

A latent class analysis of sexual and romantic relationships among HIV-positive and HIV-negative gay and bisexual men in Vancouver

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Quantitative studies of gay and bisexual men have often reduced relational experiences to single dimensions and explored linkages with sexual risk behaviours. We sought to document the intersection of multiple relationship dimensions among 218 HIV-positive and 556 HIV-negative gay and bisexual men, and estimate associations with love and affection as well as various health and social covariates. We performed latent class analysis of relationships, employing five indicators: relationship status, sexual agreement (monogamous/open), and number of recent sex partners, sex parties, and anonymous sex encounters. We assessed differences in love and affection, and identified covariates using multinomial logistic regression. Two latent classes involved single men: 'single, less sex partners' (45% of sample) and 'single, more sex partners' (17%), differentiated by number of partners (52% vs. 92% of each class had ≥ 5 partners, respectively), party sex (3% vs. 57%), and anonymous sex (2% vs. 58%). Three involved regular partners: 'monogamish' (15%) (78% were monogamous yet 50% reported ≥ 1 recent sex partner); 'open, less sex partners' (15%) (100% open, 43% ≥ 5 partners, 10% party sex, 4% anonymous sex); and 'open, more sex partners' (9%) (96% open, 92% ≥ 5 partners, 47% party sex, 69% anonymous sex). Love and affection were common across classes, although more prevalent among partnered (85–91%) versus single (48–51%) men. Relative to 'single/less partners,' the study demonstrated that higher sexual sensation seeking scores were associated with membership in every class except 'monogamish'; erectile dysfunction drug use was associated with being in the 'more partners' (single and open) classes; anxiety and older age were associated with the 'open/less partners' class; and loneliness was associated with reduced odds of membership in all three partnered classes. We uncovered considerable relational diversity among gay and bisexual men and complex associations with love and wellbeing. Findings are relevant for sex researchers, educators, and therapists.

KEY WORDS: Latent class analysis, HIV, gay and bisexual men, relationships, sex, love, sexual agreements, monogamish

The pathologizing of gay and bisexual men's sexuality in health research has been critiqued for decades (Coveney & Bunton, 2003; Flowers & Langdridge, 2007; Worth & Rawstorne, 2005). Even today, in the context of HIV, most studies remain

focused on risk-taking rather than the pleasures of sex (Berg, 2009; van Kesteren, Hospers, & Kok, 2007). Further, experiences of sex are often studied separately from romantic relationships despite calls for integration (Lefkowitz, Gillen, Vasilenko,

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Fincham, & Cui, 2011). When they are modelled concurrently, studies generally employ a variable-centred approach, such a regression analysis, using single, dichotomized variables to measure these constructs. Less attention has been paid to how multiple dimensions of sexual and relational experiences may group together and, in turn, be related to positive aspects of sexuality as well as social, sexual, and mental health factors in complex ways. Even less is known about whether and how these patterns may vary by HIV-status. To address these gaps, we used a person-centred approach called latent class analysis (LCA) (Lanza, Bray, & Collins, 2013) to delineate latent classes of sexual and romantic relationships among HIV-positive and HIV-negative gay and bisexual men, and examined how these classes were associated with love and affection, as well as various health and social covariates, using data from the Momentum Health Study in Vancouver, British Columbia (BC), Canada.

Sexuality among gay and bisexual men

Sexuality among gay and bisexual men has traditionally been studied from a risk perspective, as seen by the large literature on condomless anal sex (Berg, 2009; van Kesteren et al., 2007). Research attention on sexual risk behaviours is due in part to their continued high rates of HIV globally and in Canada (Beyrer et al., 2012). In 2014, gay and bisexual men made up 58% ($n = 151/261$) of new HIV diagnoses in BC (BC Centre for Disease Control, 2015). HIV prevalence among this population in Metro Vancouver is estimated at 23.4% (Moore et al., 2016), significantly higher than provincial and national estimates of 0.01% (Government of Canada, 2016). Without negating the continued importance of prevention efforts, particularly among those unaware of their HIV status and not on HIV treatment, there are also many benefits and pleasures to sex that are elided in much of the quantitative health research landscape among gay and bisexual men (Brennan, Bauer, Bradley, & Tran, 2016).

Today's new era of HIV treatment and prevention (TasP), known as the "End of AIDS" (Havlik & Beyrer, 2012), presents an unparalleled opportunity to transform the narrative of what it means to be a gay man and to live with HIV, including the possibility of continued vibrant sex lives. In the latest and largest studies of HIV transmission risk to date, no HIV-positive participant on combination antiretroviral therapy (cART) with an undetectable viral load, gay or heterosexual, transmitted HIV to their main sexual partner through condomless sex (Rodger et al., 2014; Rodger et al., 2016), leading many activists and community groups to promote the notion that 'undetectable' means 'untransmittable' (Prevention Access Campaign, 2017). This represents remarkable progress in the field of sexuality and HIV from the 1980s when clinicians and researchers including sex therapists (Kaplan, Sager, & Schiavi, 1985) advised "there is no such thing as safe sex" and "immunopositive individuals can never...have sex again" (p. 211).

In light of these developments and the growing recognition of sexual rights for all, regardless of gender, sexual identity, HIV status, and so forth (World Association for Sexual

Health, 2014), understanding other aspects of gay and bisexual men's lives relevant to sexual well-being such as relationship context, sexual interests and experiences, and receipt of love and affection is important and is gaining traction in both scientific reviews (Fortenberry, 2013; Hull, 2008) and empirical studies (Calabrese, Rosenberger, Schick, & Novak, 2015; Rosenberger, Herbenick, Novak, & Reece, 2014).

Dimensions of romantic relationships and sexual experiences

One dimension of intimate same-sex relationships measured in observational studies is relationship status. While providing little insight into the quality of intimate encounters, one's view of the relationship (i.e., single, dating, married, etc.) – whether a mutually agreed upon status or unconfirmed assumption – plays a role in where sexual and romantic encounters are viewed along the continuum between emotions and physical pleasures, which are not mutually exclusive and highly connected (Armstrong & Reissing, 2015; Epstude & Förster, 2011; Förster, Özsel, & Epstude, 2010). Within HIV epidemiological research, there has also been great interest in differentiating between casual and committed sexual relationships. Most often, this is assessed via the use of a single question asking men about whether they consider their sexual partner(s) to be "regular" or "serious" versus "casual" (Mustanski, Newcomb, & Clerkin, 2011), with some recent quantitative studies offering more nuanced categories on the subject (i.e., serious relationship, casually dating but not serious, sleeping with but not dating, one night stand, or stranger or anonymous partner) (Newcomb, Ryan, Garofalo, & Mustanski, 2014). Importantly, though, other studies (White et al., 2017), particularly those involving qualitative narratives (Amaro, 2016; Persson, 2014), suggest that partnerships among gay and bisexual men do not fall neatly into these discrete categories, and that romantic arrangements and sexual behaviours vary not only across, but also within, these partnership types.

For instance, agreements about whether or not to have sex with outside partners are common among gay couples of various HIV statuses (i.e., concordance and discordance), and a burgeoning area of research (Gass, Hoff, Stephenson, & Sullivan, 2012; Gomez et al., 2012; Grov, Starks, Rendina, & Parsons, 2014; Hoff & Beougher, 2010; Hoff, Beougher, Chakravarty, Darbes, & Neilands, 2010; Hoff et al., 2009; LaSala, 2004; Mitchell, 2014b; Mitchell, Harvey, Champeau, Moskowitz, & Seal, 2012; Parsons, Starks, DuBois, Grov, & Golub, 2013; Parsons, Starks, Gamarel, & Grov, 2012; Prestage et al., 2008; Wheldon & Pathak, 2010). Although agreements help couples negotiate safety and reduce HIV risk (Kippax et al., 1997; Prestage et al., 2006), research suggests the main driver behind establishing them is to express trust and love, and to help further refine the structure of the relationship in ways that are meaningful and responsive to each partner's sexual interests and desires (Hoff & Beougher, 2010). It is estimated that 44% to 66% of gay and bisexual men in relationships with main partners have such agreements (Grov et al., 2014; Hoff & Beougher, 2010; Mitchell, Harvey, Champeau,

Moskowitz, et al., 2012; Parsons & Grov, 2012; Wheldon & Pathak, 2010), and 20–30% report breaking them at some point (Gomez et al., 2012; Hoff et al., 2009; Mitchell, Harvey, Champeau, Moskowitz, et al., 2012; Mitchell, Harvey, Champeau, & Seal, 2012). The likelihood of breaking an agreement is known to increase with relationship length (Mitchell, 2014a) while trust, communication, commitment, and social support are protective factors (Gomez et al., 2012). Among those with agreements, open arrangements are common (e.g., 42%) (Parsons et al., 2013), often defined by whether men can have sex with others on their own or only as a couple (Parsons et al., 2013).

