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Developmental Changes in Sexual Risk and Substance Use among African American Females: An Integrated Data Analysis Approach using Time-Varying Effect Models

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Abstract

Introduction: The aim of this study was to describe age-related changes in sexual risk and substance use using existing data from three HIV/sexually transmitted infection (STI) prevention trials conducted in Atlanta, Georgia, that enrolled young African American women. We used two novel analysis methods: integrative data analysis (IDA) and time-varying effect models (TVEM).

Methods: Each trial collected self-reported behavioral data and vaginal swab specimens assayed for chlamydia, gonorrhea, and trichomonas. Baseline data from all participants and follow-up data from participants not randomized to an active intervention arm were integrated in a pooled dataset using an IDA approach. The pooled dataset included observations for 1,974 individuals, aged 14–25 years for behavioral outcomes and 16–25 years for STI outcomes. We used TVEM to model age-related changes in sexual risk and substance use behaviors and STI acquisition, adjusting for trial as a fixed effect.

Results: Coital frequency and condomless sex increased through the early 20s while multiple partnerships remained fairly steady. Alcohol use and cigarette smoking increased through about age 24 years before declining. Marijuana use peaked at age 16–17 years and thereafter generally declined. STI acquisition was highest at age 16 years.

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Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human subjects were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the studies from which the data were obtained.

Conclusions: This study demonstrates the feasibility and utility of innovative methodological techniques to address novel questions related to adolescent development using existing data from multiple trials. The results suggest that mid-adolescence and the early 20s may be periods of particular risk. The findings may be useful for timing culturally and developmentally relevant prevention interventions for young African American women.

Keywords

Integrated data analysis; Time-varying effect models; African American; Women; Sexual risk; Substance use

Young African American women have disproportionate risk for HIV and sexually transmitted infections (STIs) (Centers for Disease Control and Prevention, 2017a, 2017b). African Americans account for two-thirds of new HIV infections among women in the United States (U.S.); African Americans in the South are particularly affected (Centers for Disease Control and Prevention, 2017b). Nationally, gonorrhea and chlamydia rates are highest among African American women aged 15–24 years (Centers for Disease Control and Prevention, 2017b). Young African American women also have disproportionate risk of *Trichomonas vaginalis* (Koumans et al., 2007; Miller et al., 2005). These STIs are associated with increased HIV acquisition (Centers for Disease Control and Prevention, 2017b; Miller et al., 2005). Certain sexual behaviors, including higher frequency of intercourse, sex without a condom, and having multiple sex partners increase HIV/STI risk, particularly in geographic areas with high rates of HIV and other STIs, like the Southern U.S. (Centers for Disease Control and Prevention, 2017a, 2017b). Substance use, even at low levels, is strongly associated with HIV/STI risk among young African American women (Seth et al., 2011; Swartzendruber, Sales, Brown, DiClemente, & Rose, 2016). Adolescent substance use is also associated with a range of other adverse outcomes, including adult dependence, lower educational attainment, relationship problems, mental health problems, trouble with the law, and overdose death (Hall et al., 2016).

Sexual risk behavior and substance use change dramatically during adolescence and emerging adulthood (Sales et al., 2012). Adolescence is marked by identity explorations, increasing independence from family, expanding social networks, pursuit of new experiences, and initiation intimate relationships. Initiation of sexual activity during adolescence is exceedingly common and developmentally appropriate. Engagement in substance use is also highly prevalent during adolescence and young adulthood and subject to developmental influences. However, sexual risk behaviors and substance use can have significant health consequences, and African Americans are more likely to experience long-term negative consequences (Centers for Disease Control and Prevention, 2017a, 2017b; Keyes et al., 2015). As young people mature and contextual factors change, engagement in risk behaviors may change considerably. For example, engagement in some risk behaviors early in adolescence, such as having multiple sex partners, may be associated with reduced levels of engagement as young people form more adult identities and assume new and greater responsibilities associated with young adulthood. In contrast, some behaviors, such as alcohol use, may become more common as young people age; gain more independence; encounter new situations, responsibilities, and stressors; and perceive social norms

supportive of alcohol use. Understanding age-related changes in sexual and substance use behavior and factors that contribute to these changes may reveal critical periods of risk, highlight optimal ages for administering prevention interventions, identify new intervention targets, and may aid development and implementation of developmentally appropriate prevention interventions.

