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Historical and Developmental Changes in Condom Use among Young Men Who Have Sex with Men Using a Multiple Cohort, Accelerated Longitudinal Design

Gregory Swann^{1,2}, Michael E. Newcomb^{1,2}, Shariell Crosby^{1,2}, Daniel K. Mroczek^{1,3}, and Brian Mustanski^{1,2}

¹Department of Medical Social Sciences, Northwestern University Feinberg School of Medicine, Chicago, IL

²Northwestern University Institute for Sexual and Gender Minority Health and Wellbeing, Chicago, IL

³Department of Psychology, Northwestern University Weinberg College of Arts & Sciences, Evanston, IL

Abstract

Objective: Young men who have sex with men (YMSM) have the highest HIV incidence in the US. The last 5 years has seen emergence of new methods for HIV prevention and societal shifts in gay rights. It is important to understand if there have been generational shifts in condom use during the developmental transition from adolescents to young adulthood. To disentangle history from development requires a multiple cohort, longitudinal design—a methodology never before applied to study YMSM.

Methods: We followed three cohorts of YMSM recruited in 2007, 2010, and 2015 (N = 1,141) from the ages of 17 to 26 and modeled their longitudinal change over time in counts of anal sex acts and the ratio of condomless anal sex acts to anal sex acts using latent curve growth modeling.

Results: We found that no significant developmental change in raw counts of anal sex acts, but there was a significant decline in the ratio of anal sex acts that were condomless. We also found significantly different patterns for ratio of condomless anal sex (CAS) acts for the 2015 cohort. The 2015 cohort reported a significantly lower ratio of CAS acts at age 17, but significantly higher growth in ratio of CAS acts over development.

Conclusions: The present study suggests that YMSM recruited in 2015 have very different trajectories of condomless anal sex compared to previous cohorts, including lower risk in late adolescence, but with the potential for higher risk after the transition into adulthood.

Keywords

YMSM; Condomless; HIV; Development

INTRODUCTION

Youth between the ages of 13 and 24 represented 22% of HIV diagnoses in the United States in 2015 with the majority of new infections in this age group occurring in young men who

have sex with men (YMSM) (CDC, 2016). Every year since 2008 the CDC has reported increases in the rates of HIV diagnoses among 13–24 year old YMSM and between 2001 and 2011 they were the fastest growing age group for new infections (CDC, 2008, 2012). In their 2015 surveillance report, the CDC estimated that rates of diagnoses stabilized in this group, but rates continued to increase among MSM ages 25–34 (23% increase from 2010 to 2015) (CDC, 2016). Given these high rates and trends, understanding how HIV risk changes from adolescence to young adulthood is especially important.

The past five years have also seen major sociopolitical shifts in recognition and acceptance of same-sex relationships, such as marriage equality. There have also been major medical advancements in the treatment of HIV, such that those who initiate and sustain treatment are expected to live a normal lifespan (Samji et al., 2013; Teeraananchai et al., 2017). Similarly, there have been major innovations in the prevention of HIV, such as the introduction of Pre-Exposure Prophylaxis (PrEP) (Karim & Karim, 2011) and the findings that effective treatment to an undetectable viral load essentially eliminates transmission (treatment as prevention or TasP) (WHO, 2012). While these biomedical discoveries are revolutionary for HIV prevention, PrEP is not currently FDA approved for adolescents under 18, PrEP uptake has been low among YMSM (particularly YMSM of color) (Morgan, Moran, Ryan, Mustanski, & Newcomb, 2017; Strauss et al., 2017), and rates of achieving viral suppression hover around 50% (CDC, 2017) and are lower among youth (Zanoni & Mayer, 2014). As such, condom use continues to be a critical tool for HIV prevention among YMSM. In a time that has seen both new methods for HIV prevention and large societal shifts for YMSM, it is important to understand how condom use behavior has changed across the developmental transition from adolescence into adulthood as well as generational shifts in condom use patterns among YMSM. Studies that can disentangle development (or change of any kind) from history are rare because they require longitudinal data from multiple cohorts enrolled at the same ages but in different years. To our knowledge no such approach, sometimes known as cohort-sequential designs (Duncan, Duncan, & Hops, 1996; Galbraith, Bowden, & Mander, 2017; Miyazaki & Raudenbush, 2000), has been used to study YMSM.

Previous research on generational cohort differences in condom use have largely focused on the impact of effective and available antiretroviral therapy for treating HIV on sexual risk behavior by comparing cohorts from the mid-to-late 1990s with cohorts from the early-to-mid 2000s (Chen et al., 2002; Elford & Hart, 2003; Fendrich, Mackesy-Amiti, Johnson, & Pollack, 2010). The consensus from these studies was that MSM in the 2000s engaged in higher rates of condomless anal sex compared to their earlier counterparts. Research on change in sexual risk-taking in the mid- to late-2000s has shown a somewhat different pattern. Leichliter, Haderxhanaj, Chesson, and Aral (2013) compared sexual risk-taking behaviors in a sample of MSM taken from the 2002 National Survey of Family Growth with a cohort measured on the same survey from 2006–2010. They found a significant decrease in the number of male sex partners reported by the later cohort, but no differences in condom use at last sex. Menza, Kerani, Handsfield, and Golden (2011) sampled MSM in 2003 and 2006 and found that the later cohort was less likely to have had condomless anal sex compared to the earlier cohort. Existing research comparing cohorts from different time periods have focused on adult MSM with scant previous research focused on YMSM. Likewise, there has been little research that has included more recent cohorts.

