness has been previously associated with substance use, suicidality and HIV risk behavior and, might arise when the need for meaningful social or emotional connection is unmet.^{7,8} Some tools used to seek these connections are telephone chatlines or online dating platforms such as geosocial networking apps (eg, Grindr, Blued, Jack'd, and Scruff).⁹ Although 31% to 36% of gbMSM in the United States, Australia, and China use these platforms,¹⁰ lonely gbMSM might be more likely to use them to obtain social and emotional connections.¹¹

Seeking emotional and social connections might also be affected by self-rated attractiveness.¹² Evolutionary theories postulate physical attractiveness as an indicator of health, favored in partner selection.¹³ This preference may be observed in online dating profiles through the use of optimized photographs and verbal descriptions to impress prospective sexual partners.¹³ Thus, low self-rated attractiveness might lead to higher difficulty obtaining social connections through online dating platforms.¹² Gay, bisexual, and other men who have sex with men also tend to experience higher normative pressure to meet beauty standards,¹⁴ which, if not met, may lead to low psychological well-being and negative concepts, thus increasing their likelihood of engaging in high HIV risk behaviors.¹⁵ Contrarily, meeting partners offline via venues such as bars and clubs has been associated with lower HIV risk behaviors.¹⁶ Unlike online dating and in-person encounters, the relationship between gay telephone chatlines and HIV risk is less known.

Previous studies have linked HIV risk behaviors with each of these factors: self-esteem, loneliness, attractiveness and increased use of online dating platforms.^{15,17} However, given the slow control of HIV transmission among gbMSM, individual risk factors may be insufficient to explain the current HIV transmission dynamics,⁵ highlighting a need to understand the complex interrelationships between them. Thus, our objectives were to (1) analyze the association of loneliness and self-rated attractiveness, individually and in combination, with increased HIV acquisition risk; and (2) determine whether gay telephone chatlines or online dating platforms mediate the relationship between loneliness, self-rated attractiveness and increased HIV acquisition risk.

MATERIALS AND METHODS

Study Data and Design

Data were obtained from the Momentum Health Study at baseline, a biobehavioral prospective cohort study of gbMSM living in Vancouver, British Columbia, and surrounding areas.¹⁸ Participants were recruited from February 2012 to February 2015 using respondent-driven sampling (RDS).¹⁸ To be eligible for the Momentum Health Study, gbMSM needed to identify as a man (cisgender or transgender), be 16 years or older, report engaging in sex with another man in the past 6 months, and able to complete a questionnaire in English. To assess HIV risk in this study, only participants who were HIV-negative at enrolment in the Momentum Health Study were included. Initial or "seed" participants were recruited through members of the Community Engagement Committees, advertisements on mobile phone applications, and websites used by gbMSM. Seeds were offered 6 vouchers to invite eligible members of their social network. Subsequently, referred nonseed participants were given vouchers leading to peer recruitment chains. All participants pro-

vided written informed consent before completing a questionnaire about their demographics, sexual behaviors and risks, and substance use during the last 6 months. The recruitment procedures were detailed elsewhere.¹⁹

Outcomes

Our outcome was HIV acquisition risk assessed using the HIV Incidence Risk Index for men who have sex with men (HIRI-MSM) scores.²⁰ The HIRI-MSM scores were dichotomized as less than 10 and 10 or greater, a threshold shown to effectively distinguish gbMSM at a higher versus lower risk for HIV acquisition.²⁰

Exposures

Our exposures were loneliness and self-rated attractiveness, measured at enrolment. Loneliness was assessed using the 6-Item Scale for Overall, Emotional, and Social Loneliness (LSESL).²¹ The LSESL has been validated in a sample of gbMSM.²² It has 2 subscales: (i) emotional loneliness, deriving from the absence of intimate relationships, and (ii) social loneliness, deriving from the absence of social networks.²¹ The LSESL featured a Likert response scale composed of 5 items (definitely yes, somewhat yes, more or less, somewhat no, and definitely no). For each subscale, the sum of the Likert responses was used to dichotomize the responses as 0 or 1, resulting in loneliness scores that ranged from 0 to 6, where a score of 2 or greater was considered lonely.²³ Self-rated attractiveness was assessed through the question: "On a scale of 1 (not at all attractive) to 10 (very attractive), how physically attractive would you say you are?" Responses consisted of very unattractive (1), unattractive (2), moderately unattractive (3), mildly unattractive (4), below average (5), above average (6), mildly attractive (7), moderately attractive (8), attractive (9), very attractive (10). After consultation with the research team, responses were dichotomized, where a rating of 6 or greater was considered attractive.

