

https://dspace.org/

Developmental Trajectories of Transactional Sex and AgeDisparate Relationships During Adolescence An HPTN 068 Analysis

N. L Bhushan; K. B Rucinski; M. C. D Stoner; S. M DeLong; E et al ...

https://hdl.handle.net/10539/44102
WOS

Downloaded from a DSpace repository. https://dspace.org/

AIDS and Behavior (2024) 28:4274–4282
https://doi.org/10.1007/s10461-024-04470-4

ORIGINAL PAPER

Developmental Trajectories of Transactional Sex and Age-Disparate Relationships During Adolescence: An HPTN 068 Analysis

Nivedita L. Bhushan[1] · Katherine B. Rucinski[2] · Marie C. D. Stoner[3] · Stephanie M. DeLong[4] · F. X. Gómez-Olivé[5] · Kathleen Khan[5] · Rhian Twine[5] · Sheree R. Schwartz[4] · Audrey E. Pettifor[6]

Accepted: 16 August 2024 / Published online: 3 September 2024
© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2024

Abstract

Transactional sex and sexual relationships with older partners increase HIV risk in adolescent girls and young women (AGYW), yet little is known about how these behaviors co-evolve over time. We characterize temporal patterns of transactional sex and age-disparate relationships among AGYW in South Africa. Longitudinal data are from a randomized controlled trial (HPTN 068) of school-aged, HIV-negative, AGYW who attended ≥ 3 study visits. We used group-based trajectory modeling to identify trajectories of transactional sex and age-disparate relationships (partner ≥ 5 years older) in the last year and assessed the interrelationship (conditional probability) between both trajectories. At baseline, median age was 14 years, 14.5% of girls were sexually active, and transactional sex (2.1%) and age-disparate relationships were uncommon (2.7%). We identified two trajectories for transactional sex ("low" [81.9%] and "increasing" [18.1%]) and two for age-disparate relationships ("low" [91.7%] and "increasing" [8.3%]). In a separate joint trajectory analysis, nearly a third (28%) had increasing trajectories for both transactional sex and age-disparate relationships, but most (53%) had a low trajectory of both outcomes. Baseline reporting of early sexual debut, depression, and inequitable gender norms were highest in the increasing transactional sex group. Prior pregnancy, early sexual debut, and IPV were highest among those with increasing age-disparate relationships. AGYW who engage in transactional sex or age-disparate partnerships in early adolescence are more likely to experience sustained engagement in both behaviors as they transition to adulthood, increasing HIV risk. Engaging girls early may maximize effectiveness of behavioral and biomedical HIV prevention efforts.

Keywords Adolescents; age-disparate Partnerships · Transactional sex · HIV · Developmental Trajectories

Introduction

Over the last two decades, there has been a substantial decline in HIV incidence across most countries in sub-Saharan Africa (SSA) [1, 2]. Despite this progress, a high incidence of new HIV infections still persist among vulnerable populations, particularly adolescent girls and young women (AGYW) 15-24 [3–5]. AGYW represent 10% of the population in SSA but account for more than 20% of all new HIV infections [3, 4]. In South Africa, AGYW account for the highest proportion of new infections in the country, are three times more likely to be living with HIV than adolescent boys and young men, and acquire HIV much earlier in life than their male counterparts [2, 5–8]. Understanding how patterns of HIV risk develop from early adolescence is critical for tailoring the delivery and content of existing and future HIV prevention interventions.

✉ Nivedita L. Bhushan
nbhushan@rti.org

1 Center for Communication and Engagement Research, RTI International, Research Triangle Park, NC, USA

2 Department of International Health, Johns Hopkins University, Baltimore, MD, USA

3 Women's Global Health Imperative, RTI International, Berkeley, CA, USA

4 Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

5 MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), University of the Witwatersrand, Johannesburg, South Africa

6 Department of Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Gender disparities in HIV infection among young people in SSA are largely reflective of existing structural, economic, and social dynamics that favor males, as well as biological factors that increase female's vulnerability to acquiring HIV through sexual transmission [9–12]. Age-disparate partnerships and transactional sex are well established drivers of HIV infection among AGYW and illustrate the association between gender disparities and HIV risk. Male HIV prevalence in South Africa rapidly increases with age, peaking at over 25% among those aged 30–34. Older men are also less likely to test for HIV and to engage in HIV treatment, if found to be positive [13]. AGYW who engage in partnerships with older men are thus at a higher risk of HIV exposure than if they were in a relationship with an individual their own age. Further, several studies have documented HIV-related sexual behaviors within age-disparate partnerships such as condomless sex, transactional sex, and concurrent sexual partnerships [14–17]. Social and economic power differentials in age-disparate partnerships, and among partners that engage in transactional sex, may make it difficult for AGYW to refuse sex, negotiate condom use, discuss HIV prevention, or advocate for their sexual interests [6, 18–21].