None of the previous studies comparing MSM from different cohorts have considered longitudinal change over time in condom use. However, longitudinal change in condom use has been addressed in single cohort studies. Most longitudinal research on condom use has been conducted with adult MSM samples (Chen et al., 2002; Crepaz et al., 2009; George et al., 2006; Pines et al., 2014). Pines et al. (2014) found that MSM who were younger at baseline were more likely to fall into a high risk trajectory group that had higher increases in condomless sex over time. Wong, Schrager, Chou, Weiss, and Kipke (2013), in a two-year study of changes in condom use and number of sex partners over time, reported high within-person variability in sexual risk-taking, including inconsistent condom use, over the course of the study. In a study of changes in condomless sex in a sample of 18 and 19-year-old YMSM over the course of 18 months, researchers found no significant changes over time in either insertive or receptive condomless anal sex (CAS) (Kapadia, Bub, Barton, Stults, & Halkitis, 2015). The few studies that have considered condom use over time in YMSM have been relatively short (2 years) and have focused on the transition from late adolescence to very early adulthood. Less is known about change in CAS engagement over longer periods for YMSM. Given that MSM ages 25–34 have the highest incidence of new HIV infections (CDC, 2016), it is especially important to understand change in patterns of condom use from adolescence into young adulthood.

Age has not been the only demographic characteristic associated with unequal risk in the HIV epidemic. HIV incidence has disproportionally affected Black YMSM compared to their White YMSM counterparts (CDC, 2016). Despite having the highest incidence of HIV, Black YMSM have repeatedly been found to either engage in less CAS or show no differences compared to White YMSM (Clerkin, Newcomb, & Mustanski, 2011; Millett, Flores, Peterson, & Bakeman, 2007; Rosenberg, Millett, Sullivan, Del Rio, & Curran, 2014; Rosenberger et al., 2012). Kapadia et al. (2015) also found that Black YMSM decreased over time in CAS acts compared to White YMSM. The majority of research comparing Latino/Hispanic YMSM and non-Hispanic White YMSM has found no significant differences in condom use during anal sex between the two groups (Golub, 2014; Kapadia et al., 2015; Newcomb & Mustanski, 2013).

In addition to racial differences, previous studies have found differences in condom use between gay and bisexual men (Friedman et al., 2014; Rosenberger et al., 2012). In one study, those who identified as bisexual and unsure/questioning were more likely to use a condom, irrespective of sexual position, than gay men (Rosenberger et al., 2012). Friedman et al. (2014) conducted a meta-analysis with past research on HIV infection rates and sexual risk behavior with men who have sex with men and women (MSMW). They found that MSMW were significantly less likely to engage in condomless receptive anal sex compared to MSM. However, there were not significant differences in overall rates of condomless anal sex or condomless insertive anal sex between MSMW and MSM. Men who have sex with both male and female partners have also been found to have cohort differences similar to their MSM counterparts. Leichter et al. (2013), in their comparison of 2002 and 2006–2010 MSM cohorts, found that MSMW in the 2006–2010 cohort were more likely to report condomless sex with their last female partner compared to MSMW in the 2002 cohort. There were no differences for last male partner.

The goal of the present study was to observe how engagement in CAS changes over time from late adolescence to adulthood in YMSM. We also set out to assess whether cohorts of YMSM recruited in 2007, 2010, and 2015 differed in patterns of change in CAS from late adolescence to adulthood—this methodology that allows for modeling both historical and developmental change is referred to as a multiple cohort longitudinal design (Duncan et al., 1996; Galbraith et al., 2017; Miyazaki & Raudenbush, 2000). We predicted that with the advancements of PrEP and TasP the most recent cohort would have larger increases over time in CAS compared to the earlier cohorts. In addition, we hypothesized that Black YMSM would have lower rates of CAS and lower growth over time compared to White and Latino/Hispanic YMSM, regardless of cohort. We also hypothesized that gay and bisexual-identifying YMSM would report similar rates of CAS, regardless of cohort. In exploratory analysis, we also examined whether change in CAS differed depending on partner type by examining differences in trajectories for CAS in the context of serious and casual partners.

METHODS

Participants & Procedures

Data came from RADAR, an ongoing community-based longitudinal cohort study of HIV risk and substance use among YMSM recruited in Chicago (Mustanski, Swann, Newcomb, & Prachand, 2017; Swann, Bettin, Clifford, Newcomb, & Mustanski, 2017). The RADAR study is a merging of two previous longitudinal studies of YMSM, Project Q2 (N = 117 YMSM) which was first recruited in 2007 and Crew 450 (N = 450) which was first recruited in 2010, and a new sample of YMSM recruited between 2015 and 2016 (N = 827). Recruitment criteria for YMSM in all three cohorts included being between the ages of 16 and 20 at baseline, assigned male at birth, English speaking, and reporting a sexual encounter with a man in the previous year or identifying as a sexual minority.

