HHS Public Access

Author manuscript

J Acquir Immune Defic Syndr. Author manuscript; available in PMC 2019 June 01.

Published in final edited form as:

J Acquir Immune Defic Syndr. 2018 June 01; 78(2): 155–162. doi:10.1097/QAI.0000000000001656.

HIV risk among adolescent girls and young women in age-disparate partnerships: Evidence from KwaZulu-Natal, South Africa

Brendan Maughan-Brown, PhD[1], **Gavin George, PhD**[2], **Sean Beckett, MA**[2], **Meredith Evans, MA**[3], **Lara Lewis, MSc**[4], **Cherie Cawood, BCom, MBA**[5], **David Khanyile, BA Honours**[5], and **Ayesha BM Kharsany, PhD, MS Epi**[4]

[1]Southern Africa Labour and Development Research Unit (SALDRU), Department of Economics, University of Cape Town, Cape Town, South Africa.

[2]Health Economics and HIV and AIDS Research Division (HEARD), University of KwaZulu-Natal, Durban, South Africa.

[3]Department of Anthropology, York University, Toronto, Canada.

[4]Centre for the AIDS Programme of Research in South Africa (CAPRISA), University of KwaZulu-Natal, South Africa.

[5]Epicentre AIDS Risk Management (Pty) Limited, South Africa.

Abstract

Background—Evidence on the role of age-disparate partnerships in high HIV-infection rates among young women in sub-Saharan Africa remains inconclusive. This study examined the HIV-infection risk associated with age-disparate partnerships among 15–24 year-old women in a hyper-endemic setting in South Africa.

Methods—Face-to-face questionnaire, and laboratory HIV and viral load data were collected during 2014–2015 among a representative sample (15–49 years-old) in KwaZulu-Natal. The association between age-disparate partnerships (age-difference ≥5 years) and HIV-status among 15–24 year-old women (N=1459) was assessed using multiple logistic regression analyses. Data from the male sample on all on-going partnerships (N=1229) involving 15–24 year-old women were used to assess whether young women's age-disparate male partners were more likely to have a viral load ≥1000 copies/ml, a marker of HIV-infection risk.

Results—Women reporting an age-disparity in any of their three recent partnerships were more likely to test HIV-positive compared to women with only age-similar partners (aOR:1.58, 95%CI: 1.20–2.09,p<0.01). Among partnerships men reported with 15–24 year old women, the age-

Corresponding author, Brendan Maughan-Brown; Southern Africa Labour and Development Research Unit, University of Cape Town, Private Bag, Rondebosch, 7701, Cape Town, South Africa; brendan.maughanbrown@gmail.com; *Telephone*: +27-21-650-5695; *Fax*: +27-21-650-5697.

Conflicts of interest

We have no conflicts of interest to declare.

Meetings at which part of the data were presented

9th IAS Conference on HIV Science, Paris, France, 25th July, 2017, TUAC02

disparate male partners were more likely to be HIV-positive and have a viral load ≥1000 copies/mL (aOR:2.05, 95%CI:1.30–3.24,p<0.01) compared to age-similar partners. Results were similar for each category of age-disparity: partners 5–9 years older (aOR:2.01, 95%CI:1.18–3.43,p=0.010) and those ≥10 years older (aOR:2.17, 95%CI:1.01–4.66,p=0.048).

Conclusions—Results indicate that age-disparate partnerships increase young women's HIV risk, although conclusive evidence was not ascertained. Interventions addressing risk from age-disparate sexual partnering, including expanding antiretroviral treatment among older partners, may help to reduce HIV-incidence among young women.