Beyond agreements, there are a multitude of sexual activities and interests among gay and bisexual men. To date, within the context of HIV research, number of recent male sex partners, anonymous sex, and participation in sex parties are some of the most well-studied aspects of sexual behaviour within this population (Klein, 2012; Mimiaga et al., 2011; Semple, Patterson, & Grant, 2000, 2004), as well as condom use and sexual positioning (Card, Lachowsky, Cui, Carter, et al., 2016; Card, Lachowsky, Cui, Sereda, et al., 2016). Within this literature, ‘sex partners’ are often defined by whether or not anal sex occurred, and if sexual practices are reported, the focus is generally not on the full range of men’s diverse sexual experiences but rather ‘unprotected anal intercourse’ (UAI) (Bauermeister, 2015; Mustanski et al., 2011; Newcomb et al., 2014), a term still commonly used to describe sex without condoms despite the existence of other equally or more effective prevention strategies such as TasP (Rodger et al., 2014; Rodger et al., 2016), pre-exposure prophylaxis (PrEP) (Molina, Charreau, & Spire, 2016), and sero-adaptive behaviours (Vallabhaneni et al., 2012). Moreover, quantitative (Bracchi et al., 2015; McCarty-Caplan, Jantz, & Swartz, 2014) and qualitative (Amaro, 2016; Race, 2015) research is increasingly illuminating how illicit drugs such as ‘club drugs’ and ‘sex drugs’ often shape such intimate encounters, and vice versa, both of which are closely connected to the construction of gay social bonds, identities, and communities (Race, 2011). Implicit in epidemiological HIV discourse, however, is the belief that non-normative sexual and drug practices are inherently dangerous and disconnected from notions of ‘healthy’ sexuality and ‘stable’ sexual relationships (Coveney & Bunton, 2003; Flowers & Langdridge, 2007; Holt & Treloar, 2008; Race, 2008; Worth & Rawstorne, 2005). Without ignoring the risk these practices and activities involve, recent attempts, particularly within HIV social science research, have been made to approach them as expressions of sexuality that are valid, applicable, and meaningful to gay sexual culture and an important source of connection, enjoyment, and erotic intimacy among a large segment of men (Amaro, 2016; Race, 2015). As Race (2015) asserts, a significant “challenge, then, is to produce analyses of the relevant sexual practices, cultures, and relations so that possibilities of care, safety, and pleasure that are immanent within these cultures can be acknowledged, identified and fostered” (p. 254). This is perhaps one of the most important new

nexus for research with gay and bisexual men: concurrent consideration of HIV, relational dynamics, sexual pleasure, and sexual rights.

Latent class analysis: A person-centred approach

While traditionally studied as single variables, the importance of investigating how dimensions of relationships and sexuality intersect in different ways has received growing attention in recent years. Person-centred approaches such as LCA (Lanza et al., 2013) have become increasingly popular in this regard on account of their ability to identify clusters of individuals that share a common set of characteristics. Among gay and bisexual men, LCA has been used to model risk factors for acquiring HIV (Chan et al., 2015), rules regarding non-monogamy (Grov et al., 2014), seroadaptive sexual decision-making (Card, Lachowsky, Cui, Carter, et al., 2016), and levels of interaction and familiarity with partners (White et al., 2016). Researchers, however, have been primarily interested in sexual risk-taking, investigating how characteristics of relationships or sexual behaviours intersect to affect HIV risk (i.e., the odds of UAI). While research on risk reduction among gay and bisexual men is vital toward informing the development of interventions aimed at empowering men with relevant health information, rarely are their choices, interests, and experiences regarding sex affirmed in empirical studies as a positive part of male sexuality, irrespective of one’s HIV status, including studies involving LCA. One notable exception is a recent study by Calabrese and colleagues (2015) among 21,696 US men ages 18–87 that delineated latent classes marked by differing levels of pleasure, affection, and love and compared profiles among Black men with other racial groups (White, Latino, Asian). They found no differences in positive sexual experience patterns, countering historical stereotypes around Black men’s sexual interactions as aggressive, hypermasculine, and emotionally detached (Ford, Whetten, Hall, Kaufman, & Thrasher, 2007). Alternative narratives of gay and bisexual men’s sexuality such as these are needed, particularly within the research field of epidemiology and the practice of public health.

Research objectives

Building on this literature and using LCA among 218 HIV-positive and 556 HIV-negative gay and bisexual men in Vancouver, BC, we sought to explore how multiple measures of sexual and relational experiences intersect and to quantify their associations with positive dimensions of sexuality and various health and social covariates. We had three main research questions. First, are there underlying types of relationships among gay and bisexual men marked by different patterns of sexual and romantic behaviours, and how might these types compare in love and affection? Second, is the measurement of latent class structure invariant (i.e., the same) for HIV-positive and HIV-negative men, and if so, are there similarities or differences in class membership probabilities

by HIV-status? Third, and final, are social and economic factors (e.g., age, income), psychological concerns (e.g., anxiety, loneliness), and other social and sexual correlates (e.g., party drug use, sex work) predictive of membership in latent classes? As an exploratory analysis, we had no a priori hypotheses regarding the latent classes, or their connection to covariates. In undertaking this analysis, we sought to contribute to non-normative understandings of men's romantic encounters and lives.

METHODS

Study design

We used baseline questionnaire data from the Momentum Health Study for this analysis (study website: www.momentumstudy.ca). The Momentum Health Study is a longitudinal cohort study of sexually active HIV-positive and HIV-negative gay and bisexual men aged 16 years and older in Vancouver, Canada. Between February 2012 and February 2015, a complex respondent driven sampling (RDS) strategy (Heckathorn, 1997) was used to recruit a diverse sample of participants into the study, starting with 134 initial participants or "seeds" that subsequently recruited 640 peers for a total sample size of 774 (described in detail elsewhere: Forrest et al., 2014; Lachowsky et al., 2016). Participants complete a. Participants complete a computer-assisted, self-administered (CASI) questionnaire in-person at baseline and every 6-months that collects information about socio-demographics, sexual behaviours, and general health status, among other variables. The baseline questionnaire took approximately 1-hour to complete (median: 51 minutes; first quartile, third quartile (Q1,Q3): 41,66), after which participants met with a nurse who administered a short clinical questionnaire and tests for HIV and STIs. Among participants living with HIV, data on viral load and CD4 cell count were available through linkage with clinical data at the British Columbia Centre for Excellence in HIV/AIDS (Hogg et al., 2001). All study procedures were conducted in a private office space located in the downtown West End, Vancouver's traditional gay neighbourhood, and participants received \$50 CAD for each visit. Ethical approval for this study was received from Simon Fraser University, the University of British Columbia/Providence Health, and the University of Victoria, and all participants provided voluntary written informed consent at study enrolment.

Final analytic sample

A total of 774 gay and bisexual men completed the baseline questionnaire, including 218 self-reported HIV-positive and 556 self-reported HIV-negative/unknown individuals. All of these individuals were included in the LCA, as they reported a valid response to at least one of the indicators of latent class membership ($n = 774$). In multivariable analyses, the sample size was reduced to 556 (72% of cohort) due to invalid responses to covariates such as "don't know" or "prefer not to answer".

Study variables

Indicators of latent class membership

We included five indicators of sexual relationship experience in the LCA (Table 1). The first indicator was derived from responses to three survey questions concerning marital status, presence of a 'regular' partner (not defined in the survey), and cohabitation with a 'regular' partner for more than 12 months (i.e., common-law): "regular partner, married", "regular partner, common-law", "regular partner, live-apart relationship", "no regular partner, single", and "no regular partner, separated/divorced/widowed". The second indicator measured whether men who reported a regular partner were in "monogamous" or "open" relationships. Owing to survey skip logic, married men ($n = 44$) were not asked this question explicitly, so were coded as "monogamous" if they reported 0–1 male sexual partners in the past 6 months and "open" if they reported ≥ 2 . Three additional variables describing gay men's sexual experiences in the past 6 months were included in the LCA: number of male sex partners (coded as "0–1", "2–4", and " ≥ 5 ", and described in the survey as "guys you have had sex with"); participation in sex parties (dichotomized as "Yes" versus "No", and defined as "an event where 4 or more people get together and have some kind of sex with some or all of the other people there, whether planned or it just happens"); and participation in anonymous sex [also dichotomized as "Yes" versus "No", and described as darkroom events ("a place in a club, bar, or bathhouse for guys to have sex where you don't know or aren't able to easily see who you are having sex with") and/or blackout events ("an event – usually at a bathhouse – where the lights are very dim or turned off so that you aren't easily able to see who you are having sex with")]. The former variable, male sex partners, referred to any type of sex (i.e., not just anal sex) with men, and comprised a range of sexual activities including anal sex as the bottom (67.7%), anal sex as the top (71.5%), giving a blow job (86.1%), receiving a blow job (86.4%), rimming (61.1%), masturbating (75.5%), fisting (10.5%), sex toys (28.2%), and "watersports" (14.0%).

Grouping variable: Self-reported HIV serostatus

After creating the latent classes, we tested measurement invariance and the prevalence of class membership by self-reported HIV status ("HIV-positive" versus "HIV-negative/unknown"). We used self-reported (instead of diagnosed) HIV status since recent sexual behaviours are likely predicated on what participants perceive their HIV status to be.