While age-disparate partnerships and transactional sex both affect HIV risk in AGYW, little is known about how these behaviors co-evolve within individuals over the life course, particularly during the transition to adulthood when sex debut occurs, and sex behavior habits are often formed. Understanding the extent to which relationships develop with older partners over time, including those that include exchange of sex, is essential for understanding when to engage AGYW as they navigate sexual partnerships during this transition. Previous studies reporting on these behaviors have generally examined them separately, precluding an examination of how these potentially correlated behaviors develop together and interact over time [22, 23]. In addition, previous studies of sexual partnerships with AGYW have relied mostly on cross sectional data, liming a prospective assessment of partnership formation and dissolution over time [14, 15, 24–26].

The present secondary analysis uses data from a longitudinal conditional cash transfer study of AGYW in rural South Africa to examine two specific research aims. First, we characterize temporal patterns of age-disparate partnerships and transactional sex separately. Second, we assess the interrelationship (conditional probability) between age-disparate partnerships and transactional trajectories over time.

Methods

Study Population and Procedures

Data in this analysis were collected through the HIV Prevention Trials Network (HPTN) 068 study, a randomized trial designed to assess whether providing cash transfers, conditional on school attendance, reduced risk of HIV acquisition among AGYW in Mpumalanga province, South Africa [27]. Full enrollment procedures have been described previously [27]. Briefly, AGYW 13–20 years of age enrolled in local public high schools (grades 8–11) were eligible for participation if they were: living in a household with a parent or guardian, planning to live in the Agincourt Health and Sociodemographic Surveillance System (AHDSS) for the foreseeable future, able to read and provide consent or assent, have or be able to open a post office or bank account, and if they were not pregnant or married. Each girl's parent/guardian also needed to provide consent for self and the adolescent if under 18 to participate in the study and have or be able to open a post office or bank account or know someone who could receive intervention funds if self and child were randomized to the intervention. After providing written informed consent or assent, all AGYW and a parent or guardian were randomized to either the intervention (a monthly cash transfer conditional on school attendance; approximately $10 to the girl and $20 the parent a month) or control group (no cash transfer). During the main trial, AGYW were seen annually from enrollment until graduation from high school or study completion at 36 months, whichever came first [28].

At baseline and each annual visit (three years in total), AGYW completed biological testing for HIV and herpes simplex virus 2 (HSV-2), as well as a behavioral survey using an audio computer assisted self-interview (ACASI) to assess demographics, sexual behaviors, and other psychosocial measures. In the behavioral survey, each participant was asked a series of questions regarding their last three sexual partners. Questions included partner demographics, relationship dynamics, substance use, and pregnancy and HIV prevention behaviors, An additional 'postintervention' visit occurred 12–24 months after the end of follow-up, comprising both the behavioral survey and HIV and HSV-2 testing. HIV testing and counseling was provided during all study visits, and AGYW who tested positive for HIV were referred for treatment as per South African national guidelines.

Institutional Review Board approval for this study was obtained from the University of North Carolina at Chapel Hill and the University of the Witwatersrand Human Research Ethics Committee.

Outcomes

Main outcomes for this analysis include participation in transactional sex and relationships with older male partners, and both were assessed dichotomously at the time of each annual visit. At each visit, AGYW who reported having sex with a male partner in exchange for money or gifts in the preceding 12 months were considered to have engaged in transactional sex (yes/no). Partner age difference was calculated by taking the difference in age between each AGYW and the reported age of her oldest partner at each visit. AGYW who reported having at least one partner five or more years older were considered as having a relationship with an older partner ('age-disparate relationship') in the past 12 months (yes/no).

Candidate Predictors

Predictors of interest were based on the literature and were measured at baseline and included depression, early sexual debut (first sex ≤ age 15), ever experienced physical intimate partner violence (IPV), continuous age in years, orphan status (death of one or both parents before 18 years), prior pregnancy (ever pregnant as of baseline), condomless sex in the past 3 months, food insecurity, and presence of inequitable gender norms. Depression was a binary variable defined as having a Children's Depression Inventory score of greater than or equal to seven at baseline [29]. Food insecurity was defined as ever vs. never worrying about having enough food for oneself or family in the past 12 months. Ever experienced physical intimate partner violence was a binary variable defined as experience of any physical IPV by a partner. The Gender Equitable Men's Scale (GEMS) was used as a continuous scale and is a validated instrument assessing respondents' endorsement of statements related to gender roles in the household and the community [30, 31]. Additional details of variables and data collection procedures have been previously published [32, 33].

Statistical Analysis

We used group-based trajectory modeling, an application of finite mixture modeling, to identify distinct temporal patterns of transactional sex and age-disparate relationships over adolescence. Group-based trajectory models identify clusters of individuals that follow similar trajectories of an outcome—or outcomes—over time [34]. We first created an analytic cohort whereby we included only girls who were enrolled in grades 8–9 at baseline (2011–2012), and who completed at least three annual self-administered sexual behavior surveys over follow-up during the main trial ($n = 1{,}191$). We did this to ensure we were able to follow girls for almost the entirety of their adolescence, while allowing enough data points to ensure that the trajectory models converged [34]. Girls testing positive for HIV at baseline were excluded from the main analysis on the basis that receipt of an HIV diagnosis early in adolescence could potentially alter relationship trajectories over time. Sequential HIV testing was done using both the Determine HIV-1/2 test (Alere Medical Co., Ltd, Matsudoshi, Chiba, Japan) and the Uni-gold Recombigen HIV test (Trinity Biotech plc, Bray, Co. Wicklow, Ireland).