Data collection for Project Q2 and Crew 450 included eight waves of data. Participants in Crew 450 were surveyed every 6 months. In Project Q2, participants were surveyed at 6- to 18-month intervals. Upon enrollment into the RADAR study, participants came in every 6 months. Fifteen participants were enrolled in both Project Q2 and Crew 450. For those participants, data were taken from the study where the participant completed the most waves. In the newest cohort, participants could recruit their serious partners and up to three peers into the study. Partners and peers were only included in the present analyses if they were between the ages of 16–20 at baseline and assigned male at birth. The analytic N for the most recent cohort was 589. The final analytic N for the full sample was 1141. The protocol for each study was approved by the institutional review boards (IRBs) with a waiver of parental permission for participants under 18 years under 45 CFR 46, 408(c) (Mustanski, 2011). For the duration of the manuscript, the Project Q2 cohort will be referenced as the 2007 cohort, the Crew 450 cohort will be referenced as the 2010 cohort, and the new cohort will be referred to as the 2015 cohort.

Measures

Demographics—Participants in all three cohorts answered a demographics questionnaire at each time point that asked about race/ethnicity, age, and sexual orientation.

Condomless Anal Sex Acts—The number of condomless anal sex acts were assessed in each cohort using the HIV Risk Assessment of Sexual Partnerships (H-RASP) (Swann, Newcomb, & Mustanski, 2018). The H-RASP has been found to be a valid measure of sexual risk-taking in comparison to other forms of measurement, including interviewer administered measures and diary studies (Hogan et al., 2016; Swann et al., 2018). In the H-RASP, participants were asked to report on a set number of their most recent partners in the previous six months. In the 2007 and 2010 cohorts, participants were asked to report on their three most recent partners. In the 2015 cohort, participants were asked to report on their last four partners. For consistency, only the most recent three partners reported by the 2015 cohort were used in analyses. In the 2007 and 2015 cohorts, participants were asked to report the number of times they had anal sex with each partner in the previous six months and to report the number of times that anal sex was condomless. In the 2015 cohort, these questions were asked separately for insertive and receptive anal sex and were combined. In the 2010 cohort, participants were asked to report the number of times they had anal sex with each partner and the proportion of those times that a condom was used on a 5-point scale (1 = “always,” 2 = “More than half the time,” 3 = “About half the time,” 4 = “Less than half the time,” and 5 = “Never”). CAS acts were calculated for the 2010 cohort by multiplying the number of anal sex acts by the proportion (“always” = 0, “more than half the time” = .25, “about half the time” = .50, “less than half the time” = .75, and “never” = 1). For all cohorts, the ratio of CAS acts was calculated by summing the number of CAS acts across all three partners at each wave and then dividing that total by the total number of anal sex acts (range: 0 – 1).

Participants in each cohort were asked to report how serious their relationship was with each partner with the response options: “serious,” “casually dating but not serious,” “sleeping with this person but not dating,” “one night stand,” and “stranger or anonymous person.” We calculated CAS acts separately for relationships defined as “serious” and relationships that fell into the other four categories that we defined as “casual.”

Statistical Analyses

Latent growth curve models were run in MPlus in order to observe change in reported number of anal sex acts from the age of 17 to 26 in our sample of YMSM (see Supplementary Table 1 for descriptives of outcomes by age). MPlus accommodates missing data using full information maximum likelihood estimation. In order to control for differences in interview schedule and age among the participants within the three cohorts, we used person-specific factor loadings called time scores. The time scores for the current study were centered at age 17. We looked at change across number of anal sex acts and ratio of CAS acts. We included the ratio of CAS acts as an outcome in order to control for increases in total anal sex acts over time. Increases in anal sex from late adolescence into adulthood, by itself, may be considered normative and can mask if YMSM are maintaining or changing their rate of condom use. In other words, changes in the number of CAS acts over time could be more reflective of changes in number of anal sex acts instead of changes in patterns of condom use. We compared model fit for each variable for 1) an intercept only model, 2) an intercept and slope model, and 3) an intercept, slope, and quadratic model to determine what pattern of change best described our data. Initially, we also tested for cubic

effects within the growth models, but dropped those terms because models did not converge. The best-fitting model was determined using Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC). In situations where the AIC and BIC were not in agreement about the best fit, we deferred to the BIC values to identify the most appropriate model. We compared unrestricted models that included random slopes with restricted models where variance for the slope was set to zero to determine if there was meaningful variance between participants. Percentage of change between the restricted and unrestricted models were computed using change in AIC values. The final reported models include the intercept and slope with random effects for the slope term. In all models, we controlled for cohort effects, sexual orientation, and race/ethnicity.

RESULTS

Demographics

Participants in the 2015 cohort represented the largest proportion of the current sample, 51.6% (N = 589), followed by 38.3% (N=437) in the 2010 cohort, and 10.1% (N=115) in the 2007 cohort. The average age at baseline was 19.01 (SD = 1.24) and the average age at participants' most recently completed wave was 21.36 (SD = 2.56). The racial/ethnic breakdown was 38.2% (N=436) African American/Black, 25.4% (N=290) Hispanic/Latino, 25.1% (N=286) White, and 11.3% (N=129) as Asian/Pacific Islander, Native American, or identifying as another race/ethnicity. The majority of the sample (69.3%) identified as gay, followed by bisexual (23.1%), and straight/questioning or "other" (7.4%).