Potential Mediators

Our potential mediators, defined as variables that may fully or partially explain the effect of an exposure on an outcome,²⁴ were the use of gay telephone chatlines or online dating platforms (eg, smartphone apps, Internet hook-up sites or other websites), used individually or in combination, to meet other men for sex in the last 6 months. The use of telephone chatlines was assessed through the question: "In the past 6 months, how often have you used gay telephone chatlines to meet other guys for sex (eg, Interactive Male, Cruiseline)?" Online dating platforms included smartphone apps and Internet hook-up sites. The use of these platforms was assessed from 2 questions: "In the past 6 months, how often have you used smartphone apps to meet other guys for sex (eg, Growlr, Scruff)?" "In the past 6 months, how often have you used Internet hook-up sites or other websites to meet other guys for sex (eg, Squirt, Craigslist, Manhunt)?" The questionnaire featured a 4-item Likert response scale (more than once per month, about once per month, less than once per month, and never). Responses were dichotomized (no; yes) for the use of gay telephone chatlines and online dating platforms, respectively, in the past 6 months.

Potential Confounders

Initial sociodemographic and anthropometric confounders were selected a priori based on literature-informed knowledge and included: age (<30 years; 30–44 years; ≥45 years), sexual orientation (gay; bisexual and other), ethnicity (white; other), highest education (high school or less; greater than high school), personal annual income (<CAD 30,000; ≥CAD 30,000), born in Canada

(no; yes), employment status (unemployed; employed), neighborhood (Downtown/West End; elsewhere Vancouver; outside Vancouver), in relationship with regular partner (no; yes), and body mass index (BMI) (kg/m^2) (underweight [<18.5]; normal [$18.5\text{--}24.9$]; overweight [$25\text{--}29.9$]; obese [≥ 30]).

We also sought to control for the presence of anxiety, depression, alcohol disorders, and sex work. Anxiety and depression were determined by the Hospital Anxiety and Depression Scale (HADS),²⁵ two 7-item subscales with a score of 0 to 21 to indicate the possible presence of anxiety and depression, respectively, as mild (0–10) or moderate to severe (11–21). Alcohol disorders were determined through the use of the World Health Organization's Alcohol-Use Disorder Identification Test (AUDIT),²⁶ a 10-question test to detect early harmful drinking as low risk (0–7), medium risk (8–15), and harmful or possible dependence (≥ 16).²⁶ Potential confounders related to transactional sex were self-reported and included ever received money/drugs/goods in exchange for sex (no; yes) and ever worked as an escort in the sex industry (no; yes).

To reduce the number of and collinearity between potential confounders and optimize the statistical power of our analyses, we conducted a preliminary analysis using PROC VARCLUS in SAS.²⁷ Briefly, the procedure identifies variables highly correlated to each other and groups them into clusters.²⁷ All potential confounders were categorical and participants with missing information were removed from the analysis. For each variable, PROC VARCLUS calculates the ratio of the correlation with its own cluster to the correlation of its nearest cluster (1- R^2 ratio).²⁸ Variables with the smallest 1- R^2 ratio were selected to represent the clusters due to their high correlation with their own cluster and low correlation with other clusters (Supplemental Information Table 1, <http://links.lww.com/OLQ/A843>). After PROC VARCLUS, our potential confounders were sexual orientation, ethnicity, employment status, neighborhood, in relationship with regular partner, BMI, HADS Anxiety Scale, AUDIT and ever received money/drugs/goods in exchange for sex. Potential confounders were further analyzed for inclusion in the final multivariable model through a published selection approach until the change in the coefficient for variables denoting loneliness and self-rated attractiveness was greater than 5%.²⁹ Given that age is a component of HIRI-MSM, age was only considered in the descriptive analyses that did not involve HIRI-MSM.

