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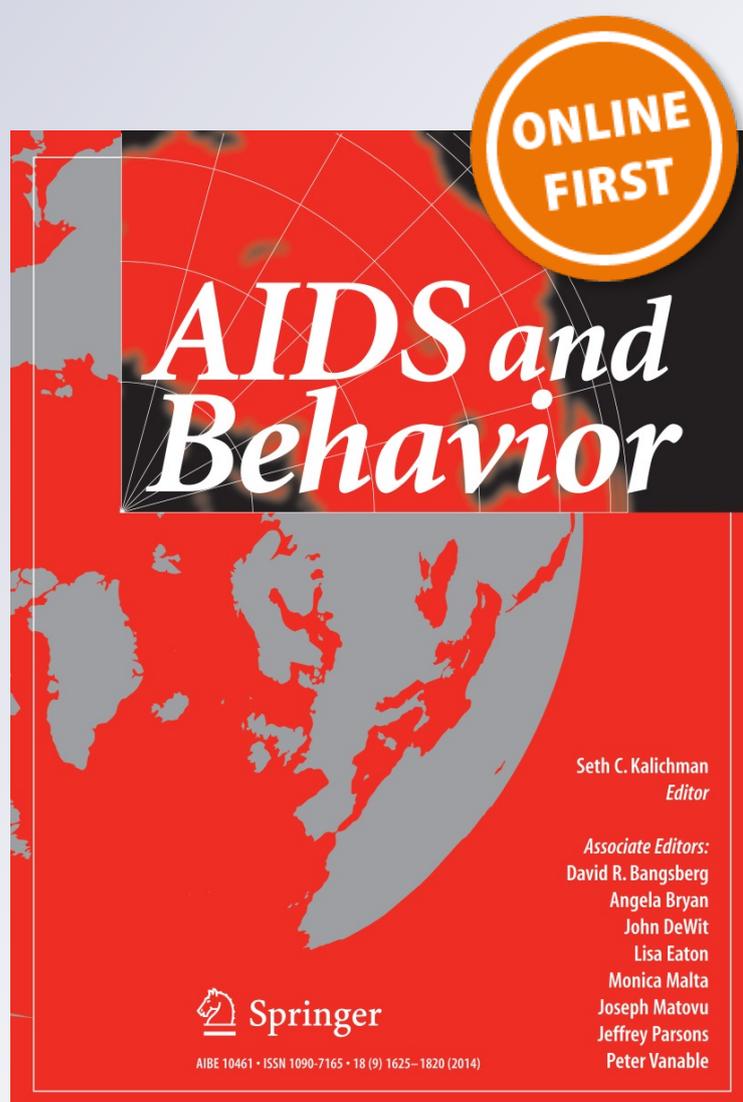
**Perry N. Halkitis, Farzana Kapadia,
Kristen L. Bub, Staci Barton, Alvaro
D. Moreira & Christopher B. Stults**

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A Longitudinal Investigation of Syndemic Conditions Among Young Gay, Bisexual, and Other MSM: The P18 Cohort Study

Perry N. Halkitis · Farzana Kapadia ·
Kristen L. Bub · Staci Barton · Alvaro D. Moreira ·
Christopher B. Stults

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Abstract The persistence of disparities in STI/HIV risk among a new generation of emerging adult gay, bisexual, and other men who have sex with men (YMSM) warrant holistic frameworks and new methodologies for investigating the behaviors related to STI/HIV in this group. In order to better understand the continued existence of these disparities in STI/HIV risk among YMSM, the present study evaluated the presence and persistence of syndemic conditions among YMSM by examining the co-occurrence of alcohol and drug use, unprotected sexual behavior, and mental health burden over time. Four waves of data, collected over the first 18 months of a 7 wave, 36-month prospective cohort study of YMSM ($n = 600$) were used to examine the extent to which measurement models of drug use, unprotected sexual behavior, and mental health burden remained consistent across time using latent class modeling. Health challenges persisted across time as these YMSM emerged into young adulthood and the measurement models for the latent constructs of drug use and

unprotected sexual behavior were essentially consistent across time whereas models for mental health burden varied over time. In addition to confirming the robustness of our measurement models which capture a more holistic understandings of the health conditions of drug use, unprotected sex, and mental health burden, these findings underscore the ongoing health challenges YMSM face as they mature into young adulthood. These ongoing health challenges, which have been understood as forming a syndemic, persist over time, and add further evidence to support ongoing and vigilant comprehensive health programming for sexual minority men that move beyond a sole focus on HIV.

Resumen La persistencia en las disparidades del riesgo de ITS/VIH en la nueva generación de adultos emergentes que son gay, bisexuales o son hombres que tienen sexo con hombres, exige marcos holísticos y nuevas metodologías para la investigación de los comportamientos relacionados con ITS/VIH para este grupo. Con el fin de comprender mejor la persistencia de estas disparidades en el riesgo de ITS/VIH entre los hombres jóvenes que tienen sexo con hombres (HJSH), el presente estudio evaluó la presencia y persistencia de las condiciones sindémicas en este grupo, examinando la concurrencia entre el consumo de alcohol y drogas, el comportamiento sexual sin protección, y la carga en la salud mental de los participantes a través del tiempo. Cuatro mediciones de información de HJSH ($n = 600$), recolectadas durante los primeros 18 meses de un estudio longitudinal de 7 mediciones en el transcurso de 36-meses, fueron utilizadas para examinar el grado en el que el consumo de drogas, el comportamiento sexual sin protección, y la carga en la salud mental se mantienen constantes a través de tiempo, utilizando un modelo de clase latente.