The 2015 cohort had a larger proportion of Hispanic/Latino participants (31.6%) compared to the 2010 (20.4%) and 2007 (13.0%) cohorts ($\chi^2(2) = 26.97, p < .001$). It also had a higher proportion of White participants (31.1%) compared to the 2010 (18.3%) and 2007 (20.0%) cohorts ($\chi^2(2) = 23.50, p < .001$) and a smaller proportion of Black participants (25.8%) compared to 2010 (53.1%) and 2007 (45.2%) cohorts ($\chi^2(2) = 81.75, p < .001$). There were no significant differences based on sexual orientation or age at baseline. Given that we are continuing to collect data on participants in each of the cohorts, the average age at most recent wave for the 2007 cohort was 24.94 (SD = 2.32), 22.43 (SD = 2.37) for the 2010 cohort, and 19.80 (SD = 1.27) for the 2015 cohort.

Participants in the 2015 and 2010 cohorts reported a higher number of sexual partners at baseline compared to the 2007 cohort (2015: M = 2.30, 95% CI 2.23: 2.38; 2010: M = 2.32, 95% CI 2.24: 2.40; 2007: M = 1.60, 95% CI 1.45: 1.74). When broken out by serious and casual partners, participants in all three cohorts reported a similar number of serious partners (2015: M = .64, 95% CI 0.59: 0.69; 2010: M = 0.71, 95% CI 0.64: 0.78; 2007: M = 0.71, 95% CI 0.58: 0.85), but the 2007 cohort reported fewer casual partners (2015: 1.66, 95% CI 1.57: 1.76; 2010: M = 1.62, 95% CI 1.51: 1.72; 2007: M = 0.88, 95% CI 0.70: 1.07). In terms of age, 57.9% of participants reported having a serious partner before age 18 and 71.8% reported having a casual partner. There were no significant differences based on cohort.

Change in Number of Anal Sex Acts

Model fit statistics are listed in Table 1. The best-fitting model for anal sex acts was the intercept and slope model. Comparison of model fit between the restricted and unrestricted model that included random slopes showed less than 1% of improvement in fit (see Supplementary Table 2). The results suggest that the variance in slope values was small. Results for growth in anal sex acts over development are presented in Table 2. The intercept indicated an average expected value of 10.17 anal sex acts in prior 6 months at age 17 ($SE = 2.26$, $p < .001$). Growth in anal sex acts was not significant overall ($Beta = 1.04$, $SE = .57$, $p = .068$). There were no significant differences between the three cohorts on change in number of anal sex acts over development (see Figure 1). There were also no differences based on race/ethnicity or sexual orientation.

For anal sex with casual partners, the best-fitting model was the intercept, slope, and quadratic model (see Table 1). Results for that model are in Table 2 and Figure 1. The intercept indicated an expected value of 4.94 anal sex acts in prior 6 months with casual partners at age 17 ($SE = 1.06$, $p < .001$). The slope ($Beta = -.48$, $SE = .69$, $p = .487$) and quadratic effect ($Beta = .06$, $SE = .09$, $p = .493$) were not significant. Similar to the overall pattern with total anal sex acts, comparisons between models that did and did not include random slopes suggested that variance between participants was small (see Supplementary Table 2). There were no cohort differences or differences based on sexual orientation. Participants in the “other” race/ethnicity category had significantly higher slopes ($Beta = 3.96$, $SE = 1.88$, $p = .035$) and a significantly lower quadratic effect ($Beta = -.44$, $SE = .22$, $p = .049$).

The best-fitting model for anal sex acts with serious partners was the intercept and slope model (see Table 1). Results for that model (see Table 2 and Figure 1) showed a significant increase in anal sex acts over time ($Beta = 1.86$, $SE = .78$, $p = .017$). The intercept indicated an expected value of 9.54 anal sex acts in prior 6 months with serious partners at age 17. There were no significant differences based on cohort, race/ethnicity, or sexual orientation. Comparisons between the restricted and unrestricted models found that inclusion of random slopes resulted in only a 0.43% improvement in model fit (see Supplementary Table 2).

Change in Ratio of Condomless Anal Sex Acts to Total Anal Sex Acts

For ratio of CAS acts across development, the best-fitting model was the intercept and slope model for the overall CAS ratio, the CAS ratio with casual partners, and the CAS ratio with serious partners (see Table 1). Results for the overall CAS ratio are presented in Table 3 and Figure 2. The expected mean ratio of CAS acts at age 17 predicted that 57% of anal sex acts were condomless at that age ($Beta = .57$, $SE = .03$, $p < .001$). The ratio of CAS acts decreased significantly across development ($Beta = -.03$, $SE = .01$, $p < .001$). The inclusion of random slopes improved model fit by 1.02% (see Supplementary Table 2). Participants in the 2015 cohort reported a significantly lower ratio of CAS acts at age 17 compared to the 2010 cohort ($Beta = -.23$, $SE = .04$, $p < .001$). However, they also reported a significantly higher increase in ratio of CAS acts over time compared to the 2010 cohort ($Beta = .04$, $SE = .01$, $p = .001$). There were no significant differences between the 2007 and 2010 cohorts. Participants who identified as White ($Beta = .02$, $SE = .01$, $p = .032$) or Hispanic/Latino

(Beta = .03, SE = .01, $p = .004$) reported higher growth in ratio of CAS over time compared to Black participants. There were no significant differences based on sexual orientation.