Statistical Analyses

We conducted bivariable analyses between potential confounders and mediators, exposures, and outcome using a weighted χ^2 test. Respondent-driven sampling-II weights, which are inversely proportional to the network size, were applied to all analyses to account for the non-random selection of participants and produce estimates that are more representative of the gbMSM population in Vancouver.³⁰ Refused to answer responses were not included in the analyses. This study consisted of a 2-pronged analysis:

- i. Individual associations and potential moderation of loneliness and self-rated attractiveness with HIRI-MSM of 10 or greater: We built multivariable RDS-II weighted logistic regression models to explore the association between loneliness, self-rated attractiveness and HIRI-MSM of 10 or greater. For moderation analysis, a subsequent multivariable weighted logistic regression model was built to explore the potential interaction between self-rated attractiveness and loneliness on increased HIV risk. In this last analysis, we used a 4-level interaction variable defined by the combination of loneliness and self-attractiveness statuses: (i) not lonely and attractive (reference category),

(ii) not lonely and not attractive, (iii) lonely and not attractive, and (iv) lonely and attractive.

- ii. Potential mediation in the individual relationship of loneliness and self-rated attractiveness with HIRI-MSM of 10 or greater: Our mediation analysis used a series of RDS-II-weighted multivariable logistic regression models evaluating the effect between each exposure, mediators and outcome. First, we examined the individual effect of loneliness and self-rated attractiveness on HIRI-MSM ≥ 10 , mediated by use of gay telephone chatlines and online dating platforms combined. Furthermore, given the potential heightened joint effect of loneliness and self-rated attractiveness on HIV risk and to evaluate the mediation effect of gay telephone chatlines and online dating platforms on this joint effect, we analyzed the mediation effect of self-rated attractiveness and HIRI-MSM ≥ 10 , stratified by loneliness status. The indirect effect of loneliness or self-rated attractiveness on HIRI-MSM 10 or greater was quantified using the Sobel test approach and the Monte Carlo 95% confidence intervals (95% CI).^{31s} The Sobel test examines the mediation effect by comparing the strength of the indirect effect of the exposures on the outcomes with the null hypothesis.^{32s} Mediation is present when the 95% CI of the estimated indirect effect excludes zero.^{32s} The level of significance was set at P less than 0.05. All analyses were performed using SAS version 9.4 (SAS, Cary North, CA).

Ethics

This study was granted ethics approval by the Research Ethics Board, Providence Health Care, the University of British Columbia, Simon Fraser University, and the University of Victoria, ethics certificate numbers H18-00949, H11-00691, H16-01226, and H16-020.

RESULTS

The Momentum Health study enrolled 774 gbMSM, 551 of whom were HIV-negative based on clinical tests at the baseline visit. Nine who did not respond to the questions measuring loneliness were excluded, whereas 2 additional participants with missing HADS score or education level were excluded from the multivariate analysis. The RDS-adjusted estimates showed that of the final 542 participants, 74.6% had an education greater than high school, 63.2% were employed, and 83.5% self-identified as gay. At baseline, 67.2% of participants were classified as lonely (scores ≥ 2 on loneliness scale), 16.0% perceived themselves as unattractive (scores < 6 on the self-rated attractiveness scale), and 55.3% had a high risk for HIV acquisition (HIRI-MSM scores ≥ 10). In comparison to participants with HIRI-MSM scores less than 10, those with scores of 10 or greater were more likely to be lonely, have lower BMI, have education level of high school or less, ever receive money for drugs and goods in exchange for sex, ever work as escort in the sex industry, and use gay telephone chatlines or online dating platforms (Table 1). We found dating platforms preference to be age-dependent. Among participants who used gay chatlines, 40.5% were 45 years or older, whereas 22.1% were younger than 30 years (P -value, 0.0002) (Supplemental Information Table 2, <http://links.lww.com/OLQ/A843>). Online dating platforms were primarily used by participants younger than 30 years versus those 45 years or older (52.7% vs 11.5%, respectively; $P < 0.0001$).