Few studies have examined sexual risk and substance use across the dynamic course of adolescence through emerging adulthood, however. Moreover, despite racial and gender differences in substance use trajectories (T. L. Brown, Flory, Lynam, Leukefeld, & Clayton, 2004; Chen & Jacobson, 2012; Kandel, Schaffran, Hu, & Thomas, 2011) and marked HIV/STI disparities (Centers for Disease Control and Prevention, 2017b), no studies have investigated age-related changes in substance use and HIV/STI risk during the full period of adolescent development through emerging adulthood exclusively among African American females. The vast majority of studies investigating substance use and HIV/STI risk among young people have used cross-sectional data or longitudinal data over a short period of time (Duncan, Strycker, & Duncan, 1999; Guo et al., 2002). Although informative, such studies provide limited knowledge about age-related changes important for understanding healthy development, critical periods of risk, and optimal timing of prevention interventions. The few studies that have assessed substance use or HIV/STI risk over a longer duration included both males and females (Duncan et al., 1999; Fergus, Zimmerman, & Caldwell, 2007; Guo et al., 2002; Huang, Lanza, Murphy, & Hser, 2012; Keyes et al., 2015; Vasilenko, 2017; Vasilenko & Lanza, 2014) with African Americans accounting for a minority of the sample in most (Duncan et al., 1999; Guo et al., 2002; Huang et al., 2012; Keyes et al., 2015; Vasilenko, 2017; Vasilenko & Lanza, 2014) but not all (Fergus et al., 2007) studies. Other studies that disaggregated by sex and race relied solely on self-reported data. This study attempts to address current gaps in the literature and provide findings with translational significance for implementing gender- and developmentally-appropriate prevention interventions for young African American women who are at particularly high risk for HIV, STIs, and other adverse health outcomes related to substance use. The study used existing data from three HIV/STI prevention intervention trials conducted in Atlanta, Georgia, that enrolled young African American women and two novel data analysis techniques: integrative data analysis (IDA) and time-varying effect models (TVEM).

IDA is an economical and efficient approach that allows for analysis of multiple original datasets that have been pooled into single dataset with harmonized variables (C. Brown et al., 2013; Curran & Hussong, 2009; Hussong, Curran, & Bauer, 2013). IDA can increase statistical power, extend the age span beyond that of a single study, and be used to test novel questions. TVEM is an innovative, flexible technique for examining developmentally-dependent outcomes over continuous time (Li et al., 2015). The objectives of this study were to present our methods for pooling and harmonizing data across three HIV/STI prevention trials using an IDA approach and to describe age-related changes in sexual risk and substance use behavior and STI acquisition using TVEM.

Methods

Participants and Procedures

This study utilized data from young African American women who participated in one of three randomized controlled trials, HORIZONS (DiClemente et al., 2004), Afiya (DiClemente et al., 2014), and N-LITEN (Swartzendruber, Sales, Rose, & DiClemente, 2016). Table 1 presents details about each trial. The trials were conducted in Atlanta, GA, and tested the efficacy of behavioral HIV/STI prevention interventions designed for young African American women. Participants were aged 14 to 24 years upon enrollment. The duration of follow-up post-intervention ranged from 12 to 36 months. At each assessment, participants provided self-reported behavioral data via audio computer-assisted self-interviews and self-collected vaginal swab specimens assayed for *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and *Trichomonas vaginalis* at a single laboratory. Specimens were assayed for *T. vaginalis* through the 18-month assessment visit in the AFIYA trial (DiClemente et al., 2014). Retention was at least 89% in each trial. There were no overall differences in attrition by trial arm. In addition, attrition did not differ by participants' baseline sociodemographic characteristics or behaviors. For this analysis, we pooled baseline data from all participants and follow-up data from participants assigned to standard of care control conditions to create an IDA dataset. Table 2 presents baseline sociodemographic characteristics by study.