We fit trajectory models for each outcome separately using Proc Traj (https://www.andrew.cmu.edu/user/bjones/index.htm), a free downloadable SAS add-on package (SAS, version 9.4, Cary, NC), identifying the optimal number of groups to describe the development of both transactional sex and age-disparate relationships over time. We decided a priori to consider linear, quadratic, and cubic terms to represent the trajectory groups for each outcome. For transactional sex and age disparate relationships, we fit models with up to five trajectory groups and specified a logit link and a binomial distribution. Model fit was determined using the following criteria: (1) how groups corresponded with prior literature on these outcomes during young adulthood; (2) average posterior class probabilities of class membership; (3) Akaike Information Criteria (AIC; smaller values indicating better fit); (4) Bayesian Information Criteria (BIC; smaller values indicating better fit); (5) entropy (values closer to one indicate more accurate classification); (6) percentage and size of the smallest trajectory group and (7) the log likelihood of each model. Each girl was then assigned to the trajectory group for which she had the highest posterior probability of group membership, examining the average posterior probability of group membership for each group to further assess model fit [34].

Once the optimal number of groups for each outcome was identified, characteristics for girls in each group were descriptively compared. We then determined the baseline predictors to include in the final Proc Traj-based trajectory model so that associations between baseline predictors and the highest risk trajectory group for each outcome could be assessed. We determined baseline predictors by running an exploratory multivariable regression model using the assigned trajectory group as the outcome and including the baseline predictors of interest. We first examined patterns of missingness for each baseline predictor and assessed multicollinearity. We then placed predictors in a full multivariable model and used backwards selection to remove predictors, with at alpha = 0.2, to obtain the final model [107]. We placed predictors from the final multivariable model into Proc Traj and estimated adjusted odds ratios (95% confidence intervals (CIs) and predicted probabilities (95% CIs

) for the association between each predictor and trajectory group membership.

After fitting trajectories for each individual outcome, we considered how trajectories of transactional sex and age-disparate partnerships co-evolved over time. We fit a dual trajectory model to assess the interrelationship (conditional probability) between transactional sex and age-disparate partnerships. The dual-trajectory model relates measurements of the outcomes of interest- age-disparate partnerships and transactional sex- in a single model to provide probabilities for membership in one trajectory class conditional upon classification in the other.

Results

Characteristics at Enrollment

Our analysis included 1,191 AGYW who were in grades 8–9 at baseline (2011–2012) and had at least three follow up visits over the study period. The median age at baseline was 14 years (IQR 14, 15). At baseline, only 14.5% ($n=172$) of girls reported having had sex with a partner in the last 12 months (Table 1). The proportion of AGYW reporting transactional sex and a male partner ≥ 5 years older were also low (2.1% and 2.7%, respectively). There were only four AGYW reporting both transactional sex and an older partner at baseline (0.35%). Intimate partner violence in the last 12 months was reported by 7.5% of girls. More than a quarter (30.6%) were depressed, and 20.3% reported the earlier death of one or more parents.

Trajectories

Figure 1a presents the average trajectories of transactional sex over the study period. Over a median of five years of follow-up (IQR 5, 6), we identified two distinct trajectories for transactional sex. Most (81.9%) girls were predicted to follow a trajectory that remained low over follow-up, with a slight increase after year 2. The second group (18.9%) had an increasing probability of transactional sex that reached over 40% after year 3. We labeled these groups as "low" and "increasing", respectively.

Figure 1b presents the average trajectories of having an age-disparate partnership over the study period. Similar to the transactional sex outcome, we identified two distinct trajectories for age-disparate partnerships. The largest group, which comprised 91.7% of the population (labeled "low"), had a low probably of age-disparate partnerships that increased slightly after year 2. The second group, which comprised 8.3% of the population (labeled "increasing") had an increasing probably of an age-disparate partnership that leveled off at year 3.

Table 1 Sample characteristics at baseline ($N=1,191$)

	Median (IQR)
Age (years)	14 (14–15)
	n (%)
Sex with ≥ 1 partner, last 12 months	172 (14.5)
Early sexual debut (≤ 15 years)	60 (6.7)
Condomless sex, last 3 months	36 (3.1)
Transactional sex, last 12 months	24 (2.1)
Older partner (≥ 5 years older), last 12 months	32 (2.7)
Physical intimate partner violence, last 12 months	87 (7.5)
Any food insecurity, last 12 months	32 (2.7)
Depression	363 (30.6)
Any orphanhood	240 (20.3)
Prior pregnancy, ever	33 (2.8)

Profiles and Predictors of Trajectory Group Membership

At baseline, AGYW in the increasing transactional sex trajectory group were more likely to be older (mean age 15.1 compared to 14.4 in low group), have experienced IPV (12.9% vs. 6.5%), be food insecure (38.6% vs. 29.3%) and have depression (39.2% vs. 15.3%) but had a similar probability of being an orphan (4.7% vs. 4.8%; Table 2). They were also more likely to have ever had a prior pregnancy (8.9% vs. 1.8%), have had one or more partners in the last 12 months (39.2% vs. 10.4%), have had condomless sex in the last 3 months (8.1% vs. 2.2%), and have had an age disparate partnership in the last 12 months (8.3% vs. 1.8%).