For ratio of CAS acts within casual partnerships (see Table 3 and Figure 2), the slope also showed a significant decline over time (Beta = $-.05$, SE = .01, $p < .001$). The mean intercept showed an expected mean of 61% of anal sex acts with casual partners were condomless at age 17 (Beta = .61, SE = .03, $p < .001$). The inclusion of random slopes in the model improved fit by 0.62% (see Supplementary Table 2). The 2015 cohort had a significantly lower ratio of CAS at age 17 (Beta = $-.34$, SE = .05, $p < .001$) and significantly higher growth over time (Beta = .05, SE = .02, $p = .001$) compared to the 2010 cohort. The 2007 cohort also reported significantly lower ratio of CAS at age 17 (Beta = $-.14$, SE = .05, $p = .006$) and higher growth (Beta = .03, SE = .01, $p = .012$) compared to the 2010 cohort. Participants who identified as White (Beta = .03, SE = .01, $p = .014$) or Hispanic/Latino (Beta = .03, SE = .01, $p = .017$) had significantly higher slopes compared to Black participants. There were no differences based on sexual orientation.

There was not a significant change over time in ratio of CAS acts with serious partners (Beta = $-.01$, SE = .01, $p = .198$) (see Table 3 and Figure 2). The mean intercept indicated that the expected average percentage of CAS acts with serious partners was 42% at age 17 (Beta = .42, SE = .04, $p < .001$). The inclusion of random slopes improved model fit by 1.21% (see Supplementary Table 2). Participants in the 2015 cohort reported significantly higher growth in CAS ratio (Beta = .03, SE = .02, $p = .023$) compared to the 2010 cohort. There were no differences between the 2007 and 2010 cohorts. Participants who identified as bisexual reported a lower ratio of CAS at age 17 compared to gay-identifying participants (Beta = $-.11$, SE = .05, $p = .024$). Participants who identified as Hispanic/Latino had significantly higher slopes (Beta = .04, SE = .01, $p = .001$) compared to Black participants.

DISCUSSION

The purpose of the current study was to model developmental changes in anal sex acts and CAS from late adolescence to young adulthood in a diverse sample of YMSM and to test for differences in three different cohorts recruited in the same city using similar procedures at various points in time during the last ten years in order to examine historical changes. We found that on average YMSM increased their number of anal sex acts, as measured by their three most recent partners at each time point, by approximately one additional act for each year of age, but that this effect was non-significant. In our models, we also found that improvements in fit with the addition of random effects for slopes were small. This finding suggested that there was a consistent pattern of developmental change that described YMSM engagement in anal sex as they aged. Where we did find change in average behavior was in growth in ratio of CAS acts over time. Across the transition from late adolescence into adulthood, YMSM decreased in their percentage of anal sex acts that were condomless.

The overall pattern of results indicated that at younger ages, YMSM were engaging in less anal sex, but individual sex acts were more likely to be condomless. As participants in our sample grew older, they became more likely to use condoms, but because they were having more sex, there sexual risk did not necessarily decrease. For instance, models indicated that

on average at age 17 YMSM in our sample engaged in 10.17 anal sex acts and that 57% of those acts were condomless, or an average of 5.80 CAS acts. At age 26, the model suggested an average of 19.53 anal sex acts and that 30% were condomless, or 5.86 CAS acts. Despite decreasing their rate of CAS nearly by half, YMSM may be maintaining a comparable level of risk across development. This finding supports previous research that has found no developmental change in raw counts of CAS from adolescence into young adulthood (Kapadia, 2015).

In terms of historical differences, we also found significantly different patterns for ratio of CAS acts for the 2015 cohort. Compared to the 2010 cohort, the 2015 cohort reported a significantly lower ratio of CAS acts at age 17, but significantly higher growth in ratio of CAS acts over time. This suggested that at age 17, this cohort was more likely to use a condom during anal sex, but over time became less likely to in comparison to earlier cohorts. Even though differences were not significant, they also reported higher growth in number of anal sex acts compared to the 2010 cohort. According to our growth models, the 2015 cohort averaged 9.53 anal sex acts at age 17 and 34% were condomless, suggesting an average of 3.24 CAS acts. At age 23, the last age we have sufficient data on this subsample, our models predict a mean of 21.77 anal sex acts and 40% of those condomless, or 8.71 CAS acts. If this same trajectory continues for this cohort, at age 26 we would estimate 27.89 anal sex acts and 43%, or 11.99 acts, would be condomless. This pattern points to emerging disparities in condom usage that could grow worse for future cohorts if the reasons for the increases in CAS that we see are not identified and addressed through intervention and prevention efforts.

Participants did not significantly change in the amount of anal sex they reported having with casual partners from late adolescence into adulthood, but they did significantly decrease in the ratio of those acts that were condomless. The results suggest that the older cohorts became less risky with casual partners over time, and may indicate that targeted efforts to increase condom use have been effective for these cohorts, especially within the context of less serious and anonymous partners. However, this pattern did not apply to the most recent 2015 cohort, who reported the lowest ratio of CAS with casual partners at age 17, but did not decrease in their ratio of CAS acts as they transitioned into adulthood. If the same pattern continues for this cohort as they get older, they will engage in higher rates of CAS with casual partners than either of the previous cohorts when they reach older ages. These results suggest that the developmental mechanisms that led to a decrease in unsafe sex for the older cohorts are either less effective or less applicable to this newer cohort. Alternatively, because the 2015 cohort started out with higher condom use at younger ages, it could be reflective of a ceiling effect that has left less room for improvement compared to the earlier cohorts who reported that a higher ratio of their anal sex acts were condomless at age 17. The lower rate of decrease for the 2007 cohort compared to the 2010 cohort (decrease of 1% vs. 4% every six months) from a significantly lower ratio of CAS at age 17 compared to the 2010 cohort (47% vs. 61%) also supports the possibility of a ceiling effect.