Measures

Monthly frequency of vaginal sex.—At each assessment, all trials asked, “*In the past [time period], how many times did you have vaginal sex?*” HORIZONS asked this question in reference to the past 60 days, AFIYA the past 90 days, and N-LITEN the past 3 months. To create a composite measure of vaginal sex in the past month, we divided HORIZONS responses by 2 and AFIYA and N-LITEN responses by 3. The final harmonized variable was a continuous measure of the number of episodes of vaginal sex per month.

Condomless sex.—All trials assessed condom use at last sex. HORIZONS asked, “The very last time you had sex, did you use protection?” Participants who endorsed using protection were then asked to indicate all types of protection used, including male condoms. Individuals who did not endorse using protection or did not indicate using condoms were assigned a value of 1. Individuals who indicated they used condoms during last sex were assigned a value of 0. Both AFIYA and N-LITEN asked, “*The very last time you had sex, did you use a condom to prevent STDs or pregnancy?*” Individuals who replied *Yes* were assigned a value of 0 and those who replied *No* were assigned a value of 1. The final harmonized variable was coded 1 for reporting condomless sex during the last episode of vaginal sex and 0 for reporting condom use.

Multiple sex partners.—At each assessment all trials asked, “*In the past [time period], how many guys have you had vaginal sex with?*” HORIZONS asked this question in reference to the past 60 days, AFIYA the past 90 days, and N-LITEN the past 3 months. In order to create a composite measure of monthly number of vaginal sex partners, we divided HORIZONS responses by 2 and AFIYA and N-LITEN responses by 3. Monthly number of

sex partners of 1 or less were assigned a value of 0 and those greater than 1 were assigned a value of 1. The final harmonized variable was coded 1 for reporting sex with multiple partners and 0 for not having sex with multiple partners.

Monthly alcohol use quantity.—This measure was calculated using data about frequency of alcohol use and amount of alcohol typically consumed. At each assessment, HORIZONS and AFIYA asked, “*In the past [time period], how many days have you used alcohol?*” HORIZONS asked this question in reference to the past 60 days and AFIYA the past 90 days. N-LITEN asked, “*How often do you have a drink containing alcohol?*” Response options included: *Never, Monthly or less, 2–4 times a month, 2–3 times a week, and 4 or more times a week.* A measure of monthly alcohol frequency was created by dividing HORIZONS and AFIYA responses by 2 and 3, respectively. N-LITEN responses were assigned the value of 0 for *Never*, 1 to *Monthly or less*, 3 to *2–4 times a month*, 10 to *2–3 times a week* (assuming an average of 8–12 times a month), and 16 to *4 or more times a week* (assuming an average of at least 16 times a month).¹

Amount of alcohol consumed was also obtained in each trial. HORIZONS and AFIYA asked, “*How many alcoholic drinks do you usually have at one time?*” Response options in both trials were: 1=One, 2=Two, 3=Three, and 4=Four or more. N-LITEN asked, “*How many drinks containing alcohol do you have on a typical day when you are drinking?*” Response options included: *1 or 2, 3 or 4, 5 or 6, 7 or 9, and 10 or more.* A measure of number of drinks consumed was created by pooling HORIZONS and AFIYA responses and assigning values to the N-LITEN response categories. The value of 1.5 was assigned to N-LITEN responses of *1 or 2*, 3.5 to *3 or 4*, and 4 to *5 or 6, 7 or 9, and 10 or more.*² In each trial, participants who denied lifetime or recent alcohol use were assigned a value of 0. Finally, a harmonized monthly alcohol use quantity measure was created by multiplying the harmonized monthly alcohol frequency and alcohol amount measures. The final harmonized variable was a continuous measure of the number of alcoholic drinks consumed per month.