Patterns for age-disparate partnership were similar to transactional sex. At baseline, young women in the increasing age-disparate partnership trajectory group were more likely to be older (mean age 15.0 compared to 14.4 in low group), have experienced IPV (15.7% vs. 6.8%), be food insecure (42.9% vs. 29.7%) and have depression (35.8% vs. 17.4%) but were less likely to be an orphan (11.8% vs. 20.9%). They were also more likely to have ever had a prior pregnancy (10.8% vs. 2.2%), have had one or more partners in the last 12 months (47.1% vs. 12.0%), have had condomless sex (10.7% vs. 2.5%), and have had transactional sex in the last 12 months (12% vs. 1.4%).

Table 3 shows the results from a multivariable logistic regression model examining baseline characteristics of AGYW in relation to trajectory group membership. Compared to the low group for transactional sex, the adjusted odds of membership in the increasing trajectory group increased with age (adjusted odds ratio (aOR) 1.56; 95% confidence interval (CI) 1.36, 1.80) and were higher in those with an early sexual debut (aOR 3.50; 95% CI 1.96, 6.25) and increased depression (aOR 2.39; 95% CI 1.60, 3.56). The odds of membership in the increasing trajectory group

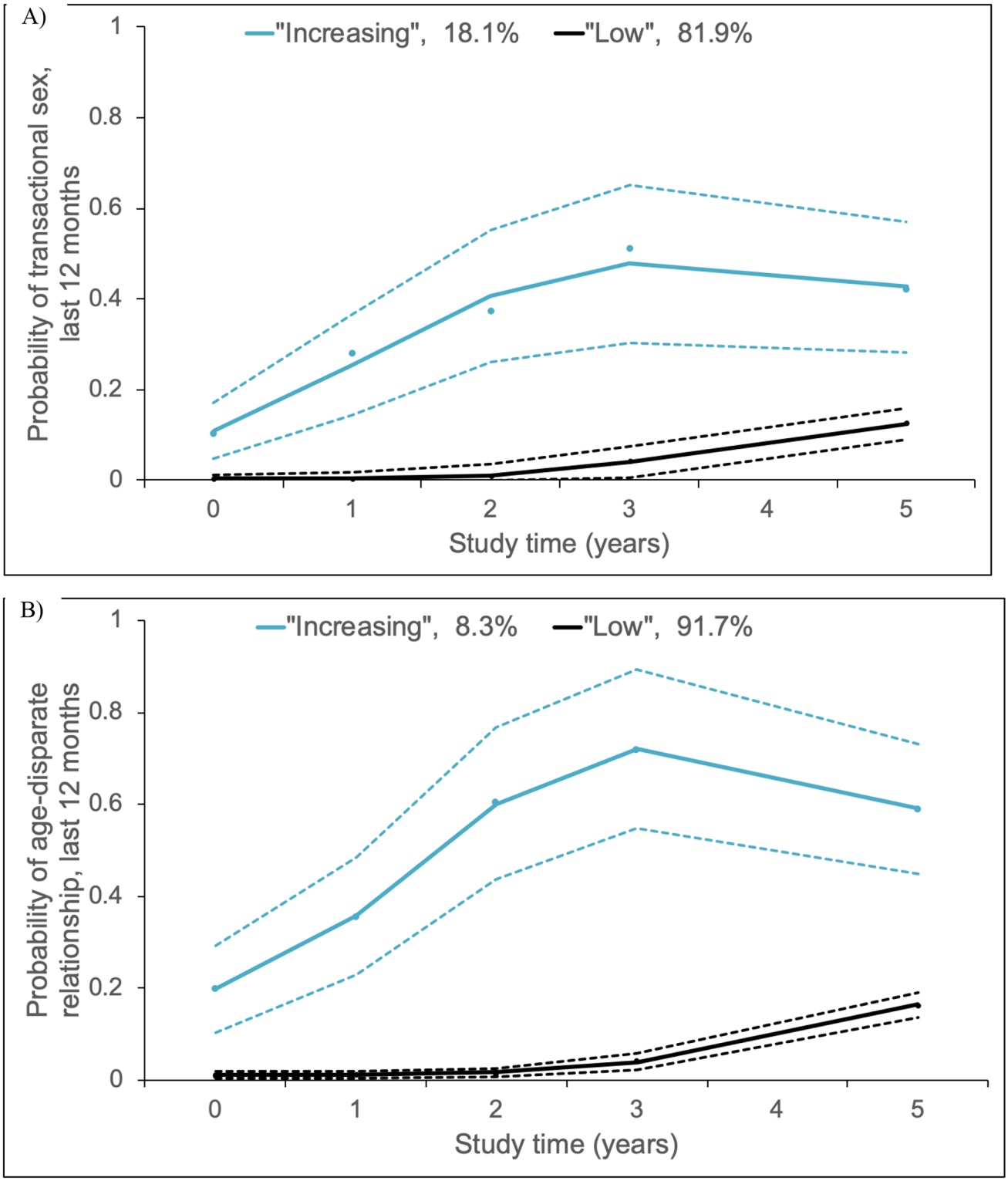


Fig. 1 Trajectories of **A**) Transactional Sex and **B**) Age-Disparate Partnerships