Correlates of latent class membership

Love and affection

To make explicit the need for research on positive aspects of sexuality, we included an indicator of love and affection in this analysis. Participants were asked about multiple dimen-

Table 1. Baseline Characteristics of Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774), Overall and by HIV Serostatus

	Overall		HIV-negative/unknown		HIV-positive		p-value
	774	(100)	556	(71.8)	218	(28.2)	
Continuous variables	MD	(Q1, Q3)	MD	(Q1, Q3)	MD	(Q1, Q3)	
Age	34	(26, 47)	29.5	(24, 39)	47	(39, 51)	<.0001
HAD Anxiety ($\alpha = 0.8350$)	8	(5, 11)	8	(5, 10)	8	(5, 11)	0.7309
HAD Depression ($\alpha = 0.7867$)	3	(2, 6)	3	(1, 6)	5	(2, 7)	<.0001
Loneliness Score ($\alpha = 0.7660$)	1	(0, 2)	2	(1, 4)	3	(1, 5)	0.0018
Sexual Sensation Seeking Scale ($\alpha = 0.7295$)	31	(28, 34)	30	(28, 33)	32	(29, 35)	0.0014
Categorical variables	N	(%)	N	(%)	N	(%)	p-value
Socio-demographic factors							
Age (years)							
< 30	289	(37.3)	278	(50.0)	11	(5.1)	<.0001
30–44	256	(33.1)	181	(32.6)	75	(34.4)	
45+	229	(29.6)	97	(17.5)	132	(60.6)	
Ethnicity							
White	585	(75.6)	414	(74.5)	171	(78.4)	0.0085
Asian	74	(9.6)	62	(11.2)	12	(5.5)	
Indigenous	50	(6.5)	29	(5.2)	21	(9.6)	
Latino/Other	65	(8.4)	51	(9.2)	14	(6.4)	
Sexual identity							
Gay	655	(84.6)	470	(84.5)	185	(84.9)	0.9088
Bisexual/Other	119	(15.4)	86	(15.5)	33	(15.1)	
Socio-economic factors							
Education							
No greater than high school	179	(23.1)	113	(20.3)	66	(30.3)	0.0031
Greater than high school	595	(76.9)	443	(79.7)	152	(69.7)	
Annual Income							
Less than \$30,000	485	(62.7)	328	(59.0)	157	(72.0)	0.0019
\$30,000–\$59,999	200	(25.8)	154	(27.7)	46	(21.1)	
\$60,000 and over	89	(11.5)	74	(13.3)	15	(6.9)	
Currently Employed							
No	283	(36.6)	160	(28.8)	123	(56.4)	<.0001
Yes	491	(63.4)	396	(71.2)	95	(43.6)	
Sex work, drug use, and disclosure factors							
Sex work in the past 6 months							
No	720	(93.0)	524	(94.2)	196	(89.9)	0.0332
Yes	54	(7.0)	32	(5.8)	22	(10.1)	
Erectile dysfunction drug use in the past 6 months							
No	587	(75.8)	469	(84.4)	118	(54.1)	<.0001
Yes	187	(24.2)	87	(15.7)	100	(45.9)	
Party drug use in the past 6 months							
No	449	(58.0)	347	(62.4)	102	(46.8)	<.0001
Yes	325	(42.0)	209	(37.6)	116	(53.2)	
Frequency of disclosure of HIV-Status							
50% or more of the time	401	(51.9)	261	(47.0)	140	(64.2)	<.0001
Less than 50% of the time	95	(12.3)	56	(10.1)	39	(17.9)	
Only when Asked	277	(35.8)	238	(42.9)	39	(17.9)	

Note. Party drug use includes any use of methamphetamins (i.e., crystal and speed), hallucinogens (i.e., ecstasy, ketamine, mushrooms, lysergic acid diethylamide (LSD), and other hallucinogens), or gamma-hydroxybutyrate (GHB)

sions of social support (“How often is each of the following kinds of support available to you when you need it?”). The item about love read: “someone who shows you love and affection”, with responses including “most of the time”, “a little or some of the time”, or “none of the time”. Owing to extremely

small cell sizes for “none” in bivariable analyses with latent classes, the latter two categories were combined. While our data set precluded us from capturing the differences between love and affection nor the multidimensionality of these constructs – the former usually theorized as encompassing inti-

macy, passion, and commitment (Sternberg, 1986) and the latter inclusive of kissing, cuddling, touch, and other types of physical affection (Gulledge, Gulledge, & Stahmann, 2003) – this measure provided some appraisal of men’s encounters with love and affection. It is important to note that this variable is not specific to sexual partners and participants may have considered other relationship sources (e.g., friend, parent) in their response. Nonetheless, research shows love and affection to be a crucial source of symbolic support and emotional connection between gay and bisexual men, particularly in their quest for and enactment of sexual encounters (Amaro, 2016).

Social and health variables

We considered several variables as descriptors of the study sample and/or possible predictors of latent class membership. Socio-demographic variables included: age group (“<30”, “30–44”, and “≥45”), race/ethnicity (“White”, “Asian”, “Indigenous”, and “Other ethnicity”), and sexual identity (“gay” and “bisexual/other”). Socio-economic factors included: education (“greater than high school” and “no greater than high school”), annual income (“<\$30,000”, “\$30,000 to \$59,999”, and “≥\$60,000”), and currently employed (“Yes” versus “No”). To understand the role of sex work, drug use, and disclosure, we employed these four variables: provided sex in exchange for money, drugs, goods or services (i.e., room, meals, gifts) in the past 6 months (“Yes” versus “No”), use of erectile dysfunction drugs in the past 6 months (“Yes” versus “No”), party drug use in the past 6 months [i.e., any use of methamphetamines (i.e., crystal and speed), hallucinogens (i.e., ecstasy, ketamine, mushrooms, lysergic acid diethylamide (LSD), and other hallucinogens), or gamma-hydroxybutyrate (GHB)] (“Yes” versus “No”), and frequency of HIV disclosure (“50% or more of the time”, “Less than 50% of the time”, and “Only when partners asked me”). We also assessed men’s preferences and desires for varied and novel sexual experiences (e.g., “I feel like exploring my sexuality”, “I like to have new and exciting sexual experiences and sensations”) using the 11-item Sexual Sensation Seeking Scale (study $\alpha = 0.73$), which is on a 4-point Likert (“Not like me at all” to “Very much like me”), with the total of all scale items summed to range from 11 to 44 (Kalichman & Rompa, 1995). Finally, given the documented links between discrimination, mental health, relationship quality, and sexual minority status (Frost & Meyer, 2009; Meyer, 2003), three continuous measures of mental well-being were also examined. These included the anxiety (study $\alpha = 0.84$) and depression (study $\alpha = 0.79$) sub-scales of the Hospital Anxiety and Depression Scale (HADS) (Snaith, 2003; Zigmond & Snaith, 1983), both consisting of 7-items (e.g., “Worrying thoughts go through my mind” (anxiety), “I feel cheerful” (depression)) with total possible scores ranging from 0 to 21; as well as a 6-item scale for overall emotional and social loneliness (study $\alpha = 0.77$), with responses to each item (e.g., “I experience a general sense of emptiness”, “I often feel rejected”) ranging from “Definitely no” to “Definitely yes”, which

were dichotomized to 0 and 1 such that total scores ranged from 0 (complete social embeddedness) to 6 (complete loneliness) (De Jong Gierveld & Van Tilburg, 2006).

Analysis

We conducted LCA incorporating the five indicators mentioned above, using the PROC LCA software package in SAS (available free of charge at: <https://methodology.psu.edu>) (Lanza, Collins, Lemmon, & Schafer, 2007; Lanza, Dziak, Huang, Xu, & Collins, 2015). Models with 2 to 7 latent classes were fit to the sample. For each solution, an expectation-maximization (EM) algorithm was applied until either the model converged to the maximum log-likelihood (ML) solution or the maximum number of iterations was reached (which we set to 1000) (Dempster, Laird, & Rubin, 1977). We performed 100 repetitions of model estimation for each solution, using 100 random sets of starting values, to ensure we found the global ML solution. Two sets of parameters are estimated in LCA: latent class membership probabilities (γ (gamma) parameters) and item-response probabilities conditional on latent class membership (ρ (rho) parameters); the latter parameters provide conceptual meaning to the latent classes. We carefully inspected these parameters for interpretability and used this information in combination with goodness of fit statistics [Akaike information criterion (AIC) (Akaike, 1987), Bayesian information criterion (BIC) (Schwarz, 1978), consistent AIC (CAIC) (Bozdogan, 1987) and adjusted BIC (aBIC) (Sclove, 1987)] to select the final number of latent classes, to which we then added labels to describe the individuals grouped within each class. Using the selected model, we conducted PROC LCA with grouping variables to examine measurement invariance and determine class prevalence by self-reported HIV status. We also examined reports of love and affection across the classes.