Effect of Loneliness on HIRI-MSM Scores

Loneliness scores ≥ 2 were found in a higher percentage among participants who used gay telephone chatlines or online dating platforms (70.0%), felt unattractive (84.1%), had an annual income of

TABLE 1. Baseline Characteristics of the Final Analytical Sample of Eligible HIV-Negative gbMSM From the Momentum Health Study (n = 542), Stratified by HIV Risk Level

Variables	HIRI-MSM < 10 (n = 208)		HIRI-MSM ≥ 10 (n = 334)		P
	n (Crude %)	RDS % (95% CI)	n (Crude %)	RDS % (95% CI)	
Exposure					
Loneliness score					0.0360
Not lonely (<2)	92 (41.3)	51.2 (40.9–61.4)	131 (58.7)	48.8 (38.6–59.1)	
Lonely (≥2)	116 (36.4)	41.6 (33.6–49.6)	203 (63.6)	58.4 (50.4–66.4)	
Self-rated attractiveness					0.0631
Unattractive (<6)	25 (42.4)	53.8 (36.2–71.5)	34 (57.6)	46.2 (28.5–63.8)	
Attractive (≥6)	183 (37.9)	43.0 (36.3–49.7)	300 (62.1)	57.0 (50.3–63.7)	
Mediators					
Use of gay telephone chatlines or online dating platforms in the past 6 mo					<0.0001
No	69 (59.0)	70.1 (59.0–81.2)	48 (41.0)	29.9 (18.8–41.0)	
Yes	139 (32.7)	36.0 (29.0–43.0)	286 (67.3)	64.0 (57.0–71.0)	
Use of online dating platforms in the past 6 mo					<0.0001
No	73 (58.4)	66.6 (55.0–78.1)	52 (41.6)	33.4 (21.9–45.0)	
Yes	135 (32.4)	36.1 (29.0–43.3)	282 (67.6)	63.9 (56.7–71.0)	
Use of gay telephone chatlines in the past 6 mo					0.0113
No	195 (39.3)	46.4 (39.6–53.1)	301 (60.7)	53.6 (46.9–60.4)	
Yes	13 (28.3)	26.6 (10.9–42.4)	33 (71.7)	73.4 (57.6–89.1)	
Initial potential confounders					
Sexual orientation					0.0541
Gay	167 (36.2)	42.9 (35.9–49.9)	294 (63.8)	57.1 (50.1–64.1)	
Bisexual and other	41 (50.6)	54.0 (38.4–69.6)	40 (49.4)	46.0 (30.4–61.6)	
Ethnicity					0.4756
White	160 (39.4)	45.8 (38.5–53.1)	246 (60.6)	54.2 (46.9–61.5)	
Other	48 (35.3)	42.5 (30.1–55)	88 (64.7)	57.5 (45.0–69.9)	
Highest education					0.0261
High school or less	41 (38.3)	36.6 (24.1–49.1)	66 (61.7)	63.4 (50.9–75.9)	
Greater than high school	167 (38.4)	47.5 (40.3–54.8)	268 (61.6)	52.5 (45.2–59.7)	
Annual income					0.9235
<30,000	122 (38.4)	44.9 (36.9–52.9)	196 (61.6)	55.1 (47.1–63.1)	
≥30,000	86 (38.4)	44.5 (34.0–55.0)	138 (61.6)	55.5 (45.0–66.0)	
Born in Canada					0.9704
No	45 (33.1)	44.9 (32.3–57.4)	91 (66.9)	55.1 (42.6–67.7)	
Yes	163 (40.2)	44.7 (37.4–52.0)	243 (59.9)	55.3 (48.0–62.6)	
Employment					0.4977
Unemployed	56 (36.6)	42.9 (31.7–54.0)	97 (63.4)	57.1 (46.0–68.3)	
Employed	152 (39.1)	45.9 (38.2–53.6)	237 (60.9)	54.1 (46.4–61.8)	
Received money/drugs/goods in exchange for sex ever					<0.0001
No	173 (43.3)	50.6 (43.1–58.1)	227 (56.8)	49.4 (41.9–56.9)	
Yes	35 (24.7)	26.2 (16.4–36.0)	107 (75.4)	73.8 (64.0–83.6)	
Worked as escort in sex industry ever					0.0090
No	190 (40.0)	46.7 (39.9–53.5)	285 (60.0)	53.3 (46.5–60.1)	
Yes	18 (26.9)	28.9 (14.2–43.5)	49 (73.1)	71.1 (56.5–85.8)	
In relationship with regular partner					0.2145
No	121 (36.8)	42.7 (34.4–51.0)	208 (63.2)	57.3 (49.0–65.6)	
Yes	87 (40.9)	48.2 (38.4–58.0)	126 (59.2)	51.8 (42.0–61.6)	
Neighborhood					0.3457
Downtown/West End	87 (37.7)	47.0 (37.0–57.0)	144 (62.3)	53.0 (43.0–63.0)	
Outside downtown	73 (38.4)	40.2 (29.9–50.5)	117 (61.6)	59.8 (49.6–70.1)	
Outside Vancouver	48 (39.7)	46.6 (33.4–59.7)	73 (60.3)	53.4 (40.3–66.6)	
HADS Anxiety Scale*					0.2834
Mild	165 (40.1)	46.3 (39.0–53.6)	247 (60.0)	53.7 (46.4–61.0)	
Moderate to severe	43 (33.3)	41.2 (28.2–54.2)	86 (66.7)	58.8 (45.8–71.8)	
Refused to answer	0	NA	1 (100.0)	100 (NA)	
HADS Depression Scale*					0.1953
Mild	199 (38.5)	44.3 (37.8–50.8)	318 (61.5)	55.7 (49.2–62.2)	
Moderate to severe	9 (37.5)	57.1 (27.9–86.4)	15(62.5)	42.9 (13.6–72.1)	
Refused to answer	0	NA	1 (100)	100 (NA)	
AUDIT†					0.4154
Low risk	126 (43.3)	46.9 (38.4–55.5)	165 (56.7)	53.1 (44.5–61.6)	
Medium risk	60 (35.7)	43.3 (31.7–54.8)	108 (64.3)	56.7 (45.2–68.3)	
Harmful or possible dependence	22 (26.5)	39.0 (22.0–56.1)	61 (73.5)	61.0 (43.9–78.0)	