P. N. Halkitis (✉) · F. Kapadia · S. Barton ·
A. D. Moreira · C. B. Stults
Center for Health, Identity, Behavior & Prevention Studies, New
York University, 726 Broadway, New York, NY 10003, USA
e-mail: perry.halkitis@nyu.edu

P. N. Halkitis · F. Kapadia
Global Institute of Public Health, New York University,
New York, NY 10003, USA

P. N. Halkitis · F. Kapadia
Department of Population Health, Langone School of Medicine,
New York University, New York, NY 10016, USA

K. L. Bub
Department of Educational Psychology, University of Illinois,
Urbana-Champaign, IL 61801, USA

Desafíos en la salud son persistentes a través de tiempo para este grupo de HJSH mientras emergen a la vida adulta, y los modelos de medición utilizados para el uso de drogas y el comportamiento sexual sin protección muestran consistencia a través del tiempo, mientras que el modelo de carga en la salud mental varía en el tiempo. Además de confirmar que los modelos de medición utilizados son robustos, también capturamos una manera más holística de entender las condiciones de salud relacionadas con el uso de drogas, sexo sin protección, y la carga en la salud mental, demostrando el desafiante proceso que viven los HJSH en el proceso de entrar en la vida adulta. Estos desafíos para la salud, que deben ser entendidos de manera sintémica, son persistentes a través del tiempo, y suman mayor evidencia en apoyo de un programa integral de salud en hombres de minorías sexuales con un enfoque más amplio que solo VIH.

Keywords Gay and bisexual men · Emerging adulthood · Syndemic · HIV · Structural equation modeling · Prospective cohort study

Introduction

From an epidemiological perspective, YMSM are at high risk for contracting and transmitting sexually transmitted infections (STIs), including HIV [1–3]. In 2009, YMSM accounted for 69 % of new HIV infections among persons 13–29 years old and 44 % of infections among all MSM in the US [4]. In New York City (NYC), new HIV (non-AIDS) diagnoses among MSM <30 years old surpassed that among MSM ≥30 years old for the first time in 2009. For STIs, population based incidence and prevalence data are unavailable at a national or state level specifically for YMSM [5, 6]. However, the 2011 CDC STD surveillance report indicates that the prevalence of chlamydia (CT) was ~14 and ~12 % among YMSM STD clinic patients ≤19 and 20–24 years old, respectively, across all STD Surveillance Network Sites (SSuN) [7]. Additionally, ~22 % of individuals testing positive for gonorrhea (GC) at SSuNs in NYC were MSM [7]. Finally, primary and secondary (P&S) syphilis has steadily increased from 2005 to 2013 among MSM in the US [8]. In addition, as STIs enhance the efficiency of HIV acquisition and transmission, they are important cofactors of HIV infection [9].

For YMSM, emergent adulthood [10] is a highly vulnerable period where physical, emotional, and cognitive development are coupled with the process of coming out and negotiating a sexual identity [11–13]. These processes may be further exacerbated by the confluence of substance use, unprotected sexual behaviors, and mental health burdens associated with an increased risk of HIV acquisition

among YMSM [14]. In fact, there is a substantial body of evidence indicating that there are significant disparities in behavioral factors such as unprotected sexual behavior, substance use and mental health burdens among YMSM compared with their heterosexual peers. To wit, a number of meta-analyses have provided evidence of increased likelihood of unprotected sexual behaviors [15], substance use [16] and mental health burdens [17] among sexual minority youth. Additionally, studies note that a greater burden of mental health burdens such as depression [18–20], loneliness [21], and post-traumatic stress disorder [22] among YMSM also create an increased vulnerability for unprotected sexual behavior. Nonetheless, a significant limitation of these extant studies is the investigation of sexual behaviors, substance use and mental health burden in a distinct manner, often ignoring the overlapping nature of these factors and how they increase the vulnerability to HIV infection among YMSM and, moreover, compromise the overall well-being of this population.