To describe the study sample, we reported baseline characteristics using frequencies (n) and percentages (%) for categorical variables or medians (MD) and first and third quartile values (Q1, Q3) for continuous variables, both for the overall sample and by latent class. Bivariable associations were tested using Pearson’s chi-square test statistic for the categorical variables and Wilcoxon rank-sum test for continuous. Finally, we used binomial and (upon review of these results) multinomial logistic regression to examine predictors of latent class membership, using the largest latent class as the referent group. Both unadjusted estimates (crude odds ratios (ORs) and 95% CIs (95% CIs)) and adjusted ORs (AORs) and 95% CIs of the association between covariates and latent classes are reported. In the multinomial model, the final model was selected using a backward stepwise elimination technique based on two criteria (AIC and Type III p-values), with the least significant variable dropped until the final model had the optimum (minimum) AIC (Lima et al., 2007). Note, we employed a multi-step approach (LCA model estimation followed by logistic regression) over the simultaneous approach

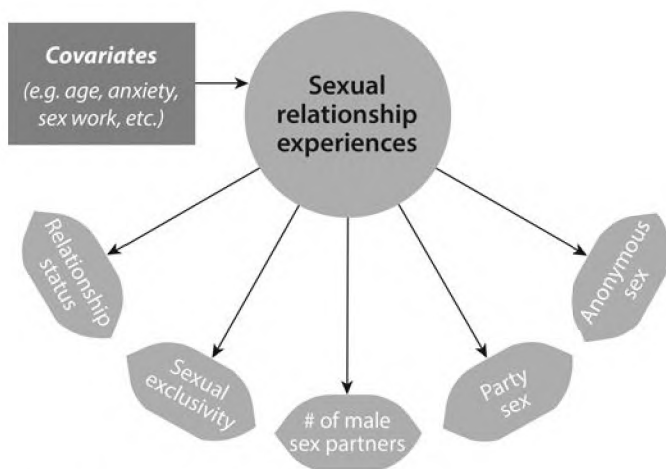


Figure 1. Latent class model of sexual relationship experiences among gay and bisexual men showing indicators of latent class membership and covariates

that combines LCA with regression into a joint model because of the number of covariates of interest, which can affect the latent class structure that forms when using a joint model (Vermunt, 2010). Doing so required assigning individuals to latent classes using posterior class membership probabilities, though we weighted people across the classes to maintain the “latent” nature of the construct (i.e., people were not assigned to one class but rather had a probability of being in each of the classes depending on their response pattern). All analyses were conducted using SAS® V9.4 for Windows (SAS, North Carolina, United States). Figure 1 depicts the conceptual relationships between the latent classes, the indicators of latent class membership, and the covariates.

RESULTS

Sample characteristics

Of the 774 participants in this study, 28.2% self-reported living with HIV and 71.8% identified as HIV-negative/unknown status (Table 1). Overall, 75.6% were White, 84.6% identified as gay, and median age was 34 years (Q1,Q3: 26,47). HIV-positive men were significantly older (median: 47; Q1,Q3: 39,51) than HIV-negative/unknown men (median: 29.5; Q1,Q3: 24,39) and more likely to be Indigenous (9.6% vs. 5.2%), with no significant differences by sexual identity. The majority of the sample had greater than high school education (76.9%) and were currently employed (63.4%), but reported incomes less than \$30,000 CAD (62.7%); men with HIV were significantly more likely than men without HIV to report low incomes (72.0% vs. 59.0%) and no employment (56.4% vs. 28.8%). The prevalence of recent sex work was 7.0% overall (10.1% HIV-positive vs. 5.8% HIV-negative/unknown), while recent party drug use was relatively common (42.0% overall; 53.2% HIV-

positive vs. 37.6% HIV-negative/unknown). About one-quarter of men reported using erectile dysfunction drugs in the past 6 months, with more prevalent use among HIV-positive men (45.9% vs. 15.7%). Men with HIV also had higher median scores on scales for depression, loneliness, sexual sensation seeking, but not anxiety. Finally, approximately half the cohort said they disclosed their HIV-status to sexual partners the majority of the time, and this was more common among HIV-positive men (64.2% vs. 47.0%).

Sexual relationship indicators and latent class analysis models

Table 2 shows the sexual relationship indicators used in LCA, overall and by HIV status. About half of the sample (54.5%) was single, with HIV-positive men more likely than HIV-negative/unknown status men to report being married (9.2% vs. 4.2%) and separated, divorced, or widowed (9.6% vs. 6.1%). Among those with a regular partner, about two-thirds (68.7%) were in open relationships, with higher rates among HIV-positive men (78.8% vs. 65.0%). Finally, just over half (56.7%) of men had 5 or more recent sex partners, while less than one-fifth participated in party sex (16.7%) and anonymous sex (17.4%); significant differences by HIV status were seen for all three of these sexual behaviours.

Table 3 shows the fit statistics for the LCA models with two to seven latent classes. The BIC and CAIC indicated the four-class model was optimal, while the aBIC pointed to the four- or five-class model and the AIC pointed to the five- or six-class model (1-unit [negligible] difference for each). Entropy (a measure of class separation) was high across all models, and model identification was considered adequate (i.e., greater than 10% (Lanza & Bray, 2010)) up until the six-class solution, as seen by the percentage of seeds associated with the ML solution for each model. After comparing the interpretability of the classes, we selected the five-class solution as it captured: 1) two conceptually distinct classes of single men who diverged on our three measures of sexual activity; 2) two analogous classes of partnered men in regular, open sexual relationships; and 3) an additional, fifth class of partnered men in regular, “monogamish” sexual relationships (i.e., we used “monogamish” in this study to describe men who reported being in monogamous or closed relationships but who also reported having more than one sex partner; slightly different than other research (Parsons et al., 2013)). In the four-class model, the two classes of open relationships were combined. Given their vastly different response patterns in relation to sexual activity, we felt it meaningful to examine these groups separately in analyses with covariates.

The sexual and relational patterns associated with the five-class model are displayed in Table 4. The most prevalent class comprised men we labelled as “single with less sex partners” (45% of sample). The second class included men who were “single with more sex partners” (17% of sample). The majority of men in both these latent classes reported their current relationship status as single (91% of men with less partners vs.

Table 2. Indicators of Latent Class among Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774), Overall and by HIV Serostatus

Variable	Overall		HIV-negative/unknown		HIV-positive		p-value
	N	(100.0) %	N	(71.8) %	N	(28.2) %	
Relationship Status							
Regular partner, Married	44	(5.7)	24	(4.3)	20	(9.2)	0.0104
Regular partner, Common Law	89	(11.5)	72	(13.0)	17	(7.8)	
Regular Partner, Living-apart Relationship	164	(21.2)	121	(21.8)	43	(19.7)	
No regular partner, Single	422	(54.5)	305	(54.9)	117	(53.7)	
No regular partner, Separated/Divorced/Widowed	55	(7.1)	34	(6.1)	21	(9.6)	
Sexual Agreement							
Monogamous	93	(12.0)	76	(13.7)	17	(7.8)	0.0681
Open	204	(26.4)	141	(25.4)	63	(28.9)	
No Regular Partner	477	(61.6)	339	(61.0)	138	(63.3)	
Number of male sex partners in past 6 months							
0–1	101	(13.1)	70	(12.6)	31	(14.2)	0.0803
2–4	234	(30.2)	181	(32.6)	53	(24.3)	
5+	439	(56.7)	305	(54.9)	134	(61.5)	
Party sex in the past 6 months							
No	645	(83.3)	478	(86.0)	167	(76.6)	0.0017
Yes	129	(16.7)	78	(14.0)	51	(23.4)	
Anonymous sex in the past 6 months							
No	639	(82.6)	477	(85.8)	162	(74.3)	0.0002
Yes	135	(17.4)	79	(14.2)	56	(25.7)	

Table 3. Fit Statistics for Latent Class Analysis Models of Sexual Relationship Experience with Two through Seven Classes, among Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774)

Number of classes	G ²	AIC	BIC	CAIC	aBIC	Entropy	Solution stability (%)
2	458	502	604	626	534	1.00	98
3	300	368	526	560	418	0.91	35
4	163	255	469	515	323	0.83	76
5	122	238	508	566	324	0.84	18
6	97	237	563	633	340	0.88	1
7	86	250	631	713	371	0.87	1

Note. AIC, Akaike Information Criteria; BIC, Bayesian Information Criteria; CAIC, Consistent Akaike Information Criteria; aBIC, Adjusted Bayesian Information Criteria; Solution % is the percentage of times the solution was selected out of a 1000 random sets of starting values. The bold solution indicates the selected model.