Continued next page

TABLE 1. (Continued)

Variables	HIRI-MSM < 10 (n = 208)		HIRI-MSM ≥ 10 (n = 334)		P
	n (Crude %)	RDS % (95% CI)	n (Crude %)	RDS % (95% CI)	
BMI [‡]					0.0069
Underweight	5 (45.5)	63.5 (31.8–95.1)	6 (54.6)	36.5 (4.9–68.2)	
Normal	114 (35.5)	38.8 (30.8–46.7)	207 (64.5)	61.2 (53.3–69.2)	
Overweight	61 (40.1)	54.1 (42.4–65.8)	91 (59.9)	45.9 (34.2–57.6)	
Obese	28 (48.3)	50.8 (32.1–69.6)	30 (51.7)	49.2 (30.4–67.9)	

*HADS, mild (scores of 0 to 10), moderate to severe (scores of 11 to 21).

[†]AUDIT, low risk (scores 0 to 7), medium risk (scores 8 to 15), harmful (scores ≥16).

[‡]BMI, underweight (<18.5), normal (18.5–24.9), overweight (25–29.9) and obese (≥30).

NA, not applicable; RDS %, RDS-adjusted proportion—the estimated proportion of individuals in the target population (ie, gbMSM in Vancouver) who possess certain characteristic.