Table 2 Profiles of transactional sex trajectory group membership

	Transactional Sex Trajectory Group		Age-Disparate Relationship Trajectory Group	
	"Low" $N=1019$	"Increasing" $N=172$	"Low" $N=1106$	"Increasing" $N=85$
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Posterior probability of group membership	0.93 (0.07)	0.85 (0.14)	0.98 (0.06)	0.85 (0.17)
Age	14.4 (1.14)	15.1 (1.22)	14.4 (1.17)	15.0 (1.23)
	n (%)	***n (%)***	***n (%)***	***n (%)***
Intervention arm of HPTN 068	535 (52.5)	78 (45.4)	574 (51.9)	39 (45.9)
Prior pregnancy, ever	18 (1.8)	15 (8.9)	24 (2.2)	9 (10.8)
Sex with ≥ 1 partner, last 12 months	105 (10.4)	67 (39.2)	132 (12.0)	40 (47.1)
Condomless sex, last 3 months	22 (2.2)	14 (8.1)	27 (2.5)	9 (10.7)
Physical IPV, last 12 months	65 (6.5)	22 (12.9)	74 (6.8)	13 (15.7)
Food insecurity	297 (29.3)	66 (38.6)	327 (29.7)	36 (42.9)
Depression	149 (15.3)	65 (39.2)	185 (17.4)	29 (35.8)
Orphanhood	48 (4.8)	8 (4.7)	230 (20.9)	10 (11.8)
Age-disparate relationship, last 12 months	18 (1.8)	14 (8.3)	14 (1.29)	18 (21.69)
Transactional sex, last 12 months	0	24 (14.0)	15 (1.4)	9 (12.0)

Abbreviations. SD: standard deviation; IPV: intimate partner violence

Table 3 Predictors of trajectory group membership

"Increasing" Transactional Sex Trajectory Group (vs. "low")		
	aOR	**95% CI**
Age, continuous years	1.56	1.36, 1.80
Early sexual debut (≤ 15 years vs. > 15 years)	3.50	1.96, 6.25
Depression (continuous 1 unit increase)	2.39	1.60, 3.56
GEMS (continuous 1-unit decrease)	0.76	0.59, 0.97
"Increasing" Age-Disparate Relationship Trajectory Group (vs. "low")		
	aOR	**95% CI**
Age, continuous years	1.27	1.05, 1.53
Prior pregnancy (yes vs. no)	2.69	1.02, 7.08
Early sexual debut (≤ 15 years vs. > 15 years)	5.74	3.07, 10.72
Orphan (yes vs. no)	0.35	0.16, 0.78
Ever IPV (yes vs. no)	2.00	1.13, 3.54

decreased with increasing gender equitable norms (aOR 0.76; 95% CI 0.59, 0.97).

Compared to those in the low trajectory group forage-disparate partnerships, the adjusted odds of membership in the "increasing" trajectory group increased with age (aOR 1.27; 95% CI 1.05, 1.53) and were higher in those with a prior pregnancy (aOR 2.69; 1.02, 7.08), early sexual debut (aOR 5.74; 95% CI 3.07, 10.72) and in those who had ever experienced IPV (aOR 2.00; 95% CI 1.13, 3.54). The adjusted odds of membership in the increasing age-disparate partnership group were lower among orphans (OR 0.35; 95% CI 0.16, 0.78).

Dual Trajectories

Trajectories of age-disparate partnerships and transactional sex co-evolved over time. Among those AGYW in the "increasing" transactional sex trajectory group (18.1% of all girls in our sample as estimated by the dual-trajectory model), 71% were also predicted to have an "increasing" probability of an age-disparate relationship over follow-up (Table 4). Likewise, among those AGYW in the "increasing" age-disparate relationship trajectory group (8.3% of all girls in our sample as estimated by the dual-trajectory model), 76.1% were also predicted to have an "increasing" probability of transactional sex over follow-up. Overall, just over half of AGYW (53%) in the study sample had a low probability of both transactional sex and an age-disparate relationship over the study period, whereas 47% had either an "increasing" probability of transactional sex, age-disparate partnerships or both. Overall, 28% had an increasing probability of both transactional sex and an age-disparate relationship together.