82% of men *more partners*), with the former class reporting a lower prevalence of separation, divorce, or widowhood (9% vs. 18%). These two classes differentiated in the number of male sex partners in the past 6 months (52% vs. 92% of each class had ≥ 5 partners, respectively) and participation in party sex (3% vs. 57%) and anonymous sex (2% vs. 58%). The three remaining classes were comprised of men who reported having ‘regular’ partners. The first was a class of “*monogamish*” men (15% of sample), most (78%) of whom said they were in monogamous relationships yet 50% reported >1 recent male sex partner. Party (2%) and anonymous (1%) sex were both infrequent among *monogamish* men. The other two relation-

ship classes involved open relationships distinguished by their level of sexual activity with others. We called these classes “*open with less sex partners*” (15% of sample; of whom, 100% were open, 43% had > 5 partners, 10% had party sex, and 4% had anonymous sex) and “*open with more sex partners*” (9% of sample; of whom, 96% were open, 92% had ≥ 5 partners, 47% had party sex, 69% had anonymous sex). The majority of men in both *open* classes were married/common-law (51% and 60%) versus men in the *monogamish* class (30%), most of whom (70%) lived apart. Figure 2 shows a simplified version of the structure of these latent classes and their association with outcomes.

Table 4. Latent Class Membership- and Item-Response Probabilities for the Five-Class Model of Sexual Relationship Experience, among Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774)

	Single, <i>less</i> sex partners	Single, <i>more</i> sex partners	Three types of relationships		
			Monogamish	Open, <i>less</i> sex partners	Open, <i>more</i> sex partners
Class membership probabilities					
Overall	0.45	0.17	0.15	0.15	0.09
As a function of HIV status					
HIV negative/unknown (n = 556)	0.48	0.13	0.17	0.14	0.08
HIV positive (n = 218)	0.36	0.27	0.11	0.15	0.10
p-value	0.0031	<.0001	0.0459	0.7231	0.2946
Item Response Probabilities					
Relationship status					
Regular partner, Married	0.00	0.00	0.07	0.18	0.24
Regular partner, Common Law	0.00	0.00	0.23	0.33	0.37
Regular Partner, Living Apart	0.00	0.00	0.70	0.49	0.40
No regular partner: Single	0.91	0.82	0.00	0.00	0.00
No regular partner: Separated/Divorced/Widowed	0.09	0.18	0.00	0.00	0.00
Sexual Agreement / Sexual exclusivity					
Monogamous	0.00	0.00	0.78	0.00	0.04
Open (includes all "Other")	0.00	0.00	0.22	1.00	0.96
No Regular Partner	1.00	1.00	0.00	0.00	0.00
Number of male sex partners in the past 6 months					
0 to 1	0.12	0.00	0.50	0.00	0.00
2 to 4	0.35	0.08	0.27	0.57	0.08
5+	0.52	0.92	0.23	0.43	0.92
Party sex in the past 6 months					
Yes	0.03	0.57	0.02	0.10	0.47
No	0.97	0.43	0.98	0.90	0.53
Anonymous sex in the past 6 months					
Yes	0.02	0.58	0.01	0.04	0.69
No	0.98	0.42	0.99	0.96	0.31

Note. Class membership probabilities estimate the prevalence of the latent classes within the entire sample. Item-response probabilities are class conditional, estimating the percentage of individuals who reported the responses indicated given membership in a particular latent class. Probabilities >0.5 are in bold to facilitate interpretation.

Measurement invariance and latent class prevalence by HIV-status

Once this baseline model was established, we incorporated HIV-status as a grouping variable to compare the restricted model, where the item-responses probabilities are constrained to be equal across groups (described above), with the unrestricted model, where these parameters are freely estimated for each group. As the restricted model is simpler, the degrees of freedom (df) were higher ($df = 301$) than the free model ($df = 251$). Free models tend to fit the data better though, as seen in the G^2 statistic (122 for the restricted model and 89 for the free model). This resulted in a likelihood ratio difference test statistic of 33 ($df = 50$). When compared to a chi-square distribution, this difference was not statistically significant (p -value = 0.97), providing evidence that measurement invariance held across HIV-status. Thus, the restricted model was used in remaining analyses. Since the meaning of the latent classes was not different for HIV-positive and HIV-negative men, we were able to assess differences in class membership probabilities

by HIV-status. As shown in Table 4, compared with HIV-positive men, more HIV-negative men were in the *single/less partners* (48% vs. 36%; $p < 0.01$) and *monogamish* (17% vs. 11%; $p < 0.05$) latent classes, and less were in the *single/more partners* class (13% vs. 27%; $p < 0.0001$). HIV-positive and HIV-negative men were equally likely to belong to the two *open* classes.

Bivariable analyses

Table 5 presents bivariable analyses of love and affection and the social and health covariates by the latent classes. Experiencing love and affection "most of the time" was common across all latent classes, though more prevalent among partnered (84.8–91.2%) versus single men (48.4–50.6%; $p < 0.0001$). Men in *monogamish* (91.2%) and relationships characterized by *open/more partners* (88.9%) reported slightly higher frequency of love and affection than men in the *open/less partners* latent class (84.8%). Patterns of relationship experience varied considerably by age. The two more sexually active classes

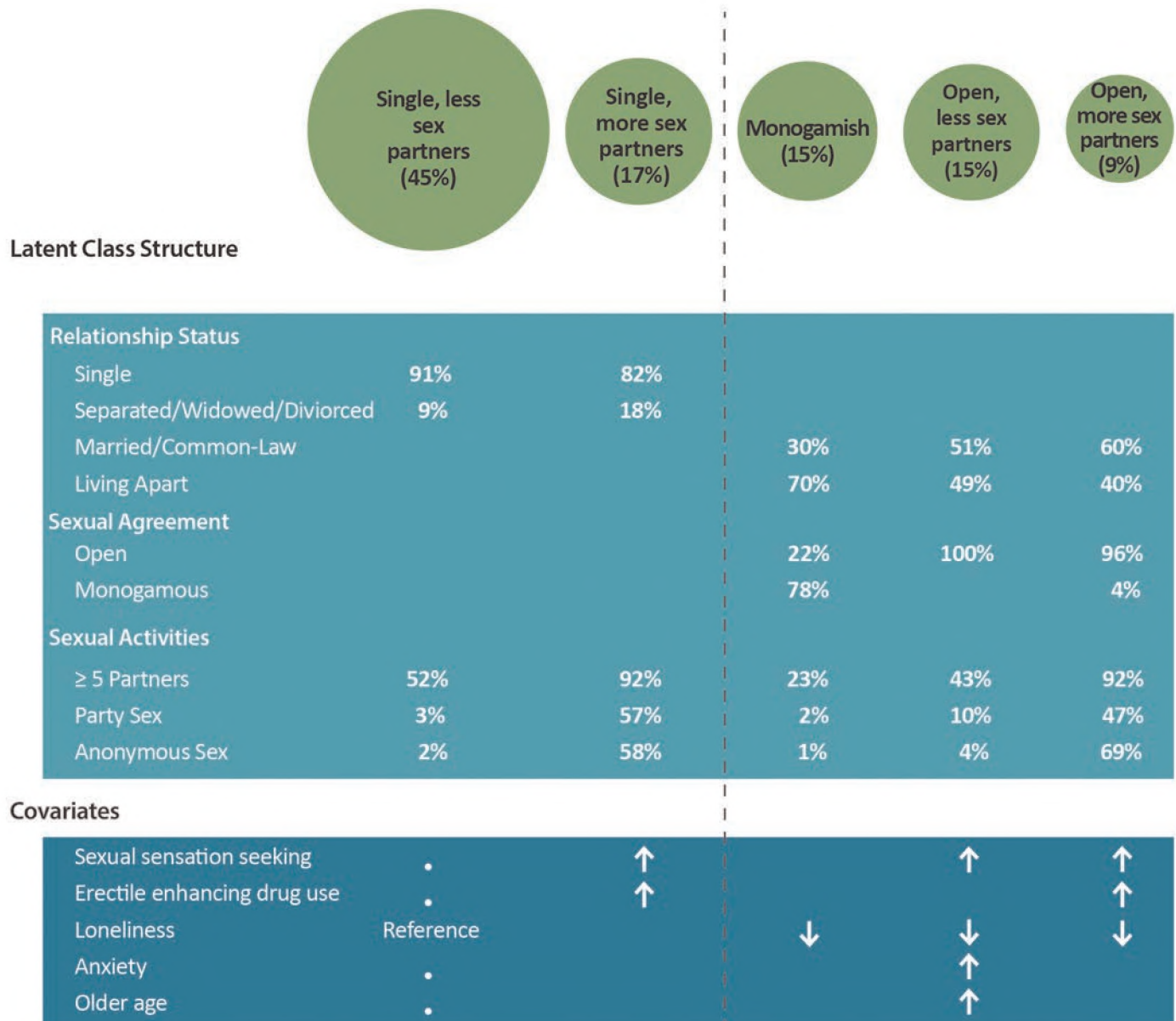


Figure 2. Five distinct patterns of sexual relationship experiences resulting from latent class analysis among gay and bisexual men enrolled in the Momentum Health Study (N = 774). These included two latent classes of single men (left of the dotted line) who diverged on three measures of sexual activities (with the largest class, comprised of 45% of the sample, reporting less sex partners, party sex, and anonymous sex) and three latent classes of partnered men (right of the dotted line) who likewise diverged on sexual activities as well as sexual agreements (open versus monogamous). Classes were associated with several markers of health and wellbeing, with arrows pointing up indicating increased odds and arrows pointing down indicating decreased odds of membership in the latent class shown, relative to the largest class, for a unit increase in the covariate.