Anal sex acts with serious partners did significantly increase over the transition from adolescence into adulthood. This aligns with expectations that serious partnerships become more common as participants become older. Ratio of CAS with serious partners did not

significantly change over the transition which suggested that condom use did not increase along with anal sex acts, and could indicate serious partnerships as an area of increasing sexual risk. Participants in the 2015 cohort reported significantly higher growth in ratio of CAS with serious partners compared to the older cohorts, and was the one cohort that actually increased in CAS ratio as they got older. The 2015 cohort consistently reported the highest engagement in CAS with serious partners over time. All three cohorts reported similar numbers of serious partners at baseline and a similar likelihood of having a serious partner prior to age 18 which might suggest that this difference is more attributable to an increase in CAS acts within partnerships than a difference in number of serious partners. The higher levels of CAS within the context of serious partnerships for the 2015 cohort may reflect changing norms for this younger generation.

At first glance, the finding that YMSM engage in a higher ratio of CAS with casual partners compared to serious partners (61% vs 42% at age 17) does not agree with past research conducted with the 2007 cohort (Mustanski, Newcomb, & Clerkin, 2011) and with the 2010 cohort (Newcomb, Ryan, Garofalo, & Mustanski, 2014) that found that the highest number of CAS acts occurred in the context of serious partnerships. However, those prior studies used total number of CAS acts as their outcome and did not look at ratio of CAS acts. When we consider the separate findings of the current study that YMSM from those earlier cohorts had a lower ratio of CAS with serious partners but a higher number of anal sex acts with those partners, the discrepancy disappears, and we find that most CAS acts occur in serious partnerships, despite the lower ratio of CAS, because YMSM are having more sex with serious partners.

Racial/ethnic differences were found in analyses of ratio of CAS acts. Black YMSM reported lower growth in percentage of acts that were condomless compared to both White and Hispanic/Latino YMSM. This is similar to past research that has found Black YMSM to engage in less sexual risk (Clerkin et al., 2011; Millett et al., 2007; Newcomb & Mustanski, 2013) and to experience a greater decline in CAS acts compared to White YMSM (Kapadia et al., 2015).

In addition to reporting higher growth in percentage of overall CAS compared to Black YMSM, White YMSM also reported higher growth specifically with casual partners. This may reflect changing norms within this particular subgroup, and in particular, it may reflect the greater access to PrEP that White MSM have compared to other racial/ethnic groups of MSM (Doblecki-Lewis et al., 2017). For Hispanic/Latino YMSM, growth in ratio of CAS acts was higher in the context of both casual and serious partnerships compared to Black YMSM. Recent data has suggested that HIV incidence rates are increasing among Hispanic/Latino YMSM (CDC, 2016). Higher risk taking with both casual and serious partners could be one factor that contributes to the increased incidence rates within this community.

We found that YMSM who identified as bisexual reported a lower ratio of CAS acts at age 17 with serious partners compared to gay-identifying participants. The current results are in line with previous research that has found bisexual men to be less likely to engage in CAS compared to their gay counterparts (Friedman et al., 2014; Rosenberger et al., 2012). However, we did not find that bisexual status was associated with CAS within casual

partnerships or change in ratio of CAS over time. The lower ratios of CAS that they report within serious partnerships at age 17 may reflect differences in when bisexual-identifying YMSM engage in serious relationships with same-sex partners, such as coming out later, or a greater caution with serious same-sex partners early on compared to gay-identifying YMSM. Future research should further explore adolescent differences in sexual practices and risk-taking between bisexual and gay adolescents.

The current study has important implications for efforts to curb sexual risk-taking in YMSM. Based on the results of our study, when YMSM in the most recent cohort engaged in anal sex acts during adolescence they were much more likely to use a condom compared to the previous cohorts. However, instead of maintaining this lower ratio, they exhibited a relative increase in CAS. These cohort differences may be interpreted in the context of historic changes in the LGBT community over the last decade, especially as they apply to large metropolitan cities, like Chicago, where the current sample was recruited. First, societal and political acceptance of LGBT individuals has continued to improve, particularly in moderate-to-liberal parts of the country (Flores & Barclay, 2016; Kreitzer, Hamilton, & Tolbert, 2014). As a result, teenage YMSM in the 2015 cohort may have had more opportunities to learn about safer sex at a younger age, which would explain their lower ratios of CAS during their teenage years. Alternatively, those YMSM from earlier cohorts who were able to come out during what was a relatively less accepting historical context may have had to navigate more challenging sexual situations due to a relative lack of available partners that could also increase likelihood of CAS (e.g., sex with older partners). The rise in popularity of phone apps for finding sexual partners, such as Grindr, may also be changing how newer cohorts of YMSM identify and negotiate condom use with sexual partners in their teen years. With regard to change over time, the rise of PrEP as a prevention strategy over the last several years may have also changed community norms about condomless sex (Bavinton et al., 2016; Newcomb, Mongrella, Weis, McMillen, & Mustanski, 2016; Storholm, Volk, Marcus, Silverberg, & Satre, 2017). The changing norms are likely to impact younger people the most, which might explain the sharper rise in CAS in the 2015 cohort (Newcomb, Moran, Feinstein, Forscher, & Mustanski, 2018). If this trend continues, the younger YMSM may pass those in the older cohorts, thus placing them at highest risk for HIV infection, especially as they enter the 25–34 age group that is currently at the highest risk for new infections. The continuation of the current pattern predicted in these models, if it occurs, could hint at even higher rates of infection for 25–34 year old YMSM than what currently occurs. Increased adoption of PrEP taken as directed could mitigate this potential future HIV risk, but not risk of other STIs. This suggests we may be in a crucial period for campaigns and interventions to continue to encourage safe sex practices.