Discussion

We explored trajectories of transactional sex and age-disparate partnerships throughout adolescence among AGYW in rural South Africa and examined whether the two sexual behavior trajectories were interrelated. We independently identified two distinct trajectory groups for transactional sex and age-disparate partnerships: low" across adolescence and "increasing" across adolescence. Almost a third of our sample had a combined increasing trajectory for both sexual behaviors but half of AGYW in our sample were in the low trajectory group for both age-disparate partnerships and transactional sex. Our findings provide evidence that AGYW who engage in age-disparate partnerships or transactional sex in early adolescence are more likely to experience sustained engagement in both behaviors as they across

Table 4 Conditional probabilities between transactional sex and age-disparate relationship trajectory groups

A	**Probability of Age-Disparate Relationship Group, Conditional on Transactional Sex Group**	
Transactional Sex Trajectory Group	1-Low (%)	2-Increasing (%)
1-Low	85.9	14.1
2-Increasing	29.0	71.0
B	**Probability of Transactional Sex Group, Conditional on Age-Disparate Relationship Group**	
Age-Disparate Relationship Trajectory Group	1-Low (%)	2-Increasing (%)
1-Low	82.4	17.6
2-Increasing	23.8	76.2
C	**Joint Probability of Transactional Sex and Age-Disparate Relationship Groups**	
Age-Disparate Relationship Trajectory Group	1-Low (%)	2-Increasing (%)
1-Low	52.6	11.3
2-Increasing	8.6	27.6

adolescence to adulthood, increasing their risk of HIV in the absence of effective interventions.

Findings from our combined trajectory analysis show that most AGYW who are increasingly engaged in transactional sex over time are also increasingly involved in partnerships with men at least five years older. Both age-disparate relationships and transactional sex have been associated with increased risk of HIV infection and have been shown to increase over time throughout adolescence. [33, 35, 36] However, these characteristics have been primarily examined as individual factors with little attention to how they co-occur or co-evolve over time. The sustained occurrence of transactional sex within age-disparate partnerships in combination with other HIV-related sexual behaviors likely puts AGYW in these relationships at increased risk of HIV, pregnancy, and other STIs. Notably, AGYW with increasing trajectories for each of these behaviors were more likely at baseline to have had an early sexual debut, to have had sex with more than 1 partner in the last 12 months and have had condomless sex in the last 3 months. Therefore, AGYW in transactional, age- disparate partnerships are important priority populations for HIV prevention programming and efforts to increase access to contraception and PrEP.

The co-development of age-disparate partnerships and transactional sex also reflects the economic and social context of AGYW in rural South Africa. [37, 38] Prior studies have found that motivations for engaging in transactional sex are related to the acquisition of basic needs but also for peer approval and an increase in social standing through visible wealth. [35, 39–41] Older men are more economically well-off making them desirable partners, particularly for AGYW engaged in transactional sex. However, AGYW in transactional and age-disparate relationships often lack power to negotiate sexual behaviors. [18, 19, 21, 42, 43] We found that baseline characteristics related to increased vulnerability and lack of agency in relationships such as inequitable gender norms, depression, having a prior pregnancy, and IPV were associated with increasing transactional sex or increasing age-disparate relationships. Therefore, efforts to reduce age-disparate partnerships and transactional sex among AGYW must address the underlying factors that motivate these sexual behaviors. Additionally, our finding that trajectories of these behaviors increase after age 14 confirms the need to identify and reach AGYW early in adolescence before they are involved in transactional and age-disparate partnerships, and the need to optimize how interventions can sustain involvement in programming to reduce engagement in these behaviors and make ongoing engagement in these behaviors safer for AGYW. [23]

There are several limitations to our study. First, we use self-reported and dichotomous measures of transactional sex and age-disparate relationships which may have been misclassified and underreported in the study due to social desirability bias. Transactional sex was based on self-report of exchange of sex for money or gifts. However, motivations for transactional sex are varied and range from basic needs to signs of affection or love from a partner. Risks associated with these motivations are very different and are hard to untangle in our analysis. Nevertheless, nearly half of AGYW reported engagement in either transactional sex or age-disparate relationships, suggesting that reporting was not uncommon. Second, our data are from a randomized trial in South Africa where all AGYW were in school at enrollment. This population thus may underestimate the occurrence of age-disparate and transactional partnerships among AGYW more broadly, including those out of school. [33, 44, 45] Finally, there may also have been a Hawthorne effect of the trial where young women were less likely to drop out of school due to trial participation. [46]

Conclusion

The probability of engaging in an age-disparate partnership and having transactional sex increased over time throughout adolescence for a large percentage of our sample of AGYW in rural South Africa. Girls for whom transactional sex or age-disparate relationship trajectories were predicted to increase were also engaged in other HIV-related behaviors and experienced other vulnerabilities as early as 8th -9th grade. These findings suggest that gender inequities and economic hardship can marginalize young women from an early age. Though half of AGYW did have low trajectories for both age-disparate partnerships and transactional sex, we also found that these behavioral outcomes co-occurred over time and over a quarter of AGYW have an increasing trajectory for both sexual behaviors. Redirecting implementation approaches to identify and target AGYW at highest risk of HIV acquisition, including those in age-disparate or transactional relationships, should be made a priority to optimize HIV prevention in South Africa, and remains central to a comprehensive HIV response.