<30,000 Canadian Dollars (CAD) (71.7%) and were unemployed (76.8%) (Supplemental Table 3, <http://links.lww.com/OLQ/A843>). After adjustment for sexual orientation, HADS Anxiety Scale and AUDIT, participants who were lonely had 1.54 (95% CI, 1.04–2.28) the odds of having HIRI-MSM scores ≥10 compared with those who were not lonely (Table 2).

The mediation analysis found that participants who were lonely were more likely to use gay telephone chatlines or online dating platforms (adjusted odds ratio [aOR], 1.63; 95% CI, 1.05–2.51); those who used gay telephone chatlines or online dating platforms were more likely to have HIRI-MSM scores ≥10 (aOR 3.90; 95% CI: 2.56–5.94). A Sobel P value of 0.0380 (Monte Carlo 95% CI of 0.0038–0.0764) suggested a significant mediation by the use of gay telephone chatlines or online dating platforms combined. The indirect effect of gay telephone chatlines or online dating platforms accounted for 30.5% of the total pathway between loneliness and HIRI-MSM of 10 or greater (Fig. 1).

Effect of Self-Rated Attractiveness on HIRI-MSM Scores

Scores of self-rated attractiveness of 6 or greater were reported in a higher percentage among participants who used online dating platforms (86.2%), were younger than 30 years (88.2%), had education greater than high school (86.8%), were employed (86.8%), had medium risk of alcohol use disorder (92.0%) and a normal weight (87.3%) (Supplemental Table 4, <http://links.lww.com/OLQ/A843>). After adjustment for sexual orientation, HADS Anxiety Scale, neighborhood, and employment, participants who perceived themselves

as attractive had 1.69 times the odds (95% CI, 1.04–2.76) of having HIRI-MSM scores of 10 or greater compared with those who rated themselves as less than 6 (Table 2). The mediation analysis found no significant indirect effect observed in relationship between self-rated attractiveness and HIRI-MSM of 10 or greater by the use of gay telephone chatlines or online dating platforms (Sobel P = 0.0701; Monte Carlo 95% CI, –0.000817 to 0.05086) (Fig. 1).

Moderation Analysis

When exploring the interaction between loneliness and self-rated attractiveness, we found that compared with those who were not lonely and rated themselves as attractive, only participants who felt lonely (loneliness scores ≥2) but rated themselves as attractive (self-rated attractiveness ≥6) were significantly more likely to have HIRI-MSM ≥ 10 (aOR, 1.70; 95% CI, 1.08–2.65) (Table 2). To further understand this interaction, we conducted a mediation analysis stratified by loneliness. With gay telephone chatlines or online dating platforms as mediators, we found no significant indirect effect of self-rated attractiveness on HIRI-MSM of 10 or greater among not lonely (Sobel P = 0.0747; Monte Carlo 95% CI, 0.0015–0.0987) and lonely participants (Sobel P = 0.2259; Monte Carlo 95% CI, –0.0087 to 0.0457) (Supplemental Information Figure 1, <http://links.lww.com/OLQ/A843>).

DISCUSSION

Our analyses indicated that a high proportion of gbMSM experienced emotional or social loneliness and perceived themselves as attractive. We found that loneliness and self-rated

TABLE 2. Weighted Multivariable Logistic Regression Model on the Probability of HIRI-MSM ≥ 10 Adjusted for Confounders

Variables	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Exposure		
Loneliness*		
Not lonely	Reference	Reference
Lonely	1.48 (1.03–2.13)	1.54 (1.04–2.28)
Self-rated attractiveness [†]		
Unattractive	Reference	Reference
Attractive	1.55 (0.98–2.47)	1.69 (1.04–2.76)
Loneliness and self-rated attractiveness [‡]		
Not lonely and attractive	Reference	Reference
Not lonely and not attractive	0.50 (0.16–1.59)	0.66 (0.19–2.27)
Lonely and not attractive	0.94 (0.54–1.63)	0.87 (0.46–1.64)
Lonely and attractive	1.57 (1.06–2.31)	1.70 (1.08–2.65)

*Multivariable model adjusted for sexual orientation, HADS Anxiety Scale and AUDIT.