were both comprised of a greater proportion of men over 45 years (*single/more partners*: 35.8% vs. *open/more partners*: 37.6%) compared with the other three classes (*single/less partners*: 27.5% vs. *monogamish*: 23.2% vs. *open/less partners*: 30.6%) ($p < 0.05$). No significant differences were noted by other socio-demographic and socio-economic indicators including race/ethnicity, sexual identity, education, income, and current employment status. Further, men in all relationship types disclosed their HIV status with similar frequency. The

classes did differ, however, with respect to sex work, erectile dysfunction drugs use, and party drug use, with the two more sexually active classes containing higher proportions of men reporting these experiences and with these being slightly more common among those who were single. Specifically, among men in the *single/more partners* class, 13.4% reported sex work, 45.6% erectile dysfunction drug use, and 57.2% party drug use (vs. 9.2%, 43.2%, and 52.7% for *open/more partners*). Those in the *open/more partners* class, however,

Table 5. Bivariable Associations with Sexual Relationships among Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774)

	Three types of relationships										p-value
	Single, <i>less</i> sex partners n = 346 (45%)		Single, <i>more</i> sex partners n = 131 (17%)		Monogamish n = 116 (15%)		Open, <i>less</i> sex partners n = 113 (15%)		Open, <i>more</i> sex partners n = 68 (9%)		
Continuous variables	MD	(Q1, Q3)	MD	(Q1, Q3)	MD	(Q1, Q3)	MD	(Q1, Q3)	MD	(Q1, Q3)	
Age	31	(25, 46)	39	28, 48	32	26, 42	35	27, 47	38	29, 49	0.0137
HAD Anxiety ($\alpha = 0.8350$)	8	(5, 10)	9	6, 12	7	4, 10	8	6, 11	8	6, 10	0.0088
HAD Depression ($\alpha = 0.7867$)	3	(2, 6)	5	2, 7	2	1, 5	3	2, 6	3	2, 6	0.0134
Loneliness Score ($\alpha = 0.7660$)	3	(1, 5)	3	1, 5	1	0, 3	2	1, 4	2	1, 4	<0.0001
Sexual Sensation Seeking Scale ($\alpha = 0.7295$)	30	(27, 33)	32	30, 36	29	27, 32	31	28, 34	34	31, 37	<0.0001
Categorical variables	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	
Shown love and affection											
Most of the time	172	(50.6)	62	(48.4)	106	(91.2)	96	(84.8)	60	(88.9)	<0.0001
Some, a little, or none of the time	168	(49.4)	66	(51.6)	10	(8.8)	17	(15.2)	8	(11.1)	
Covariates											
Socio-demographic factors											
Age Group											
<30	149	(43.0)	38	(29.0)	47	(40.3)	36	(31.8)	19	(28.5)	0.0418
30–44	102	(29.5)	46	(35.1)	42	(36.5)	42	(37.7)	23	(33.9)	
45+	95	(27.5)	47	(35.8)	27	(23.2)	34	(30.6)	26	(37.6)	
Ethnicity											
White	258	(74.5)	100	(76.4)	88	(75.5)	90	(80.1)	49	(72.0)	0.8638
Asian	38	(10.9)	8	(6.4)	10	(8.6)	8	(7.2)	10	(14.7)	
Indigenous	22	(6.4)	10	(7.5)	8	(6.6)	7	(6.6)	<5	(4.2)	
Latino/Other	28	(8.2)	13	(9.6)	11	(9.3)	7	(6.2)	6	(9.1)	
Sexual identity											
Gay	289	(83.6)	113	(86.2)	99	(85.3)	90	(80.2)	63	(93.1)	0.1978
Bisexual/Other	57	(16.4)	18	(13.8)	17	(14.7)	22	(19.8)	<5	(6.9)	
Socio-economic factors											
Education											
No greater than high school	74	(21.4)	31	(23.6)	36	(30.6)	25	(22.0)	14	(20.1)	0.3198
Greater than high school	272	(78.6)	100	(76.4)	81	(69.4)	88	(78.0)	54	(79.9)	
Annual Income											
Less than \$30,000	233	(67.2)	80	(61.4)	73	(62.8)	63	(55.5)	36	(53.5)	0.1101
\$30,000–\$59,999	82	(23.7)	38	(29.0)	30	(26.1)	31	(27.9)	18	(26.8)	
\$60,000 and over	31	(9.1)	13	(9.7)	13	(11.1)	19	(16.6)	13	(19.7)	
Currently Employed											
No	120	(34.7)	61	(46.6)	40	(34.3)	41	(36.0)	22	(31.7)	0.1289
Yes	226	(65.3)	70	(53.4)	76	(65.7)	72	(64.0)	46	(68.3)	
Sex work, drug use, and disclosure factors											
Sex work in the past 6 months											
No	325	(93.8)	113	(86.6)	116	(99.4)	105	(92.8)	62	(90.8)	0.0025
Yes	21	(6.2)	18	(13.4)	<5	(0.6)	8	(7.2)	6	(9.2)	
Erectile dysfunction drug use in the past 6 months											
No	292	(84.3)	71	(54.4)	103	(88.2)	83	(73.4)	39	(56.8)	<0.0001
Yes	54	(15.7)	60	(45.6)	14	(11.8)	30	(26.6)	29	(43.2)	
Party drug use in the past 6 months*											
No	216	(62.4)	56	(42.8)	82	(70.6)	63	(55.7)	32	(47.3)	<0.0001
Yes	130	(37.6)	75	(57.2)	34	(29.5)	50	(44.3)	36	(52.7)	
Frequency of disclosure of HIV-Status											
50% or more of the time	174	(50.3)	72	(55.0)	59	(51.1)	63	(55.8)	33	(48.9)	0.8982
Less than 50% of the time	41	(11.9)	19	(14.5)	13	(11.5)	13	(11.2)	9	(13.3)	
Only when Asked	131	(37.9)	40	(30.5)	43	(37.4)	37	(33.0)	26	(37.8)	

Note. Frequencies are weighted according to LCA posterior probabilities. Note: Party drug use includes any use of methamphetamines (i.e., crystal and speed), hallucinogens (i.e., ecstasy, ketamine, mushrooms, lysergic acid diethylamide (LSD), and other hallucinogens), or gamma-hydroxybutyrate (GHB).

Table 6. Unadjusted and Adjusted Odds Ratios (OR and AOR) and 95% CIs (95% CI) from Multinomial Logistic Regression Analysis Assessing Predictors of Class Membership, in Reference to ‘Single Less Sexually Active’, among Gay and Bisexual Men Enrolled in the Momentum Health Study (N = 774)

	Single, more sex partners		Three types of relationships					
			Monogamish		Open, less sex partners		Open, more sex partners	
	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)	OR (95% CI)	AOR (95% CI)
Continuous variables								
HAD Anxiety ($\alpha = 0.8350$)	1.07 (1.02–1.12)	1.05 (0.99–1.12)	0.95 (0.90–1.01)	1.01 (0.95–1.08)	1.03 (0.98–1.09)	1.08 (1.01–1.15)	1.02 (0.96–1.09)	1.05 (0.97–1.13)
HAD Depression ($\alpha = 0.7867$)	1.06 (1.00–1.12)	Not selected	0.92 (0.85–0.99)	Not selected	1.00 (0.94–1.06)	Not selected	0.99 (0.91–1.07)	Not selected
Loneliness Score ($\alpha = 0.7660$)	1.11 (1.00–1.22)	0.99 (0.87–1.12)	0.79 (0.71–0.89)	0.80 (0.70–0.91)	0.88 (0.78–0.98)	0.80 (0.70–0.91)	0.91 (0.79–1.04)	0.83 (0.71–0.97)
Sexual Sensation Seeking ($\alpha = 0.7295$)	1.15 (1.09–1.21)	1.11 (1.05–1.17)	0.95 (0.90–1.00)	0.96 (0.91–1.01)	1.07 (1.01–1.12)	1.06 (1.00–1.12)	1.19 (1.12–1.27)	1.17 (1.10–1.25)
Categorical variables								
Age Group (Reference: < 30)								
30–44	1.77 (1.07–2.91)	1.47 (0.87–2.49)	1.32 (0.81–2.15)	1.41 (0.86–2.33)	1.73 (1.04–2.89)	1.73 (1.02–2.92)	1.74 (0.9–3.34)	1.55 (0.78–3.06)
45+	1.93 (1.17–3.18)	1.40 (0.80–2.45)	0.90 (0.53–1.55)	0.96 (0.54–1.70)	1.51 (0.88–2.57)	1.52 (0.85–2.70)	2.06 (1.08–3.93)	1.58 (0.78–3.23)
Sex work in the past 6 months (Reference: No)								
Yes	2.34 (1.20–4.56)	2.00 (0.96–4.14)	0.09 (0.01–1.00)	0.10 (0.01–1.11)	1.17 (0.51–2.70)	1.20 (0.51–2.86)	1.53 (0.60–3.88)	1.47 (0.54–3.96)
Erectile dysfunction drug use in the past 6 months (Reference: No)								
Yes	4.51 (2.87–7.07)	3.41 (2.09–5.57)	0.72 (0.38–1.35)	0.75 (0.38–1.48)	1.94 (1.17–3.23)	1.58 (0.91–2.73)	4.08 (2.33–7.15)	2.78 (1.51–5.12)
Party drug use in the past 6 months (Reference: No)								
Yes	2.22 (1.47–3.34)	Not selected	0.69 (0.44–1.09)	Not selected	1.32 (0.86–2.03)	Not selected	1.85 (1.10–3.12)	Not selected