A growing number of studies have applied a syndemic framework for understanding these multiple and mutually reinforcing epidemics for their effects on adverse health outcomes among YMSM [23–30]. However, syndemic theory [31, 32], particularly as it relates to the additive effects of behavioral and psychosocial health problems on HIV/AIDS, has predominantly been empirically assessed in cross-sectional investigations of adult MSM and YMSM, both in the US and globally [29, 33, 34]. For example, earlier work by Stall and colleagues [35] examined the sum of a range of negative psychosocial conditions as components of a syndemic that contributed to HIV related disparities among a sample of predominantly White YMSM. More recently, Santos and colleagues (2014) found an increased risk for unprotected sexual behavior and HIV risk with increasing number of syndemic conditions including adverse psychosocial factors, mental health burdens and substance use with unprotected sexual behaviors and HIV infection in a global cross-sectional survey of $n = 3934$ MSM from 151 countries. In an effort to move beyond investigation of sum scores of syndemic conditions, in our own earlier work we applied structural equation modeling to develop a second-order model incorporating substance use variables and mental health burdens that was associated with a first-order model for unprotected sexual behavior, which was also comprised of a range of key unprotected sexual behavior indicator variables [25]. Building on this earlier work, which has demonstrated the robustness of measurement modeling of these health states as part of syndemic using our baseline data, we sought to investigate the extent to which the measurement of health states, namely drug use, unprotected sexual behavior, and mental health burden, can be supported using multiple waves of longitudinal data.

Despite the robustness of these aforementioned findings, the examination of health conditions among YMSM remains understudied in longitudinal assessments. Even in our own earlier analysis, our modeling is limited by the use of the cross-sectional baseline data thus, failing to capture the persistent nature of a health conditions which were conceptualized to form a syndemic [25, 31, 32, 35]. Thus, in the present study, we sought to extend and enhance our understanding of syndemic theory by examining the extent to which our measurement models, based on cross-sectional data [25], are replicated across time. Using structural equation/latent class modeling, we examined the extent to which the constructs of drug use, unprotected sexual behavior, and mental health burden remained consistent over an 18-month period.

Methods

Study Design and Sample Characteristics

Data for this analysis are derived from the Project 18 (P18) Cohort Study, a prospective study of YMSM residing in the New York City metropolitan area. The purpose of this study is to understand syndemic production in a new generation of racially/ethnically and socio-economically diverse YMSM. Study details and methodology for this project have been described previously [36–39]. Briefly, participants were recruited into this study between May 2009–June 2011 using both active and passive recruitment techniques. Eligible participants, those between 18 and 19 years old, biologically male, reporting sex with another man in the past 6 months, and self-reporting an HIV negative serostatus, provided written, informed consent to take part in P18. Upon enrollment, participants completed an ACASI based baseline assessment to provide information on sociodemographic characteristics, mental health, psychosocial characteristics and social factors. Next, data on recent (past 30 day) sexual and drug use behaviors were ascertained via an interviewer-administered, calendar-based approach methodology known as the Timeline Followback (TLFB) [40]. Upon completing these assessments, participants received HIV pre-test counseling, provided an oral swab sample for HIV antibody testing and received their results as well as post-test counseling. All participants were scheduled for a follow-up appointment six months from their respective baseline visit. To date, participants have completed four (baseline, 6-, 12- and 18-months post-baseline) study visits. Data from these visits are included in the present analysis. The New York University Institutional Review Board approved the study protocol, and the study holds a federal certificate of confidentiality.

Among the $n = 2,068$ participants screened for the P18 study, $n = 600$ met eligibility criteria and were enrolled in the study; however baseline ACASI data were not properly saved for $n = 2$ participants while TLFB information was obtained for the entire baseline sample. Among those who completed the baseline visit, $n = 460$ (89.5 %), 446 (88.5 %), and 428 (85.9 %), completed the 6-, 12- and 18-month follow-up visits on-site in NYC, respectively. Finally, $n = 2$ participants did not complete the 12-month ACASI assessment and data for $n = 1$ participant is unavailable for the 18-month ACASI assessment. Thus, the final analytic sample for the present study is $n = 598$, 458, 442, 425 for the baseline, 6-, 12-, and 18-month study visits, respectively.

Last, we compared key sociodemographic characteristics across follow-up visits for participants returning for on-site study visits and constituting our analytic sample (Table 1). These comparisons of participant sociodemographic characteristics across the baseline, 6-, 12- and 18-month follow-up visits yielded no statistically significant differences between those returning by race, perceived socioeconomic status (SES) and foreign-born status across the four study visits examined here. However as is expected during emerging adulthood there are differences noted in sexual orientation. Finally, differences are noted in HIV serostatus as a subset of the men seroconverted during the course of the 18 months of assessment.

Measures

Demographic Characteristics

A full description of demographic characteristics is previously reported by Halkitis and colleagues [36]. Briefly, during the baseline assessment participants self-reported their race/ethnicity, perceived familial SES, current school enrollment status, foreign-born status, and lifetime arrest history. Participants also provided information on their sexual identity utilizing the Kinsey scale; values range from 0 to 6 where zero indicates exclusively heterosexuality and six represents exclusively homosexuality.