Recent marijuana use.—At each assessment, HORIZONS and AFIYA asked, “*In the past [time period], how many days have you used marijuana?*” HORIZONS asked this question in reference to the past 60 days and AFIYA the past 90 days. N-LITEN asked, “*In the past month, on how many days did you use marijuana (pot, weed, grass, herb, reefer)?*” Individuals who reported any use on 1 or more days were assigned a value of 1 and those who reporting 0 days were assigned a value of 0. Participants who denied lifetime use of marijuana, asked at each assessment in all 3 trials, were also assigned a value of 0. The final harmonized variable was coded 1 for engagement in recent marijuana use and 0 for no recent marijuana use.

¹Several potential harmonized measures of monthly alcohol frequency were created and assessed. All harmonized alcohol frequency variables divided the HORIZONS and AFIYA responses by 2 and 3, respectively. Different harmonized variables were created after assigning different values to N-LITEN responses. All harmonized measures were found to be highly correlated ($r>0.93$). Therefore, the harmonized variable which used the midpoint of the N-LITEN response categories, was selected.

²Several potential harmonized measures of alcohol amount were created and assessed. All harmonized alcohol amount variables pooled HORIZONS and AFIYA responses but collapsed and assigned different values to N-LITEN responses. The first harmonized alcohol amount measure assigned the value of 1.5 to *1 or 2*, 3.5 to *3 or 4*, and 4 to *5 or 6, 7 or 9, and 10 or more.* The second harmonized measure differed only in the assignment the value of 1 to *1 or 2* and 3 to *3 or 4*. Lastly, a third harmonized variable was created and differed only in the assignment of 2 to *1 or 2* and 4 to *3 or 4*. All harmonized measures were found to be highly correlated ($r>0.93$). Therefore, the first harmonized variable created was selected.

Cigarettes per day.—At each assessment, HORIZONS and AFIYA asked participants, “*How many cigarettes do you smoke a day?*” N-LITEN asked, “*On the days that you smoke, how many cigarettes do you smoke, on average?*” All responses were pooled to create the harmonized measure. HORIZONS and AFIYA participants who responded *No* to “*Do you smoke cigarettes?*” and N-LITEN who responded *No* to “*Have you ever smoked a cigarette?*” were assigned a value of 0. The final harmonized variable was a continuous measure of the number of cigarettes smoked per day.

Bacterial STI acquisition.—An incident bacterial STI was defined as a positive chlamydia and/or gonorrhea test result subsequent to a negative result or documented treatment at the previous assessment.

Trichomonas acquisition.—An incident *T. vaginalis* infection was defined as a positive trichomonas test result subsequent to a negative result or documented treatment at the previous assessment.

Data Analysis

The pooled dataset included observations for 1,974 individuals (age was missing for 2 individuals) and 3,195 person-waves. Time-varying effect modeling was used to examine behavior and risk over chronologic age, coded to the nearest day. Unlike traditional longitudinal models, TVEM does not assume a linear or any parametric change pattern and does not require a fixed time metric. TVEM facilitates examination of dynamic associations by modeling continuous time rather than discrete stages. Furthermore, it allows for multiple measurements per participant in the same way hierarchical linear growth modeling does. For this study, we used the TVEM SAS Macro (version 3.1.0) (Li et al., 2015). We assessed random intercept models using logistic link functions for binary outcomes and Poisson link functions for count outcomes and 10 splitting points. P-spline smoothing was used for all models.