Note. 95% CIs excluded the null value of ‘1’ are bolded for emphasis. Party drug use includes any use of methamphetamines (i.e., crystal and speed), hallucinogens (i.e., ecstasy, ketamine, mushrooms, lysergic acid diethylamide (LSD), and other hallucinogens), or gamma-hydroxybutyrate (GHB).

had a higher median score on the Sexual Sensation Seeking Scale (median: 34; Q1,Q3: 31,37) compared with their *single/more partners* counterparts (median: 32; Q1,Q3: 30,36) ($p < 0.0001$). All three classes defined by regular partners (i.e., *monogamish*, *open/less partners*, *open/more partners*) also had lower median loneliness scores versus the single classes. In terms of anxiety and depression, median scores for the *monogamish* class were also lower than those for both single classes, while the scores for open classes were only lower compared with the *single/more partners* class (not the *single/less partners* class).

Binomial and multinomial logistic regression analyses

Table 6 presents the unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) between the latent classes and covariates, with the largest latent class (*single/less*

partners) used as the reference. In unadjusted analyses, relative to men in the *single/less partners* class, men with higher sexual sensation seeking scores had higher odds of membership in every class except *monogamish*. The effect estimates were slightly reduced upon adjusting for other covariates, but the 95% CIs still excluded the null value of ‘1’. Further, the adjusted odds were highest among men in the *open/more partners* class (AOR: 1.17 per 1-unit increase in score; 95% CI: 1.10–1.25), followed by *single/more partners* (AOR: 1.11 per 1-unit increase in score; 95% CI: 1.05–1.17), and *open/less partners* (AOR: 1.06 per 1-unit increase in score; 95% CI: 1.00–1.12). The only latent class found to be associated with sex work was the *single/more partners* class; specifically, men involved in sex work had 2.34 times higher unadjusted odds (95% CI: 1.20–4.56) of being in this latent class relative to men in the *single/less partners* class. In adjusted analyses, the AOR was 2.00 and the 95% CI ranged from no effect to more

than 4-fold greater odds (0.96–4.14). Erectile dysfunction drug use was similarly associated with the *single/more partners* class (AOR: 3.41; 95% CI: 2.09–5.57), along with the *open/more partners* class (AOR: 2.78; 95% CI: 1.51–5.12). In contrast, loneliness was independently associated with reduced odds of membership for men in all three partnered classes relative to men in the *single/less partners* class; effect estimates strengthened slightly upon adjustment (*monogamish*: AOR: 0.80; 95% CI: 0.70–0.91; *open/less partners*: AOR: 0.80; 95% CI: 0.70–0.91; *open/more partners*: AOR: 0.83; 95% CI: 0.71–0.97). Additionally, those with higher anxiety scores (AOR: 1.08 (95% CI: 1.01–1.15)) and aged 30–44 years versus <30 (AOR: 1.73 (95% CI: 1.02–2.92)) were more likely to be in the *open/less partners* class. While anxiety and older age also showed unadjusted associations with the classes defined by more partners, the best estimates were reduced and the 95% CIs included ‘1’ after adjustment. Finally, despite bivariable associations being observed between the *single/more partners* latent class and depression and party drug use, as well the *open/more partners* latent class and party drug use, both covariates were not selected for in the final multivariable model.

DISCUSSION

Gay and bisexual relationships are diverse and, in this study we sought to quantify this complexity by delineating latent classes of romantic and sexual experiences among Vancouver HIV-positive and HIV-negative gay and bisexual men and examining how these classes varied in receipt of love and affection and were associated with health and social factors. LCA resulted in 5 latent classes, the structure and nature of which did not vary by HIV-status despite differences in class membership prevalence by HIV-status. The classes were, however, differentiated by several different markers of relevance to sexuality and relationships among urban gay and bisexual men including relationship status and commitment level, negotiated relationship arrangements, and sexual activity and sexual variety. Gay and bisexual men frequently reported love and affection, most commonly among men with regular partners, though no significant differences emerged by monogamous versus open agreements. We also found that latent classes were independently associated with loneliness and anxiety, sexual sensation seeking, sex work, and erectile dysfunction drug use covariates. These findings, contextualized further below, suggest great diversity in gay and bisexual men’s sexual and romantic experiences and intersection with important sexual, social, and mental health factors in men’s everyday lives, information that is essential to informing more nuanced sex-positive and socially-inclusive research, education, and support.

We found that just under one-half (45%) of men in this study self-identified as single with little participation in party and anonymous sex, yet these participants were sexually active, with 35% reporting 2 to 4 male sex partners in the past 6 months and 52% reporting 5 or more such partners (*single/less partners*). A further 17 percent were also single,

but differed on participation in party sex and anonymous sex (42–43%) as well as having more partners (92% had ≥ 5) (*single/more partners*). These quantitative findings support recent qualitative accounts of the sexual and relational diversity in gay and bisexual communities (Amaro, 2016; Race, 2015). Clearly, and perhaps unsurprisingly, different men have different behaviours in regard to sex and sexual pleasure. While some men have sex with one or multiple consecutive partners, others are involved in anonymous encounters and sex partying, sometimes accompanied by substance use (Hurley & Prestage, 2009). Studies sometimes portray this as ‘abnormal’ and requiring intervention. (Coveney & Bunton, 2003; Flowers & Langdridge, 2007; Worth & Rawstorne, 2005). For example, Klein (2012) recently called for more research on the topic of anonymous sex, asking, “what exactly it is that they like about this practice and what rewards they perceive themselves to derive from engaging in it when other, less impersonal ways of having sex are also available.” (p. 479). Implicit in such research narratives is the privileging of heteronormative sex over other kinds of sex. While harm reduction for practices that may carry more risk for HIV is important (Card, Lachowsky, Cui, Carter, et al., 2016; Vallabhaneni et al., 2012), research shows these sexual and drug contexts also remain crucial sites of social relations, communal belonging, sexual pleasure and experimentation, and forging of emotional ties among gay and bisexual men (Amaro, 2016).

While epidemiological research tends to focus on “regular partners” as a single group (Mustanski et al., 2011; Newcomb et al., 2014), this analysis revealed three distinct latent classes of regular partnerships with variation in the kinds of sexual agreements and sexual activities men engaged in. Fifteen percent of men in this study were *monogamish* (i.e., half of these men were actually monogamous, while the other half were in monogamous relationships with closed agreements yet reported multiple partners). While very few of these men reported participating in sex parties or anonymous sex, about one-half had more than one partner. Cheating and infidelity in committed romantic relationships, whether gay or heterosexual, is common (Blow & Hartnett, 2005), particularly among those not living together, which comprised a large proportion of men in the *monogamish* latent class (70%). Thus, this may represent a break in sexual agreements, which past studies estimate happens among approximately one-quarter of gay male couples (Gomez et al., 2012; Hoff et al., 2009; Mitchell, Harvey, Champeau, Moskowitz, et al., 2012; Mitchell, Harvey, Champeau, & Seal, 2012). Alternatively, it may be that individual men or couples define monogamy differently. In heteronormative relationships, any kind of sex or intimacy outside a committed relationship is usually considered cheating. On the contrary, qualitative research among gay male couples suggests some men in closed or monogamous relationships may accept some degree of outside sex (Hoff & Beougher, 2010). For example, those involved in sex work may view their work-related sexual encounters as work, not a disruption in agreement or even sex outside the relationship (Hoff & Beougher, 2010). Others may be open sexually once

in a while (e.g., allowing threesomes occasionally) yet still label their relationship as closed if it is monogamous in other respects (e.g., emotional and romantic commitment) (Hoff & Beougher, 2010). We were unable to examine the exact nature of relationship arrangements and dynamics within this quantitative data set, though research shows considerable heterogeneity (Hoff & Beougher, 2010; van Eeden-Moorefield, Malloy, & Benson, 2016), with higher levels of positive dynamics being protective against broken agreements (Gomez et al., 2012). We also we did not ask men when their main relationship began, and it is possible that some sexual encounters in the past 6 months preceded the establishment of an exclusive, romantic relationship (i.e., some partners may have been sequential rather than concurrent). Continued research in this area is warranted including the varied meanings of monogamy, whether couples are congruous in their definitions, and whether and how these perceptions change over time.