Drug Use Indicators

Participant drug use was assessed utilizing two distinct approaches: the TLFB and urine-based drug testing with a ten panel urine drug test (iCup[®] DX). First, the TLFB utilizes a calendar-based measure to ascertain substance use during the 30 days preceding the study interview. During each on-site study visit, participants were asked to report on the days they used the following drugs: alcohol, marijuana, inhalant nitrates, powder cocaine, ecstasy, GHB, ketamine, crack cocaine, heroin, rohypnol, methamphetamine, as well

Table 1 Sociodemographic characteristics of participants returning for follow-up visits, The P18 Cohort Study, New York, NY

	Baseline (<i>n</i> = 600) ^b	6 Month (<i>n</i> = 460) ^b	12 Month (<i>n</i> = 445) ^b	18 Month (<i>n</i> = 428) ^b		
	% (<i>n</i>)	% (<i>n</i>)	<i>p</i>	% (<i>n</i>)	<i>p</i>	
Race			.97		.81	.91
Hispanic	38.3 (229)	37.6 (172)		38.7 (171)		38.8 (165)
White non-Hispanic	28.9 (173)	30.3 (139)		29.2 (129)		27.8 (118)
Black non-Hispanic	14.9 (89)	15.9 (73)		16.1 (71)		16.9 (72)
Mixed race	9.4 (56)	8.1 (37)		7.0 (31)		7.8 (33)
Asian	4.8 (29)	4.6 (21)		5.7 (25)		4.9 (21)
Other	3.7 (22)	3.5 (16)		3.4 (15)		3.8 (16)
Perceived Familial SES			.82		.94	.87
Lower	9.4 (56)	7.6 (35)		8.1 (36)		7.8 (33)
Lower middle	24.1 (144)	25.5 (117)		23.8 (105)		25.6 (109)
Middle	37.1 (222)	36.9 (169)		39.4 (174)		38.4 (163)
Upper middle	25.3 (151)	24.9 (114)		24.7 (109)		24.0 (102)
Upper	4.2 (25)	5.0 (23)		4.1 (18)		4.2 (18)
Foreign born status			.95		.66	.82
US born	89.0 (532)	89.1 (408)		89.8 (397)		89.4 (380)
Foreign born	11.0 (66)	10.9 (50)		10.2 (45)		10.6 (45)
School enrollment status ^a					.06	
Enrolled in school	85.6 (512)	–		80.1 (354)		–
Not enrolled in school	14.4 (86)	–		18.6 (82)		–
Sexual orientation			.31		.004	.02
Exclusively homosexual	41.5 (248)	43.4 (199)		46.2 (204)		46.7 (200)
Predominantly homosexual, only incidentally heterosexual	29.4 (176)	30.8 (141)		33.0 (146)		30.4 (129)
Predominantly homosexual, but more than incidentally heterosexual	13.0 (78)	11.6 (53)		8.8 (39)		9.9 (42)
Equally heterosexual and homosexual	11.7 (70)	9.6 (44)		6.3 (28)		8.7 (37)
Predominantly heterosexual, but more than incidentally homosexual	2.5 (15)	3.5 (16)		3.8 (17)		2.6 (11)
Predominantly heterosexual, only incidentally homosexual	1.8 (11)	0.4 (2)		1.4 (6)		0.5 (2)
Exclusively heterosexual	0.0 (0)	0.7 (3)		0.5 (2)		0.9 (4)

^a Assessed only at the 12 month follow-up visit

^b Due to missing demographic data, analytic sample across timepoints is 598, 458, 442, and 425, respectively.

as the following pharmaceuticals without a prescription: PDE-5 inhibitors (i.e., Cialis[®], Levitra[®], Viagra[®]), opioid pain relievers (e.g., Percocet[®], Oxycontin[®]), benzodiazepines (e.g., Valium[®], Xanax[®]) and ADHD drugs/stimulants (e.g., Adderall[®], Ritalin[®], Concerta[®]). Based on these disaggregated data, four summary drug use variables were created by totaling the number of days that participants reported using (1) marijuana, (2) alcohol, (3) inhalant nitrates, and (4) all other drugs. Sum scores for each of these indicator variables ranged from 0 (no drug use days) to 30 (drug use on each of the 30 days preceding study visit). Second, urine-based drug test kits were used to detect the following substances: cocaine, THC (marijuana), MDMA

(ecstasy), methamphetamine, amphetamines, opiates, methadone, benzodiazepines, barbiturates and oxycodone. Participants whose urine tested positive for any of these substances received a score of 1. A composite variable including a sum of all of the substances a participant tested positive for was created with a possible score ranging from 0 to 10.

Unprotected Sexual Behavior Indicators

Sexual behavior was assessed using the TLFBI approach as well. Participants were asked to provide information on type of sexual behavior they engaged in on each day during

the 30 days preceding interview. Thus, we obtained information on both unprotected insertive and receptive anal intercourse as well as unprotected receptive oral sex. By employing this approach, we were able to capture multiple episodes of a given type of sexual activity as well as multiple types of activities on a single day. Finally, these episodic data were tallied to create a separate sum score for each distinct type of sexual activity.