Analysis of each outcome by study showed some heterogeneity across studies, but similar overall trends (data not shown). Graphs of the sexual risk outcomes by trial showed 95% confidence intervals substantially overlapped within the central age ranges and followed similar trends. Confidence intervals for these measures were wider at the youngest and oldest ages and did not overlap due to data sparsity given that single trials contributed data at these extremes of the age range. The substance use measures showed greater heterogeneity across trials. Graphs of the substance use outcomes by trial showed less substantial overlap in the confidence intervals. The alcohol use measure showed the greatest heterogeneity. This may be due to differences in recruitment across studies. For example, an eligibility criterion of the N-LITEN trial was alcohol use on three or more occasions in the past 90 days whereas the other trials had no substance use eligibility criteria. N-LITEN recruited individuals up to 24 years of age versus 20 and 21 years in AFIYA and HORIZONS, respectively. In addition, participants were recruited from community venues in the N-LITEN trial and from reproductive health clinics in the other trials. Despite greater heterogeneity for the substance use measures, overall trends were similar.

All analyses proceeded using data pooled from all 3 trials, controlling for study as a fixed, time-invariant, effect. Results for dichotomous outcomes were converted from odds ratios to proportions. Results are presented as figures. Figures for behavioral outcomes span the entire age range represented in the data (14–25 years, inclusive), whereas figures for the STI acquisition outcomes span ages 16–25 years due to sparse data at younger ages.

Results

Sexual Behavior

Figure 1 presents the results for monthly number of vaginal sex episodes (1a), multiple partners (1b), and condomless sex (1c). Overall, sexual risk behavior increased during adolescence and emerging adulthood. The expected number of vaginal sex episodes per month was lowest at fewer than 2 at age 14 and then steeply rose to a peak of approximately 6 at age 21 and slowly declined through age 25 years. The estimated percentage of participants reporting multiple sex partners increased from a low of about 4% at age 14 to about 10% at age 17 years and stayed around 10% through age 25. The estimated percentage who reported not using condoms at last sex was lowest at 40% at age 14 and increased to approximately 66% by age 25.

Substance Use Behavior

Figure 2 presents the results for monthly alcohol quantity (2a), recent marijuana use (2b), and cigarettes per day (2c). The expected number of alcoholic drinks consumed per month was approximately 1 before age 16 and increased to a peak of almost 4 drinks per month at age 23 before declining. The estimated percentage of participants who reported recent marijuana use generally decreased during adolescence and emerging adulthood but not in a uniform fashion. The estimated proportion reporting recent marijuana use increased from about 31% at age 15 to a peak of about 45% at age 17 and then declined to about 5% at age 25 years. Despite the general decline from age 17 through 25 years, there were small fluctuations at approximate ages 18.5, 20.25, and 23 years. The expected number of cigarettes smoked per day was lowest at almost 0 at age 14 and steadily increased to a peak of about 2.5 around age 24 before declining.

STI Acquisition

Figure 3 presents the results for bacterial STI (3a) and trichomonas (3b) acquisition. The estimated percentage of participants who acquired a bacterial STI generally declined from age 16 through 25 years, with some variations. The percentage with an incident bacterial infection was highest at approximately 27% at age 16 years, declined to about 6% at age 17.25, and rose to about 16% at age 18.25 before declining again to about 5% at age 20 years. After age 20, the percentage rose to approximately 10% at age 22 before reaching its nadir of less than 2% at age 24.5. The estimated percentage with an incident trichomonas infection was relatively stable over time but highest at 17% at age 16. The estimated percentage was then about 8% at age 19 and 10% at age 23.

Discussion

This study demonstrates the feasibility and utility of new methodological techniques to address novel questions related to development during adolescence and emerging adulthood using existing data. Although IDA offers multiple advantages, one particular challenge can be conducting analyses of datasets that collected information at different assessment points. Use of TVEM, which accommodates unequal spacing of measurements within and across individuals, fully addressed this challenge. One challenge of TVEM is the requirement of a large sample. The IDA approach helped to address this challenge by facilitating the integration of data from three existing datasets and increasing the sample size beyond that of a single trial. This study offers unique findings relevant to a highly vulnerable population. The study precisely modeled and statistically tested age-related changes in both sexual and substance use risk across adolescence and emerging adulthood among young African American women. The pooled single gender and single race dataset offered unique strengths to limit bias and aid optimal development and implementation of prevention interventions for young African American women.