We also found that most anal sex acts occurred in the context of serious relationships and this was an area where rates of condomless sex remained more stable over time compared to CAS with casual partners. Developmentally, serious relationships become more normative and longer in duration as people age (Arnett, 1998; Arnett, 2000), which might explain the significant rise in counts of anal sex within serious relationships and the stability in ratios of CAS acts. YMSM in the 2015 cohort had the highest increases in ratio of anal sex and CAS in serious relationships compared to the other cohorts. This could be an early indication that

norms about being in serious relationships may be changing. It could also have implications for HIV prevention insofar as we know that most new HIV infections among YMSM occur in the context of serious relationships (Sullivan, Salazar, Buchbinder, & Sanchez, 2009).

The present study included a number of important limitations. We used individually-varying time scores to account for differences in age at baseline and differences in assessment schedules. Individually-varying time scores made it easier to compare cohorts over time and to adjust for age differences within our models (Mehta & West, 2000; Sterba, 2014), but the downside of this approach is that every age did not have equal coverage, so estimates might be less precise for data points at the youngest and oldest ages included in the study. The current study also focused on aggregate measures of CAS to model change across the late-adolescent to young adulthood period. Previous research has indicated that the decision to engage in condomless sex for YMSM is influenced by event and partner-level factors (e.g., substance use before sex, partner age, partner HIV status, etc.) that were not included in the current study. These factors were measured in each study but challenges in harmonizing the data across the studies for these factors led to their exclusion. Future research should seek to include these predictors in order to understand the effects of contextual factors on CAS trajectories. The 2015 cohort had a lower percentage of Black participants and a higher percentage of White and Latino/Hispanic participants compared to the 2010 and 2007 cohorts. The effects of race were controlled for in all models, but the racial/ethnic differences may be indicative of additional differences between the cohorts that could not be adjusted for that could have influenced the results we found. Finally, the cohorts from the current study were recruited from a single metropolitan area, and the results we found could reflect changes unique to YMSM in the Chicago area. Specifically, our findings may be less likely to generalize to socially conservative or rural areas where political and cultural acceptance of LGBT people may change more slowly over time (Kreitzer et al., 2014) and access to medications such as PrEP are more limited (Li et al., 2018).

Future research on changes in CAS engagement should continue to follow YMSM further into adulthood and recruit new cohorts to follow at younger ages. The current study illustrates how YMSM change in their ratio of CAS over time and how cohorts only five years apart can have different patterns of change. Continuing to follow YMSM and recruit new cohorts will inform researchers on how patterns continue to shift and if newer cohorts continue to follow different trajectories from their predecessors. Researchers should also attempt to understand why this most recent cohort was different from past cohorts, including what factors have successfully encouraged YMSM to adopt higher rates of condom use in adolescence and what factors may be encouraging them to reduce their rates of condom use as they get older.

The present study illustrates how condomless anal sex trajectories change over time in YMSM from the ages of 17 to 26. It also shows that trajectories of CAS are different for a cohort recruited in 2015 compared to past cohorts recruited in 2010 and 2007. YMSM who have reached late adolescence or early adulthood by the time of the 2015 recruitment have come of age in a rapidly changing landscape for LGBT rights and HIV/STI risk prevention. The significant differences in ratios of CAS, including lower ratios at age 17 and higher growth in CAS over time, for this cohort suggest that understanding the effects of that rapid

change is necessary for tailoring prevention efforts to current and future generations of YMSM.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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FIGURE 1: Change in Number of Anal Sex Acts from Ages 17 to 26

Notes: For 2015 Cohort, estimates past age 23 are denoted with a dashed line to indicate that this sample has not yet provided data for ages 24–26 and that trajectories beyond age 23 are speculative.

FIGURE 2: Change in Ratio of Condomless Anal Sex Acts from Ages 17 to 26

Notes: For 2015 Cohort, estimates past age 23 are denoted with a dashed line to indicate that this sample has not yet provided data for ages 24–26 and that trajectories beyond age 23 are speculative.

TABLE 1:

Model Fit Statistics

	Intercept Only		Intercept & Slope		Intercept, Slope, & Quadratic	
	AIC	BIC	AIC	BIC	AIC	BIC
Anal Sex Acts	49299.16	49349.30	49090.49	49190.77	49034.10	49189.53
Casual Anal Sex Acts	27850.67	27900.24	27855.37	27954.52	27745.86	27899.54
Serious Anal Sex Acts	31273.22	31321.59	31103.99	31200.74	31071.39	31221.35
CAS Ratio	5776.19	5826.33	5667.92	5768.20	5637.44	5792.87
Casual CAS Ratio	4316.60	4366.18	4223.13	4322.28	4205.00	4358.68
Serious CAS Ratio	3654.26	3702.63	3585.33	3682.07	3567.30	3717.26

Notes: Best-fitting model in bold.