Mental Health Burden Indicators

Mental health burdens included indicators of (1) post-traumatic stress disorder (PTSD), (2) depression, (3) loneliness and (4) suicidal ideation. First, PTSD was assessed using the Trauma Awareness & Treatment Center PTSD scale [41] which includes ten items measured on a Likert scale ranging from 1 (not at all) to 5 (extremely). Items in this measure explore recurring traumatic memories, loss of interest in activities, as well as a sense of isolation during the past 12 months. Second, presence of depressive symptoms during the preceding 12 months were assessed using the Beck Depression Inventory (BDI) [42, 43] which utilizes a Likert scale ranging from 0 (none) to 3 (very much). Third, the UCLA Loneliness Scale [44], a four-item measure utilizing a Likert-type scale ranging from 0 (never) to 3 (often) was used to explore perceptions of feeling shy, alone or outgoing. The individual items are summed to produce a sum score that was used in the present analysis. Fourth, suicidal ideation and attempts were examined through a series of binary questions (yes/no) that assessed first whether a participant had suicidal thoughts during the past 12 months. Due to the referent period for experiencing these mental burdens (past 12 months), these items were only ascertained at the baseline and 12-month follow-up visit.

Statistical Analysis

For the present study, these data were analyzed in three stages. First, we estimated means and standard deviations for all observed indicators of latent constructs representing drug use in the past month (i.e., alcohol use, marijuana use, inhalant nitrate use, other drug use, presence of drug metabolites in urine), unprotected sexual behavior in the past month (i.e., episodes of unprotected oral receptive intercourse (UROI), episodes of unprotected anal insertive intercourse (UIAI), and episodes of unprotected anal receptive anal intercourse (URAI)) and mental health burden (i.e., suicidal thoughts, depressive symptoms, loneliness, and PTSD) across follow-up visits. Inspection of these means provided descriptive information on whether reported involvement in these observed indicators remained stable or varied across time.

Second, we estimated separate measurement models for each follow-up visit (i.e., baseline, 6, 12, and 18 months) using confirmatory factor analysis to examine whether factor loadings were stable across time. Factor loadings for alcohol use, UROI and suicidal thoughts were fixed to 1 at each follow-up visit to provide a constant/reference category for the latent constructs for drug use, unprotected sexual behavior, and mental health burden, respectively. The remaining indicators for each latent construct were freely estimated for each follow-up visit. In other words, no constraints were placed on the estimation of the factor loadings across time, thereby allowing for the possibility that the relative contribution of a given indicator could be different across visits. These *unconstrained models* provided primarily descriptive information on whether syndemic factors were similar or varied over time. Thus, we examined factor loadings and model-fit-statistics across time only to explore stability in constructs over time; this did not constitute formal tests for stability in the constructs over time.

Finally, to formally test for factorial invariance across follow-up visits and provide a valid comparison of latent constructs across time, factor loadings for each observed indicator within a latent construct were fixed to be the same at each follow-up visit. Again, factor loadings for alcohol use, UROI, and suicidal thoughts were fixed to 1 to provide a constant/reference category for the each latent construct. For the remaining indicator variables, factor loadings were then fixed to be equal to one another across time. These *constrained models* provide a statistical test of the hypothesis that the latent constructs for drug use, unprotected sexual behavior, and mental health burden are the same at each assessment point. Model goodness of fit was evaluated using multiple fit indices including X^2 (where lower, non-significant values suggest a good model fit), comparative fit index (where values between .90 and 1.00 suggest a good model fit), root mean square error of approximation (where values between 0 and .1 suggest a good model fit), and effect sized indexed by the R^2 statistic (where values between .13 and .25 were considered medium and values greater than .25 were considered large) [45]. All models were fit in MPlus version 5.1 (Los Angeles, CA) [46].

Results

In this sample of YMSM, observed over an 18-month period, there was evidence of the persistence of health problems over time that included the domains of substance use, sexual behavior and mental health burdens (Table 2). With regard to substance use, self-reported alcohol and marijuana use increased between the baseline and 18-month follow-up.

Table 2 Descriptive characteristics for drug use, sexual behavior and mental health across follow-up visits, The P18 Cohort Study, New York, NY

	Baseline Mean (SD)	6 Month Mean (SD)	12 Month Mean (SD)	18 Month Mean (SD)
Drug use (Last 30 days)				
Alcohol use (# of days)	4.08 (4.17)	4.23 (4.68)	4.76 (5.25)	5.16 (5.19)
Marijuana use(# of days)	4.78 (8.67)	5.17 (8.88)	5.60 (9.41)	6.86 (10.47)
Inhalant use (# of days)	0.07 (.64)	0.07 (.42)	0.07 (.42)	0.08 (.43)
Other drugs use (# of days)	0.55 (2.55)	0.64 (2.40)	0.61 (2.15)	0.72 (2.57)
Any drugs in urine (yes/no)	36 %	32 %	38 %	39 %
Unprotected Sexual Behavior (Last 30 days)				
UROI (# of episodes)	1.85 (3.45)	2.18 (3.89)	2.31 (3.72)	2.60 (3.76)
UIAI (# of episodes)	0.40 (1.99)	0.55 (2.34)	0.70 (2.91)	0.63 (2.27)
URAI (# of episodes)	0.52 (2.26)	0.64 (2.42)	0.57 (2.03)	0.65 (2.06)
Mental Health Burden (past year)				
Suicidal ideation (yes/no)	17 %	–	9 %	–
Depressive Symptomology	9.95 (8.79)	–	8.05 (8.31)	–
Loneliness	4.64 (2.50)	–	4.01 (2.33)	–
PTSD	16.85 (7.07)	–	15.41 (6.73)	–