We found that the frequency of vaginal sex increased during adolescence through the early 20s. We also found that the percentage reporting condomless sex increased with age but a fairly stable level of multiple partnerships across adolescence and emerging adulthood. Increasing frequency of sex and increasing condomless sex may be related to formation of more stable partnerships. However, having multiple partners was common and consistent among this sample. Overall, our findings suggest that sexual risk behavior may accelerate and peak during emerging adulthood before declining or stabilizing. Few longitudinal studies have assessed sexual risk behavior during both adolescence and emerging adulthood. However, a study conducted among a predominately African American sample in Flint, MI, detected very similar sexual risk behavior patterns during these life periods (Fergus et al., 2007). That study modeled trajectories across assessment waves conducted every four years rather than participant ages as reported in the current study. Our findings are also consistent with a recent nationally-representative study that used TVEM to assess multiple partnerships among sexually active individuals across adolescence and young adulthood (Vasilenko, 2017); however, the proportion reporting multiple partners was generally lower in the current study. Multiple studies have reported increased HIV/STI risk among young African American women despite moderate and low levels of sexual risk behavior, further highlighting the importance of examining and preventing risk among this priority population (Bunnell et al., 1999; Fergus et al., 2007). Early intervention, before or around age 14 years, may help prevent escalation of sexual risk among young African American women. Substantial observed sexual risk at age 14 suggests that prevention interventions designed for African American women younger than age 14 years are warranted. In addition, culturally and developmentally appropriate prevention interventions designed for young African American women in their early 20s may help address peak sexual risk observed during this period. Several efficacious HIV/STI prevention interventions specifically designed for young African American women exist, including the interventions tested in the trials that contributed data for the current study (DiClemente et al., 2004; DiClemente et al.,

2014). Such interventions foster gender and cultural pride, emphasize diverse factors related to HIV/STI risk, and increase knowledge and skills (e.g., condom negotiation).

Alcohol use and cigarette smoking also accelerated during adolescence and peaked during emerging adulthood. Trends in alcohol use detected in the current study appear to be consistent with national trends among females with peak use at about age 23 years before declining (Chen & Jacobson, 2012). In contrast, national trends among African Americans show peak use in the late 20s with a less steep decline thereafter (Chen & Jacobson, 2012). Our study more precisely identifies age-related changes among African American women specifically. The current study's cigarette smoking results are consistent with those from the Flint, MI, study showing cigarette use among females increased in a fairly linear fashion between the ages of 14 and 24 years (Buu, Dabrowska, Heinze, Hsieh, & Zimmerman, 2015). National Add Health data also show increasing cigarette use across adolescence and emerging adulthood among African Americans with peak use at around age 30 (Chen & Jacobson, 2012). TVEM analysis of Add Health data show that peak smoking prevalence among African Americans is lower (31% vs. 44%) and occurs at later age (29 vs. 19 years) as compared to Whites (Evans-Polce, Vasilenko, & Lanza, 2015). Despite typically lower levels of substance use as compared to Whites, young African Americans are more likely to experience long-term negative health consequences (Keyes et al., 2015). Developmental factors that may be related to observed alcohol use and cigarette smoking trajectories (increasing use through adolescence and emerging adulthood followed by declines) could include use of these substances in pursuit of new experiences and sensation-seeking, which evidence suggests follows a similar trajectory (Shulman, Harden, Chein, & Steinberg, 2015). The observed trajectories could also be explained by substance use as a means of coping with changing contexts and greater social and impulse control and assumption of more adult responsibilities and social roles in the mid 20s. Interventions administered before or around age 14 years may help to prevent escalation of engagement in alcohol use and cigarette smoking among young African American women. Evidence suggests that parental influences may be salient determinants of substance use avoidance among African American adolescents (Resnicow, Soler, Braithwaite, Ahluwalia, & Butler, 2000). Multiple interventions designed to address substance use among African American adolescents and young African American women, specifically, have been found to be efficacious, including family-centered (Brody, Murry, Chen, Kogan, & Brown, 2006) and mother-daughter intervention approaches (Schinke, Fang, Cole, & Cohen-Cutler, 2011). Interventions to address peak use in the early 20s also appear warranted.