For other regular relationships identified in this analysis, about one-quarter of the sample was navigating consensual non-monogamy or open relationships. These men were split into two latent classes (*open/less partners vs. open/more partners*), with the latter defined by more sex partners and greater sexual variety including participation in party and anonymous sex. Collectively, these three relationship latent classes (i.e., *monogamish, open/less partners, open/more partners*) may represent, in some ways, varied stages of relationships. As Hoff and Beougher (2010) explained in their research on sexual agreements among 39 gay male couples in San Francisco, “several participants described how their prior experiences in monogamous relationships led them, for one reason or another, to open (or desire to open) their current relationship and allow sex with outside partners” (p. 777). Thus, it may be that these two latent classes had similar agreements about sex outside their relationship but differing levels of enactments (i.e., one class was more likely to act on the open arrangement while the other was not). Alternatively, it may reflect originally differing agreements.

Prior qualitative research suggests gay and bisexual men in open relationships have a continuum of sexual arrangements, with some having no conditions whatsoever and others agreeing to several rules and stipulations regarding outside sexual encounters such as with whom (e.g., strangers, friends, exes), types of sexual activities (e.g., kissing, touching, intercourse with or without condoms, etc.), boundaries around physical versus emotional intimacy, the frequency of such encounters, the disclosure or non-disclosure of such encounters to one’s main partner, and whether activities are enjoyed together or separately (Hoff & Beougher, 2010; van Eeden-Moorefield et al., 2016). We were unable to investigate the variety of acceptable sexual behaviours with outside partners with the data available. We also did not have dyadic data, and, thus, it is difficult to tell how dyadic interaction might influence how these arrangements emerged and were operationalized in daily life (i.e., relationship dynamics may have given rise to one partner wanting an open relationship more than another partner). Overall, the prevalence of non-monogamy among

gay and bisexual men in existing relationships in the Momentum cohort (67%) is comparable with other studies (e.g., 56% among a community-based sample of partnered gay and bisexual men in New York) (Groves et al., 2014).

In our sample, love and affection was common regardless of sexual behaviours, though it was more frequently reported among men in regular, romantic partnerships versus those who were single. It is important to re-emphasize that such experiences were not limited to sexual partners in our survey, though this data are consistent with past research showing main partnerships are an important source of intimacy for gay men, though clearly such experiences are common to more casual liaisons as well (Amaro, 2016; Calabrese et al., 2015; Race, 2015). We did not measure forms of affection (physical or emotional), something that merits future inquiry, though recent research with gay and bisexual men shows kissing (62%) and cuddling (76%) to be common (Calabrese et al., 2015), especially with main partners (90% and 91%, respectively) versus casual (75% and 63%) and new (70% and 47%) partners. In our study, among those with regular partnerships, relatively similar levels of love and affection were seen across *monogamish* and *open* latent classes, echoing findings by Parsons, Starks, et al. (2012) that showed monogamous and non-monogamous agreements to be comparable in relationship quality, debunking traditional stereotypes about the latter group as lacking care and affection. Relationship quality, however, is defined by far more than just love and affection and it is important to consider that relationships (casual or otherwise) can be high quality without love and affection if it satisfies other needs and expectations (e.g., good sex, friendship, etc.). Continued research on relationship quality and other sex-positive components of sexual wellbeing among gay and bisexual men is necessary.

We also found that latent classes were associated with several other sexual, social, and mental health covariates. Sexual sensation seeking – defined by a desire or affinity for greater levels of novelty, excitement, stimulation, and arousal during sexual experiences – was found to be associated with membership in every class, except *monogamish* (whose odds were actually reduced but non-significantly), relative to the *single/less active* men. This echoes past research showing sensation seeking to be related to several sexual and relational indicators such as condomless sex (Semple et al., 2004) and anal sex roles (Rich et al., 2016). Sex work and erectile dysfunction drug use likewise predicted membership in all classes except *monogamish*, though only the latter variable was significant in the final multiple adjusted model and only for men in the *single/more partners* and *open/more partners* latent classes. While party drug use was not selected for, clear patterns of difference were seen in the bivariable analysis with *monogamish* men reporting the lowest levels of use, which is consistent with prior research (Parsons et al., 2013), and the two *more partners* classes reporting the most. ‘Party and play’ has become popular among some gay and bisexual men, with drug use practices constituting an important part of sexual encounters (Amaro, 2016; Race, 2015). Crystal meth, for

instance, is known to enhance sexual sensation and keep men awake, while GHB is a depressant that is used intermittently such that interactions involve so-called “temporal phases” where men engage in “sex, chilling, chatting, smoking, taking G, sex” (Race, 2015, p. 268), while erectile dysfunction drugs are often consumed too to offset drugs’ effects on sustaining an erection (Holt, 2009).

Mental health also appears to be instrumental in the construction of gay men’s sexuality and sexual relations, and vice versa. The finding linking higher loneliness to reduced odds of membership in all three classes of partnered men observed in our study, irrespective of levels of openness/monogamy and sexual activity, relative to those who were single with less sex partners, demonstrates psychological benefits that intimate relationships can impart. However, men who were single with more sex partners were, however, no more or less likely to report feelings of loneliness than men in the *single/less partners* class, suggesting that more sex does not guarantee reduced isolation and loneliness, rather relationships may be more helpful in that regard. This is evident in prior research among gay men (Hoff & Beougher, 2010; Mitchell, Harvey, Champeau, Moskowitz, et al., 2012; Parsons et al., 2013). In terms of other aspects of mental health and wellbeing, higher odds of anxiety were associated with being in *open/less active* relationships compared with being single with similar low levels of sexual activity. It could be that these men are anxious about their open relationship arrangements, so not having outside sex. Or, they are not having outside sex (i.e., not acting on their agreement), which is contributing to increased anxiety. An additional alternative is that they are anxious about their partner who may be having sex with outside partners while they are not. Further, if agreements don’t discuss safety, then anxiety around HIV risk may also play a role in mental health outcomes. Research does show that some men feel anxious about seeking sex outside their main partnership, even if they agreed to it (Hoff & Beougher, 2010). How men behave with regards to agreements is as important as their understanding of them (Hoff & Beougher, 2010). Given the connections revealed here and the links between mental health and sexual minority status shown elsewhere (Frost & Meyer, 2009; Meyer, 2003), continued research in this area is vital.

LIMITATIONS

While this study adds to the literature by advancing understanding of the multidimensional nature of sexual behaviours and romantic relationships among gay and bisexual men there are several limitations to mention. First, we were restricted to the data available in the Momentum Health Study, which, like most HIV cohorts, focuses on sex and substance use from a mostly risk perspective. This limited our ability to understand the expansive diversity of sexuality and relationships in a more holistic and sex-positive way. In particular, we were unable to

measure the quality of relationships and sexual encounters. While we did measure love and affection (an under-researched component of gay and bisexual men’s sexuality), this variable was neither specific to their sexual encounters nor is it the only factor relevant to relationships. Intimacy, passion, trust, commitment, relationship satisfaction, and power equity, among other factors, also underlie relationship dynamics and can influence sexual behaviours (Gomez et al., 2012). Among the latent classes of partnered men, differences on these dimensions may explain why some adhered to or acted on agreements about sexual monogamy or openness, and others did not. In addition, because of the cross-sectional nature of the study, we are unable to determine the direction of associations (i.e., anxiety and latent class). Latent transition analysis, a longitudinal extension of LCA, could fill this gap in knowledge and reveal how various factors (e.g., drug practices, mental health) may contribute to (in)stability in transitions in latent class membership over time. Finally, as most participants were White, the extent to which findings are applicable to men of diverse cultural backgrounds is limited.

CONCLUSIONS AND IMPLICATIONS

In this study, LCA was a useful person-centred approach that demonstrated the heterogeneity in men’s sexual and romantic relations, revealing five multidimensional classes that were associated with important measures of health and wellbeing. Our findings have implications for sex researchers, educators, and therapists toward better understanding and responding to the diversity of same-sex relations among men. With regards to research, investigators should be aware of the diversity of men’s sexual experiences and relationships and how they overlap, and also consider inquiries from a positive, affirming perspective that does not pathologize experiences differing from heteronormativity. Also, the importance of longitudinal research, both quantitative and qualitative, cannot be overstated. Little is known about how men transition between casual, monogamous, and varied kinds of open sexual relationships, and between break-ups and newly dating again, nor the forces underlying these transitions. For sex educators and therapists, an affirmative approach that recognizes the value and legitimacy of gay sexual practices and activities, especially among HIV-positive men, is key (Rutter, 2012). Providing information and support for decision-making around the construction of relationship agreements that work for men (individually and for their partners) is also critical, especially men who may feel anxious, pressured, or have less power. Supporting gay and bisexual men in creating satisfying relationships and pleasurable sexual experiences while simultaneously communicating about reducing HIV risk within the varied and often fluid contexts of men’s relationships is an important goal and worthy of continued research, advocacy, and support.

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