UROI unprotected receptive oral intercourse, *UIAI* unprotected insertive anal intercourse, *URAI* unprotected receptive anal intercourse

This increase was also evident, although on a slightly smaller scale, for use of other drugs. In addition, urine testing on a random sample of participants indicated that more than one-third of the sample was using some sort of drug at baseline; this value increased to slightly less than 40 % by the 18-month assessment. Self-reported unprotected sexual activity in the 30 days preceding interview also increased over time. First, UROI increased from an average of 1.85 episodes per month at baseline to an average of 2.60 episodes per month by the 18-month follow-up visit. Second, while both UIAI and URAI increased, overall, from baseline to the 18-month follow-up visit, there was considerable variability in reports of these two sexual behaviors both within and across time. With regard to mental health burdens, indicators for depression and PTSD were slightly lower at the 12-month assessment compared with the baseline assessment. And while loneliness did not vary across visits, the number of participants who reported having suicidal thoughts, decreased by nearly 50 % between baseline and the 12-month assessment.

Drug Use Latent Construct

Using the indicators of alcohol use (fixed to 1), marijuana use, inhalant nitrate use, other drug use, and presence of drugs in urine, we identified a single latent construct for drug use at each follow-up visit. The model fit statistics and factor loadings suggest, however, that there are differences in how well the single construct fits the data at each assessment as well as the relative contribution of each indicator to the latent construct. More specifically, model fit is relatively good at baseline (column 1), declines at the

6- and 12-month assessments (columns 2 and 3), and then improves considerably by the 18-month assessment (column 4). Factor loadings for some indicators differed across time, while others were relatively stable. For example, the contribution of marijuana use to the construct declined between baseline ($\beta = 4.02, p < .001$) and the 6-month follow-up visit ($\beta = 2.81, p < .001$) and then increased steadily from the 12- to 18-month follow-up visit ($\beta = 3.85, p < .001$ at 12 months and ($\beta = 7.25, p < .001$ at 18 months). These changes in the relative contribution of the indicators likely reflect differences in the frequency and variability of reported marijuana use across time. The factor loadings for inhalant nitrate use and other drug use were somewhat stable across time (Table 3) which is reflective of the mean levels of each indicator across time (Table 2). Effect sizes (indexed by the R^2 statistic) were statistically significant for four of the five indicators, although the magnitude of the effects varied considerably across indicator and time.

Unprotected Sexual Behavior Latent Construct

While a single latent construct for sexual behavior was identified for each time point that included all sexual behavior indicator variables, there was less evidence of stability in this construct over time. This may be due to pronounced differences in the relative contribution of each observed indicator to the latent construct representing unprotected sexual activity over time. As example, while the factor loading for UIAI was $\beta = .400$ ($p < .001$) at baseline, it declined to $\beta = .171$ by the 6-month visit

Table 3 Factor loadings and model-fit-statistics at follow-up visits for unconstrained measurement models representing drug use indicator variables, The P18 Cohort Study, New York, NY

	Measurement models			
	Baseline Unstandardized (standardized)	6 Month Unstandardized (standardized)	12 Month Unstandardized (standardized)	18 Month Unstandardized (standardized)
Factor loadings				
Alcohol use	1.00 (.389)	1.00 (.445)	1.00 (.330)	1.00 (.235)
Marijuana use	4.02 (.752)***	2.81 (.660)***	3.85 (.708)***	7.25 (.843)***
Inhalant use	.053 (.135)**	.042 (.211)**	.039 (.163)**	.056 (.160)*
Other drugs use	.632 (.402)***	.551 (.477)***	.488 (.392)***	.495 (.234)**
Any drugs in urine	.210 (.723)***	.143 (.645)***	.234 (.855)***	.299 (.757)***
R² Statistics				
Alcohol use	.15***	.20**	.11**	.05*
Marijuana use	.57***	.44***	.50***	.71***
Inhalant use	.02	.04	.03	.03
Other drugs use	.16***	.23**	.15***	.06*
Any drugs in urine	.52***	.42***	.73***	.57***
Model Fit Statistics				
χ^2 (df)	32.70 (5)***	56.42 (5)***	60.46 (5)***	14.73 (5)
CFI	.895	.772	.772	.937
RMSEA	.096	.150	.158	.067

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4 Factor loadings and model-fit-statistics at follow-up visits for an unconstrained measurement models representing unprotected sexual behavior indicator variables, The P18 Cohort Study, New York, NY