The overall trend detected for marijuana use contrasts the trends observed for alcohol and cigarette use. However, the general trend of increasing use followed by declining levels over a longer duration is consistent with findings from two recent national studies that also used TVEM to examine marijuana use among young people (Evans-Polce et al., 2015; Lanza, Vasilenko, & Russell, 2016). However, we observed higher percentages of use at all ages and younger age of peak use as compared to females and African Americans overall (Evans-Polce et al., 2015; Lanza et al., 2016). This study contributes urgently needed knowledge given increasing marijuana rates among African Americans in recent years (Miech, Johnston, O'malley, Bachman, & Schulenberg, 2016). Prevention interventions implemented before age 14 years and for 14–17 year olds may be optimally timed to address high and

increasing levels of marijuana use among by young African American women during these ages.

To our knowledge, this is the first study to use TVEM to assess STI acquisition or any biologic outcome by age. Further, this study makes a significant contribution by providing age-related findings about *T. vaginalis* acquisition. Despite being the most common curable STI and its recognized role in individual- and population-level HIV transmission dynamics, *T. vaginalis* remains a vastly understudied STI. Few studies have examined *T. vaginalis* acquisition. Although prevalence has been shown to increase with age among young women (Helms et al., 2008; Miller et al., 2005), studies that have investigated incidence among young women have not identified differences by age (Fortenberry et al., 1999; Helms et al., 2008; Krashin et al., 2010). Although our findings suggest that *T. vaginalis* acquisition may be highest among younger adolescents, we found relatively stable levels of acquisition through emerging adulthood. Further research to describe *T. vaginalis* epidemiology, particularly among African American women, is needed. Our study found that acquisition of bacterial STIs was highest at age 16. Younger females may be particularly vulnerable to these infections due to immature cervixes with large areas of cervical ectopy. Prevention interventions, particularly for young African American women younger than age 16 years, appear warranted. Our findings also highlight STI screening and treatment needs of young African American women.

The study has a number of limitations. The findings may not be generalizable to young African American women in other geographic regions. However, use of data from participants recruited from both clinic and community venues potentially increases the degree of generalizability to other high-risk young African American women in the urban South. Other limitations include reliance on single-item measures of some behaviors and the possibility of age-related changes in reporting behavior. Although harmonization may have reduced precision inherent in the individual trials, it increased overall sample size and facilitated developmental analyses. In addition, findings at the youngest and oldest ages may be subject to cohort effects given that data at the age extremes were contributed by individual trials.

Despite these limitations, this study demonstrates the use of innovative methodologic techniques to enhance understanding of age-varying outcomes using existing data from multiple trials. The study had a number of strengths to limit bias. We utilized three HIV/STI trials for African American female adolescents in the South conducted by a single investigator. Each trial achieved high retention and attrition did not differ by baseline characteristics. In addition, each trial used highly similar data collection methods: audio computer-assisted self-interviews, similar empirically validated and culturally appropriate measures of sexual risk and drug use behaviors, and biologic samples assayed for chlamydia, gonorrhea and trichomonas, the three most common curable STIs, using DNA amplification at a single lab using identical procedures. The homogeneity and size of the sample offered a high degree of validity.