[†]Multivariable model adjusted for sexual orientation, HADS Anxiety Scale, neighborhood, employment.

[‡]Multivariable model adjusted for ethnicity, sexual orientation, employment, in relationship with regular partner, neighborhood, HADS Anxiety Scale, received money/drugs/goods in exchange for sex, AUDIT, BMI.

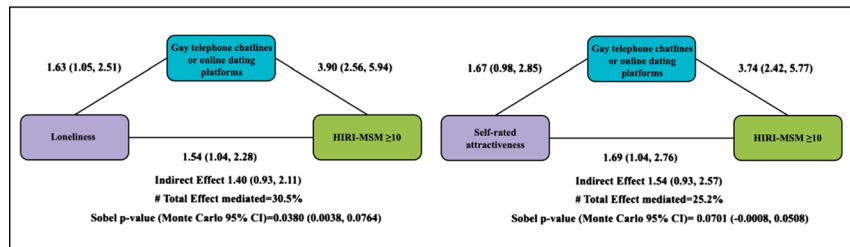


Figure 1. Mediation results of the use of gay telephone chatlines or online dating platforms. Note: aOR with a 95% CI were reported in the mediation; Gay telephone chatlines and online dating platforms = Use of gay telephone chatlines, smartphone apps, or Internet hook-up sites or other websites to meet other guys for sex. Loneliness mediation analysis was adjusted for sexual orientation, HADS Anxiety Scale and AUDIT. Self-rated attractiveness mediation analysis was adjusted for sexual orientation, HADS Anxiety Scale, neighborhood, employment.

attractiveness were each associated with increased risk of HIV acquisition, determined by HIRI-MSM of 10 or greater. This association was further heightened when loneliness and self-rated attractiveness were present together. The use of gay telephone chatlines or online dating platforms was also widespread among gbMSM and partially drove (ie, mediated) the association between loneliness and HIRI-MSM of 10 or greater. Together, our findings highlight the public health importance of interventions that provide mental health support and promote safer sex behaviors among gbMSM and support the provision of these interventions through gay telephone chatlines or online dating platforms as a promising strategy to reduce alleviate the HIV burden among gbMSM.

Concordant with our study, increased HIV acquisition risk has been previously associated with loneliness.⁸ This association might be because of a variety of individual, and societal factors such as feelings of isolation, lack of social network and decreased sense of belonging,^{33s,34s} leading individuals to seek emotional connections through the use of online dating platforms,⁹ and, thus, engage in increased HIV acquisition risk behaviors.^{35s} Moreover, previous studies have described that gbMSM may engage in condomless sex because of a perception that unprotected intercourse can be used to develop emotional intimacy with partners.^{36s} Similarly, self-rated attractiveness can also affect the use of online dating platforms¹²; however, to our knowledge, no previous study has evaluated this relationship directly. Factors influencing the association between self-rated attractiveness and increased HIV acquisition risk can include, first, societal pressures experienced by gbMSM to meet beauty standards leading to negative self-concepts and engagement in high HIV risk behaviors,¹⁵ and, second, the “halo effect,” a cognitive bias where positive traits are attributed to attractive individuals.^{37s} This effect postulates that attractive individuals are perceived as healthier, more powerful and intelligent.^{37s} Hence, attractive partners can be perceived as less likely to be living with HIV and sexual partners may be less inclined to use condoms.¹² Thus, a combination of societal pressure and the “halo effect” may partially explain our findings that gbMSM who perceived themselves as attractive were more likely to engage in increased HIV acquisition risk behaviors.