Funding NLB, KBR, and SMD were each supported by the National Institute of Allergy and Infectious Diseases (T32 AI00700140; T32 AI102623; and T32AI102623, respectively). MCDS and KBR were supported by the National Institute of Mental Health (R21HD106583 and K01MH129226, respectively). The HIV Prevention Trials Network is funded by the National Institute of Allergy and Infectious Diseases (UM1AI068619, UM1AI068613, and UM1AI1068617), with co-funding from the National Institute of Mental Health and the National Institute on Drug Abuse, all components of the US National Institutes of Health. This work was also supported by the National Institute of Mental Health (R01MH087118) and the Carolina Population Center and its NIH Center Grant (P2C HD050924).

Declarations

Competing interest The authors have no competing interests to declare.

References

1. UNAIDS. Miles to go: closing gaps, breaking barriers, righting injustices. Geneva: Joint United Nations Programme on HIV/AIDS; 2018.
2. UNAIDS, Global HIV, AIDS Statistics Factsheet. &. 2019. http://www.unaids.org/en/resources/fact-sheet (accessed April 24, 2019).
3. UNAIDS. Women and HIV: a spotlight on adolescent girls and young women. Geneva, Switzerland: Joint United Nations Programme on HIV/AIDS; 2019.
4. Karim SSA, Baxter C. HIV incidence rates in adolescent girls and young women in sub-saharan Africa. Lancet Global Health. 2019;7:e1470–1.
5. Birdthistle I, Tanton C, Tomita A, et al. Recent levels and trends in HIV incidence rates among adolescent girls and young women in ten high-prevalence African countries: a systematic review and meta-analysis. Lancet Global Health. 2019;7:e1521–40.
6. Pettifor AE, Rees HV, Kleinschmidt I, et al. Young people's sexual health in South Africa: HIV prevalence and sexual behaviors from a nationally representative household survey. AIDS. 2005;19:1525–34.
7. Auvert B, Ballard R, Campbell C, et al. HIV infection among youth in a South African mining town is associated with herpes simplex virus-2 seropositivity and sexual behaviour. AIDS. 2001;15:885–98.
8. Gómez-Olivé FX, Angotti N, Houle B, et al. Prevalence of HIV among those 15 and older in rural South Africa. AIDS Care. 2013;25:1122–8.
9. Pettifor A, Stoner M, Pike C, Bekker L-G. Adolescent lives matter: preventing HIV in adolescents. Curr Opin HIV AIDS. 2018;13:265–73.
10. Dellar RC, Dlamini S, Karim QA. Adolescent girls and young women: key populations for HIV epidemic control. J Int AIDS Soc. 2015;18:19408.
11. Viner RM, Ozer EM, Denny S, et al. Adolescence and the social determinants of health. Lancet. 2012;379:1641–52.
12. Gray RH, Wawer MJ, Brookmeyer R, et al. Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1-discordant couples in Rakai, Uganda. Lancet. 2001;357:1149–53.
13. Shisana O, Rehle T, Simbayi LC et al. South African national HIV prevalence, incidence and behaviour survey, 2012. 2014.
14. Maughan-Brown B, Evans M, George G. Sexual behaviour of men and women within age-disparate partnerships in South Africa: implications for Young women's HIV Risk. PLoS ONE. 2016;11:e0159162.
15. Maughan-Brown B, Kenyon C, Lurie MN. Partner age differences and concurrency in South Africa: implications for HIV-infection risk among young women. AIDS Behav. 2014;18:2469–76.
16. Beauclair R, Kassanjee R, Temmerman M, Welte A, Delva W. Age-disparate relationships and implications for STI transmission among young adults in Cape Town, South Africa. Eur J Contracept Reprod Health Care. 2012;17:30–9.
17. Bhushan NL, Shangase N, Kimaru LJ, Gomez-Olive FX, Kahn K, Pettifor AE. HIV related behaviors among male partners of adolescent girls and Young women in Rural South Africa. AIDS Behav 2022;: 1–9.
18. Jewkes R, Morrell R. Gender and sexuality: emerging perspectives from the heterosexual epidemic in South Africa and implications for HIV risk and prevention. J Int AIDS Soc. 2010;13:6.
19. Varga CA. How gender roles influence sexual and reproductive health among South African adolescents. Stud Fam Plann. 2003;34:160–72.
20. Dunkle KL, Jewkes R, Nduna M, et al. Transactional sex and economic exchange with partners among young South African men in the rural Eastern Cape: prevalence, predictors, and associations with gender-based violence. Soc Sci Med. 2007;65:1235–48.
21. Teitelman AM, Jemmott JB, Bellamy SL, et al. Partner violence, power and gender differences in South African adolescents' HIV/STI behaviors. Health Psychol. 2016;35:751–60.
22. Bauer DJ, Shanahan MJ. Modeling complex interactions: person-centered and variable-centered approaches. Model Contextual Eff Longitud Stud 2007;: 255–83.
23. Comins CA, Rucinski KB, Baral S, Abebe SA, Mulu A, Schwartz SR. Vulnerability profiles and prevalence of HIV and other sexually transmitted infections among adolescent girls and young women in Ethiopia: a latent class analysis. PLoS ONE. 2020;15:e0232598.
24. Ranganathan M, Kilburn K, Stoner MCD, et al. The Mediating Role of Partner Selection in the Association between