	Measurement models			
	Baseline Unstandardized (standardized)	6 Month Unstandardized (standardized)	12 Month Unstandardized (standardized)	18 Month Unstandardized (standardized)
Factor loadings				
UROI	1.00 (.891)	1.00 (.906)	1.00 (1.00)	1.00 (.606)
UIAI	.400 (.615)***	.171 (.257)**	.359 (.459)***	.630 (.632)***
URAI	.445 (.606)***	.384 (.558)***	.242 (.444)***	.658 (.726)***
R² Statistics				
UROI	.79***	.82***	na ^a	.37***
UIAI	.38***	.07*	.21***	.40***
URAI	.37***	.31**	.20***	.53***
Model Fit Statistics				
χ^2 (df)	.000 (0)	.000 (0)	.000 (0)	.000 (0)
CFI	1.00	1.00	.945	1.00
RMSEA	0.00	0.00	.114	0.00

* $p < .05$; ** $p < .01$; *** $p < .001$

^a The variance for UROI was non significant, suggesting minimal variability across individuals, and thus was set to 0 to fit the model

($p < .01$) but then its relative contribution increased at both the 12- ($\beta = .359, p < .001$) and 18-month follow-up visits ($\beta = .630, p < .001$). In a somewhat similar fashion, factor loadings for URAI declined across the first three time points but then increased at the 18-month follow-up visit, again suggesting somewhat less stability in the unprotected sexual activity latent construct (Table 4).

Mental Health Burden

Two measurement models for mental health burden are provided as mental health indicators were gathered only at baseline and the 12-month follow-up (see Table 5). The latent construct representing mental health burden also appears to replicate over time. That is, using an indicator

Table 5 Factor loadings and model-fit-statistics at follow-up visits for unconstrained measurement models representing mental health burden indicator variables, The P18 Cohort Study, New York, NY

	Measurement model	
	Baseline Unstandardized (standardized)	12 Months Unstandardized (standardized)
Factor loadings		
Suicidal ideation	1.00 (.468)	1.00 (.331)
Depressive symptoms	44.74 (.886)***	77.72 (.890)***
Loneliness	7.74 (.538)***	12.46 (.508)***
PTSD	31.48 (.775)***	55.56 (.786)***
R² Statistics		
Suicidal ideation	.22***	.11***
Depressive symptomatology	.79***	.79***
Loneliness	.29***	.26***
PTSD	.60***	.62***
Model fit statistics		
χ^2 (df)	.68 (2)	.64 (2)
CFI	1.00	1.00
RMSEA	0.00	0.00

* $p < .05$; ** $p < .01$; *** $p < .001$

reflecting whether or not the participant had any suicidal thoughts in the past month (fixed to 1), as well as indicators of total depressive symptoms, loneliness, and PTSD, we identified a single latent construct at baseline and 12 months. Model fit was very similar at each assessment point (see Table 4, columns 1 and 3). As was the case with the drug use and unprotected sexual activity models, however, factor loadings at each assessment differed considerably. For example, the magnitude of the factor loading for depressive symptoms increased from 44.74 ($p < .001$) at baseline to 77.72 ($p < .001$) at 12 months. Differences in the magnitude of the factor loadings across time likely reflect differences in the mean level of these indicators.

Testing Factorial Invariance of Latent Constructs Across Time

In models testing for factorial invariance, we found evidence of full factorial invariance for drug use and partial factorial invariance for unprotected sexual behavior. More specifically, a comparison of the model fit statistics for drug use indicated that, on average, the factor loadings for the observed drug use indicator variables were not significantly different at each assessment point. For unprotected sexual behavior, the constrained model provided a significantly poorer fit to the data than did the unconstrained model ($\Delta\chi^2 = 24.57$, $p = .01$). This indicates that the

factor loadings for the observed unprotected sexual behavior indicator variables may differ across some, if not all the assessment time points. In a follow-up analysis we found that factor loadings for UIAI were relatively stable across time but that the factor loading for URAI at the 6-month follow-up was significantly different from the other assessment points. When we fixed all other loadings to be equal but allowed the loading for the 6-month URAI to be freely estimated, the model did not differ significantly from the unconstrained model ($\Delta\chi^2 = 8.52$, $p = \text{NS}$). Finally, there was no evidence of factorial invariance in mental health burden between baseline and 12 months. That is, the constrained model provided a significantly poorer fit to the data than the unconstrained model ($\Delta\chi^2 = 13.05$, $p = .01$), suggesting that the factor loadings for each indicator differed between baseline and the 12-month follow-up.

Discussion

In the last decade, the application of syndemic theory has helped to re-shape investigation of STI/HIV risk and related behaviors among a range of vulnerable populations [31, 47, 48]. This shift has enabled public health researchers to move away from examining various factors for their independent associations with STI/HIV and related behaviors toward a model that acknowledges the overlapping and concurrent nature of these factors. For YMSM, in particular, the holistic nature of this theory has provided a robust framework for considering the interplay of the range of key behavioral and health-related determinants in relation to HIV, HIV related behaviors as well as overall health related disparities. Given the increased STI/HIV risk in this new generation of YMSM, investigation of syndemic conditions over time merits continued examination.