The study's approach facilitated precise examination of age-related changes in sexual risk and substance use from adolescence through emerging adulthood and identification of

particular periods of risk, which may be useful for strengthening and designing optimally timed and developmentally appropriate prevention interventions. In summary, we found that coital frequency, condomless sex, and alcohol and cigarette use were lowest at age 14 years and increased through ages 22–24. The percentage reporting multiple partners was fairly stable, but lowest at age 14. Marijuana use peaked at age 16–17 years before declining, and STI acquisition was highest at age 16 years. Based on these findings, early intervention, before or through age 14 years, may be useful for preventing escalation of sexual risk and substance use among young African American women. Interventions aimed at reducing peak levels of marijuana use and STI acquisition at around age 16 years and peak levels of sexual risk behavior and alcohol and cigarette use in the early 20s may also be warranted. Given their co-occurrence and strong associations between substance use and sexual risk, programs that target both sexual risk and substance use may be especially helpful. Examining factors that contribute to increases, decreases, or stability of sexual risk and substance use during adolescence and emerging adulthood could facilitate identification of effective intervention targets. Studies that assess age-varying associations between substance use and sexual risk may be helpful for defining priority sub-populations and tailoring intervention strategies. Ultimately, a more detailed understanding about age-related risks and protective factors may enhance precision and efficacy of prevention programs designed for adolescents and emerging adults.

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Fig. 1. Sexual behaviors from age 14 through 25 years among African American females in the urban South at high risk for HIV

Note: Gray lines indicate 95% confidence intervals.

Fig. 2.

Substance use behaviors from age 14 through 25 years among African American females in the urban South at high risk for HIV

Note: Gray lines indicate 95% confidence intervals.

3a. Bacterial STI **3b. Trichomonas** **Fig. 3.**

STI acquisition from age 16 through 25 years among African American females in the urban South at high risk for HIV

Note: Gray lines indicate 95% confidence intervals.

Characteristics of the three HIV prevention interventions that were pooled, harmonized, and analyzed

Table 1

Study	Recruitment dates	Recruitment venues	N	Baseline (BL) eligibility criteria	Assessment visits (months) ^a	Trial conditions (number randomized to each condition)	Retention ^b
HORIZONS(DiClemente et al., 2004)	03/2002 – 08/2004	Reproductive health clinics	715	<ul style="list-style-type: none"> Self-identify as an African American female Age 15–21 years Vaginal intercourse in past 60 days Not married, currently pregnant, or attempting to become pregnant 	BL, 6, 12	<ul style="list-style-type: none"> Standard of care (367) HORIZONS (348) 	91%
AFIYA (DiClemente et al., 2014)	01/2005 – 06/2007	Reproductive health clinics	701	<ul style="list-style-type: none"> Self-identify as an African American female Age 14–20 years At least one episode of vaginal sex without a condom in past 6 months Not married, currently pregnant, or attempting to become pregnant 	BL, 6, 12, 18, 24, 30, 36	<ul style="list-style-type: none"> HORIZONS (359) HORIZONS+ supplemental calls (342) 	89%
N-LITEN (Swartzendruber, Sales, Rose, et al., 2016)	01/2012 – 02/2014	Community venues	560	<ul style="list-style-type: none"> Self-identify as an African American female Age 18–24 years At least one episode of vaginal sex without a condom in past 90 days Alcohol use on 3 or more occasions in last 90 days Not currently married or pregnant 	BL, 3, 6, 9, 12	<ul style="list-style-type: none"> Standard of care (185) HORIZONS (190) HORIZONS + group motivational enhancement therapy (185) 	>90%

^aMonths post intervention completion, BL: Baseline;

^bCompleted at least 1 follow-up assessment

Table 2

Baseline participant sociodemographic characteristics in the three HIV prevention interventions

Sociodemographic Characteristics	HORIZONS	AFIYA	N-LITEN
Age, mean (SD), years	17.7 (1.7)	17.6 (1.7)	20.6 (1.9)
Graduated high school, % (n)	31.1 (221)	34.8 (244)	66.1 (370)
Had a paid job, % (n)	29.4 (210)	36.4 (255)	27.1 (152)
Lived in a household that received at least one form of governmental assistance ^a , % (n)	52.2 (373)	51.9 (364)	85.0 (476)

^aIncludes: Welfare (including Temporary Assistance to Needy Families or Supplemental Security Income); food stamps; Women, Infants and Children supplemental nutrition benefits; Section 8 housing subsidies