Table II:

Latent Growth Curve Model for Number of Anal Sex Acts

	All Anal Sex Acts				Acts with Casual Partners				Acts with Serious Partners			
	Intercept		Slope		Intercept		Slope		Intercept		Slope	
	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value
Mean	10.17(2.26)	<001	1.04 (.57)	0.068	4.94 (1.06)	<001	-.48 (.69)	0.487	9.54 (2.85)	0.001	1.86 (.78)	0.017
Variance	355.75 (28.49)	<001	15.43 (1.77)	<001	6.05 (3.38)	0.073	14.43 (2.19)	<001	313.50 (41.41)	<001	20.43 (2.86)	<001
Cohort: 2010 (referent)	-	-	-	-	-	-	-	-	-	-	-	-
Cohort: 2007	-3.91 (3.62)	0.279	1.22 (.72)	0.089	-3.16 (3.38)	0.350	1.01 (1.59)	0.527	-3.76 (4.34)	0.386	1.26 (.99)	0.202
Cohort: 2015	-.64 (3.50)	0.856	1.00 (1.04)	0.337	-1.09 (1.66)	0.514	.64 (1.49)	0.668	.70 (4.28)	0.87	1.53 (1.31)	0.245
Sexual Orientation: Gay (referent)	-	-	-	-	-	-	-	-	-	-	-	-
Sexual Orientation: Bisexual	-3.61 (3.54)	0.308	-.95 (.98)	0.324	-1.55 (2.00)	0.439	.57 (1.17)	0.625	-5.80 (4.31)	0.179	-1.47 (1.30)	0.259
Sexual Orientation: Other	-3.91 (4.35)	0.369	-.12 (1.12)	0.912	-4.15 (3.56)	0.244	3.96 (1.88)	0.035	-7.10 (6.80)	0.296	-.94 (1.67)	0.573
Race/Ethnicity: Black (referent)	-	-	-	-	-	-	-	-	-	-	-	-
Race/Ethnicity: White	2.77 (3.25)	0.395	-.33 (.87)	0.704	-1.10 (1.84)	0.549	.56 (1.14)	0.624	5.42 (4.10)	0.186	-.36 (1.14)	0.752
Race/Ethnicity: Hispanic/Latino	5.19(3.08)	0.092	-.14 (.85)	0.871	-1.16 (1.44)	0.421	1.44 (.91)	0.112	7.36 (3.89)	0.059	-.19 (1.15)	0.866
Race/Ethnicity: Other	3.12(3.63)	0.391	-.13 (.99)	0.896	.94 (2.42)	0.696	.08 (1.38)	0.956	6.55 (4.74)	0.167	-.42 (1.42)	0.766
Intercept-Slope Covariance	-40.98 (6.41)	<001			-7.23 (2.76)	0.009			-26.95 (9.72)	0.006		

Table III:

Latent Growth Curve Model for Ratio of Condomless Anal Sex Acts

	All CAS Acts			Acts with Casual Partners			Acts with Serious Partners		
	Intercept	Slope		Intercept	Slope		Intercept	Slope	
	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	Beta (SE)	p-value	p-value
Mean	.57 (.03)	<.001	-.03 (.01)	<.001	.61 (.03)	<.001	.42 (.04)	<.001	.01 (.01) .003
Variance	.09 (.01)	<.001	.003 (.001)	<.001	.08 (.02)	<.001	.10 (.02)	<.001	.001
Cohort: 2010 (referent)	-	-	-	-	-	-	-	-	-
Cohort: 2007	-.04 (.05)	0.480	.01 (.01)	0.457	-.14 (.05)	0.006	.03 (.01)	0.012	-.01 (.01)
Cohort: 2015	-.23 (.04)	<.001	.04 (.01)	0.001	-.34 (.05)	<.001	.05 (.02)	0.001	.03 (.02)
Sexual Orientation: Gay	-	-	-	-	-	-	-	-	-
Sexual Orientation: Bisexual	-.03 (.04)	0.415	-.01 (.01)	0.349	.00 (.04)	0.939	-.01 (.01)	0.333	-.01 (.01)
Sexual Orientation: Other	-.14 (.08)	0.069	.01 (.02)	0.575	-.11 (.07)	0.113	.02 (.02)	0.356	.01 (.03)
Race/Ethnicity: Black (referent)	-	-	-	-	-	-	-	-	-
Race/Ethnicity: White	-.05 (.04)	0.218	.02 (.01)	0.032	-.07 (.05)	0.144	.03 (.01)	0.014	.02 (.01)
Race/Ethnicity: Hispanic/Latino	-.07 (.04)	0.076	.03 (.01)	0.004	-.08 (.05)	0.063	.03 (.01)	0.017	.04 (.01)
Race/Ethnicity: Other	.04 (.05)	0.496	.00 (.01)	0.826	.07 (.06)	0.197	-.01 (.01)	0.446	.01 (.02)
Intercept-Slope Covariance	-.01 (.00)	<.001			-.01 (.00)	<.001	-.01 (.00)	<.001	