In recognition of this need, the present analysis sought to test the consistency of models that included drug use, sexual behavior and mental health (which have been conceived as compete of a syndemic) over time by drawing on longitudinal data from a cohort study of YMSM. Initial results from descriptive analyses demonstrated a slight increase over time in drug use and unprotected sexual behaviors as the young men in this sample transitioned from emerging into young adulthood. As such, our findings of increased drug use (for alcohol, marijuana, and other drugs) and unprotected sexual behavior (for UROI, UIAI and URAI) with increasing age are consistent with the previous literature [14, 49–51]. This finding is key as suggest the ongoing and potentially elevated health challenges YMSM face as they continue to emerge into adulthood.

More significantly, the present study extends our current understanding of how, and to what extent, syndemic conditions, namely, drug use, unprotected sexual behavior and mental health burdens, persist over time. First, the indicators for each of the three latent constructs, drug use, unprotected sexual behavior, and mental health burden, loaded onto a distinct latent factor for the respective indicators at each time point. These findings speak to the robustness of the indicator variables to inform the development of these latent constructs at each time point. It is important to note that the relative contribution of these different indicator variables varied across time points due to fluctuations in self-report of these behaviors. Nonetheless, since the indicators for each still loaded onto one latent construct across four time points, there is some confidence in the robustness of these indicators as well as the final measurement model itself. While these findings may seem amorphous and theoretical, it actually has very important concrete implications in our efforts to address the health of sexually minority men more holistically. Specifically these findings point to the fact that drug use, unprotected sexual behavior, and mental health burden are multifaceted and that assessment of these health states cannot focus solely on one variable or one condition, but rather the constellation of health behaviors that define each of the three health challenge (i.e., drug use, unprotected sexual behavior, mental health burden). More importantly, interventions and health care delivery must attend to the myriad issues YMSM face and move beyond a sole focus on HIV. To this latter point, comprehensive sexual health programming must fully incorporate substance use and mental health counseling, move beyond a sole focus on HIV and attend to the multitude of other STIs that may compromise well-being, recognizing that it is not only anal intercourse that can transmit such pathogens.

In formally testing for the consistency of these latent constructs over time (i.e., testing for factorial invariance), our findings supported one consistent model for drug use over time as well as some consistency in the construct for unprotected sexual behavior. The partial consistency of the unprotected sexual behavior variables loading is likely due to the gradual increase in sexual behavior patterns of these young men over time. In contrast, the mental health burden construct was not consistent over time, suggesting substantial fluctuations in mental health burdens as these young men mature. Moreover, as these data are only collected at yearly assessment, data on mental health burdens were only available for two assessment time points. This may have impeded our ability to look at changes in mental health burden as they may require more than two time points to compare. However, as our cohort study continues we will be able to further test the stability of the mental health burden construct over more than two assessment

points. Again these results point to the perpetuation of health challenges of YMSM as they emerge from late adolescence into young adulthood.

Before final conclusions can be drawn, strengths and limitations of the present study must be considered. A major strength of our findings is the longitudinal nature of our data which provides further support for a means of measuring health states in the population of emerging adult sexual minority men, over and beyond cross-sectional investigations. Still, there are certain limitations worth noting. First, while the use of a calendar-based technique to collect sexual and drug use data enhances participant recollection, these data are nonetheless self-reported and subject social desirability responding. Moreover, in our attempt to reduce such reporting bias, we limited data collection to one month prior to assessment. Our modeling is based, therefore, on this limited timeframe, and we may be failing to capture critical data for the entire six month period between assessment points. Second, our measurement modeling of mental health is also limited to two timepoints in the present analyses—baseline and 12 month follow-up visit. The decision to assess mental health at yearly periods was a reflection of the reference period of interest (last 12 months) in the various scales used here. Second, by employing these validated scales, we could be more confident that such states would remain more stable over time.

Conclusions

Our findings indicate that YMSM face ongoing health challenges as they emerge into adulthood, and the syndemic health states of drug use, unprotected sexual behavior, and mental health burden [25] continue to persist, and perhaps become more problematic, as these young men mature.

The significance of these findings provides us with further support for a theory of syndemics, a framework that espouses a holistic manner with which to consider STI/HIV prevention and treatments moving forward. Linking unprotected sexual behaviors, and by proxy STI/HIV, with salient overlapping and mutually reinforcing health states, provides us with a powerful lens with which to continue to understand and combat these ongoing epidemics in the gay and bisexual population. Further, these results equip investigators with the evidence necessary to leverage the syndemics framework as a lens for understanding the persistence of the HIV epidemic in sexual minority men in future studies. These findings empower researchers, public health practitioners, and clinicians with a meaningful paradigm by which to establish programming that may be more effective at stemming these multiple epidemics in

sexual minority youth three decades after the initial detected of HIV and at a time when the epidemic continue to be transformed with the implementation of powerful biomedical technologies as pre exposure prophylaxis (PrEP). More importantly we must continue to attend to the health of YMSM holistically recognizing that health is defined by more than biomedical conditions but also behavioral states driven by social and structural inequalities that undermine the health of sexual minority men. [52] Finally we must fully appreciate the fact that the AIDS epidemic of the 1980's is not the one that young and, bisexual, and other YMSM are facing, and while we can learn from the lessons of "the AIDS Generation" [53] we must also expand our understanding and approaches for addressing gay men's health.

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