The higher HIV and other sexually transmitted diseases (STDs) acquisition risk behaviors associated with dating platforms and the possibility of using these platforms to address loneliness and other negative emotional states,^{38s,39s} merit the consideration of targeted interventions delivered through gay telephone chatlines or online dating platforms. Current interventions to lower HIV and STDs acquisition risk among gbMSM have focused mainly on web-based counseling, informational modules and connecting with peer health educators.^{38s,40s} Effective interventions that have reduced HIV and other STDs risk behavior have included social media campaigns such as “Tu Amigo Pepe” that uses radio and social media to promote HIV testing and condom use.^{41s} However,

to effectively encourage health behavior change, interventions should focus on providing a combination of mental health and social support, information and promotion of safer sex practices.^{36s} In addition to promoting condom use to prevent STDs in general,^{42s} promoting the use of HIV pre-exposure prophylaxis (PrEP), which has been publicly funded in British Columbia since January 2018,^{43s} is another key strategy to reduce HIV acquisition risk. It is interesting that we observed young participants preferring online dating platforms and older participants gay telephone chatlines, suggesting that interventions should also be designed with an age-specific target audience such as campaigns and telephone-administered motivational interviewing to deliver sexual health information, promote HIV and other STDs testing, condom use and PrEP in combination with counseling offered through dating platforms.^{44s,45s} Moreover, higher dating platforms use has been associated with a lower sense of community and loneliness;^{46s} thus, frequency of use of these platforms could be an indicator of loneliness and interventions might be tailored to provide mental health support for these individuals.

Our study has some important strengths. First, we used RDS as our recruitment strategy, which reduces biases generally associated with other convenience methods of sampling. The RDS method is commonly used in studies involving hard-to-reach populations, including gbMSM, and likely increased the generalizability of our results to the gbMSM in Vancouver and other high-income urban settings.³⁰ Second, the use of a validated screening tool specially designed to identify HIV risk among gbMSM,²⁰ allowed us to evaluate HIV acquisition risk considering factors that have been previously associated with this population.⁸ Third, the use of a loneliness scale that has been validated in gbMSM,²¹ allowed us to reliably measure loneliness status among our participants. Fourth, the estimation of Monte Carlo 95% CI for the indirect effect allowed us to have enhanced precision due to the smoothness of the sampling distribution.^{47s}

Note that the baseline data of Momentum study used in our analyses were limited to February 2015. The use of online dating platforms, however, is still prevalent among gbMSM to this day.¹⁰ Follow-up interviews of Momentum study participants through July 2019 also revealed that, in a 6-month period, 4% to 11% of gbMSM remained using gay chatlines to seek sexual encounters (data not shown). Moreover, given that the use of gay chatlines was preferred by older study participants, gay chatlines may provide a safer way of interacting sexually and erotically, particularly during the COVID-19 pandemic. For these reasons and considering how the COVID-19 pandemic may also further intensify loneliness,^{48s} findings of this study remain applicable in contemporary settings.

Additional limitations should be considered. First, to analyze the causal chain of mediation, mediation analyses are ideally conducted in longitudinal data.^{49s} Given the cross-sectional nature of our data, we were thus unable to infer causality based on our

mediators. Second, our results suggest that age may modify the relationship between our exposures and mediators; however, given that age is a component of HIRI-MSM, we were unable to include age in our mediation analysis. We tried to understand the effect of age in this study by conducting a descriptive analysis between age and the preference of dating platform. Third, the dichotomized responses for the use of telephone chatlines and online dating platforms might have limited the importance of frequency usage of these platforms; however, we assessed the use of dating platforms in the last 6 months, which allowed us to capture current data.

This study established the relationship between loneliness and self-rated attractiveness, individually and in-combination, with increased HIV risk among gbMSM. Moreover, it highlighted the moderating role of self-rated attractiveness and loneliness on increased HIV risk and the mediating role of use of gay telephone chatlines or online dating platforms in the pathway between loneliness and increased HIV acquisition risk among gbMSM. The effectiveness of interventions, such as social media campaigns, peer-based programs and counseling, combined with the results obtained in our study, suggest that the provision of mental health support and promotion of safer sex behaviors through dating platforms are promising interventions to reduce HIV and other STDs acquisition risk in our gbMSM population. Future studies should build from this work and analyze the mediation effect of the frequency of use of dating platforms in the pathway between loneliness, self-rated attractiveness and increased HIV acquisition risk among gbMSM.

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