Transactional Sex and HIV Incidence among Young Women. J Acquir Immune Defic Syndr. 2020;83:103–10.
25. Stoebenau K, Heise L, Wamoyi J, Bobrova N. Revisiting the understanding of transactional sex in sub-saharan Africa: a review and synthesis of the literature. Soc Sci Med. 2016;168:186–97.
26. McCloskey LA, Eloff I, Doran K. Determinants of intergenerational sexual relationships and HIV risk among South African women outpatients in Gauteng. AIDS Care 2020;: 1–9.
27. Pettifor A, MacPhail C, Selin A, et al. HPTN 068: a Randomized Control Trial of a conditional cash transfer to reduce HIV infection in Young women in South Africa—Study Design and Baseline results. AIDS Behav. 2016;20:1863–82.
28. Pettifor A, MacPhail C, Hughes JP, et al. The effect of a conditional cash transfer on HIV incidence in young women in rural South Africa (HPTN 068): a phase 3, randomised controlled trial. Lancet Glob Health. 2016;4:e978–88.
29. Kovacs M. Children's depression inventory. Acta Paedopsychiatrica: Int J Child Adolesc Psychiatry 1992.
30. Pulerwitz J, Barker G. Measuring attitudes toward gender norms among young men in Brazil: development and psychometric evaluation of the GEM scale. Men Masculinities. 2008;10:322–38.
31. Wesson P, Lippman SA, Neilands TB, et al. Multilevel gender-Equitable norms and risk of HIV and Herpes Simplex Virus Type 2 Acquisition among Young South African women: a longitudinal analysis of the HIV Prevention trials Network 068 cohort. J Adolesc Health. 2019;65:730–7.
32. Pettifor A, MacPhail C, Hughes JP, et al. The effect of a conditional cash transfer on HIV incidence in young women in rural South Africa (HPTN 068): a phase 3, randomised controlled trial. Lancet Global Health. 2016;4:e978–88.
33. Stoner MCD, Nguyen N, Kilburn K, et al. Age-disparate partnerships and incident HIV infection in adolescent girls and young women in rural South Africa. AIDS. 2019;33:83–91.
34. Nagin DS. Group-based trajectory modeling: an overview. Handb Quant Criminol 2010;: 53–67.
35. Kilburn K, Ranganathan M, Stoner MC, et al. Transactional sex and incident HIV infection in a cohort of young women from rural South Africa. AIDS. 2018;32:1669.
36. Gottfredson NC, Bhushan NL, Reyes LM, Kahn K, Pettifor AE. Effects of early social bonds on adolescent trajectories of sexual risk behaviors among South African girls. AIDS Behav 2021; (In Press).
37. Rucinski KB, Schwartz SR, Mishra S, et al. High HIV prevalence and low HIV-Service Engagement among Young Women who sell sex: a pooled analysis across 9 sub-saharan African countries. J Acquir Immune Defic Syndr. 2020;85:148–55.
38. Atkins K, Rucinski K, Mudavanhu M, et al. Sexual relationship types, Partner HIV Self-Testing, and Pre-exposure Prophylaxis among South African Adolescent girls and Young women: a latent class analysis. J Acquir Immune Defic Syndr. 2021;86:413–21.
39. Ranganathan M, Heise L, Pettifor A, et al. Transactional sex among young women in rural South Africa: prevalence, mediators and association with HIV infection. J Int AIDS Soc. 2016;19:20749.
40. et al. 'It's because I like things… it's a status and he buys me airtime': exploring the role of transactional sex in young women's consumption patterns in rural South Africa(secondary findings from HPTN 068). *Reproductive Health* 2018; 15: 102.
41. Duby Z, Jonas K, McClinton Appollis T et al. From Survival to Glamour: Motivations for Engaging in Transactional Sex and Relationships Among Adolescent Girls and Young Women in South Africa. *AIDS Behav* 2021; published online May 5. https://doi.org/10.1007/s10461-021-03291-z
42. Dunkle KL, Decker MR. Gender-based violence and HIV: reviewing the evidence for links and causal pathways in the general population and high-risk groups. Am J Reprod Immunol. 2013;69(Suppl 1):20–6.
43. Nguyen N, Powers KA, Miller WC, et al. Sexual Partner types and Incident HIV infection among rural South African adolescent girls and young women enrolled in HPTN 068: a latent class analysis. JAIDS J Acquir Immune Defic Syndr. 2019;82:24–33.
44. Stoner MCD, Edwards JK, Miller WC, et al. Effect of Schooling on Age-Disparate relationships and number of sexual partners among Young women in Rural South Africa enrolled in HPTN 068. J Acquir Immune Defic Syndr. 2017;76:e107–14.
45. Stoner MCD, Edwards JK, Miller WC, et al. Does Partner Selection mediate the relationship between School attendance and HIV/Herpes Simplex Virus-2 among adolescent girls and Young women in South Africa: an analysis of HIV Prevention trials Network 068 Data. J Acquir Immune Defic Syndr. 2018;79:20–7.
46. Rosenberg M, Pettifor A, Twine R, et al. Evidence for sample selection effect and Hawthorne effect in behavioural HIV prevention trial among young women in a rural South African community. BMJ open. 2018;8:e019167.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.