Keywords

age-mixing; HIV prevention; key population; HIV infection risk; sub-Saharan Africa; antiretroviral therapy

Introduction

Young women in sub-Saharan Africa remain at the epicentre of the HIV epidemic, with persistent high HIV incidence.[1,2] In South Africa, incidence rates for young black African women are among the highest of any population globally.[3] A better understanding of factors that influence young women's HIV infection risk is critical for the success of efforts to reduce the burden of disease among this vulnerable population. Conflicting evidence has generated uncertainty about the role that age-disparate partnerships (i.e., those in which the male partner is 5 or more years older) play in young women's HIV risk, and consequently the value of HIV prevention interventions aimed specifically at reducing risk within such partnerships.[4–12]

Two compounding factors give plausibility to the hypothesis that age-disparate partnerships increase HIV risk for young women. First, HIV prevalence among men increases steeply with age until approximately 40 years old.[3] Unless young women are able to select older HIV-negative partners, age-disparate male partners are more likely to be HIV-positive than younger partners and therefore pose greater HIV-infection risk. Second, several studies have documented a range of riskier sexual behaviours within age-disparate partnerships, including condomless sex,[13–15] transactional sex,[16] and concurrent sexual partnering.[17]

Conversely, differences by age in the uptake of HIV testing and antiretroviral therapy (ART) among men could theoretically mitigate HIV-infection risk within age-disparate partnerships. HIV testing is positively associated with age,[18–21] and older HIV-positive men are more likely to have been diagnosed than their younger counterparts. Moreover, older men are also more likely to link to HIV care and treatment post diagnosis.[22–24] Consequently, while age-disparate partners of young women are more likely to be HIV positive, a greater percentage could be on ART and virally supressed. As viral suppression reduces the onward transmission of HIV,[25,26] age-disparate partners may, therefore, not pose additional HIV infection risk for young women if the proportion of men who are HIV positive with a suppressed HIV viral load is similar within age-similar and age-disparate partnerships.

The potential for ART to mitigate risk from age-disparate partnerships will likely vary across time and location as ART uptake, retention and adherence among men and age-differentials in ART coverage change. Contextual factors relating to ART coverage may, for example, partially explain why age-disparate partnerships among young women in The Africa Centre for Population Health cohort in rural KwaZulu-Natal were not found to increase HIV risk.[10] Men in the study region are part of an ongoing demographic surveillance system that includes regular HIV-testing and referral to care.[27] Potential geographic and temporal effects on the relationship between age-disparate partnerships and young women's HIV risk highlights the importance of regular monitoring in different contexts.

In this study we assess the association between age-disparate partnerships and HIV status among 15–24 year old women in a high burden region of South Africa. Second, we explore the biological plausibility of the hypothesis that age-disparate partnerships increase risk for young women by examining HIV status and viral load among men who partner with 15–24 year old women. Specifically, this analysis examines whether the proportion of young women's partners with a viral load ≥1000 copies/mL (i.e., a marker of individuals who pose an HIV-infection risk) differs between age-disparate and age-similar partnerships.

Methods

Data

This study used data from the baseline survey conducted within the HIV Incidence Provincial Surveillance System (HIPSS) from June 2014 to June 2015.[28] This cross-sectional household-based survey was conducted in two sub-districts (Vulindlela (rural) and Greater Edendale (urban)) of the uMgungundlovu district in KwaZulu-Natal, South Africa. Households were randomly selected using two-stage random sampling methods. First enumeration areas (EA), the primary sampling unit, were selected and then households were drawn systematically in selected EAs using a serpentine pattern from a random starting location. One individual per household, within the age range 15–49 years, was randomly selected from a roster of eligible household members. The sample comprised 9812 individuals. Venous blood samples were collected for HIV antibody and viral load tests from all participants. A face-to-face questionnaire was administered to collect data on, *inter alia,* demographics, socioeconomic status, and health related information. Details on participants' first and three most recent sexual partners, including an estimated start date of each relationship were recorded. Participants were also asked the date of their most recent HIV test and the test result.

The study was approved by the Biomedical Research Ethics Committee, University of KwaZulu-Natal, (BF269/13), the Centers for Disease Control and Prevention (CDC) of the United States of America, and by the KwaZulu-Natal Provincial Department of Health in South Africa (HRKM 08/14). Eligible participants provided informed written consent prior to study enrolment. All study procedures followed were in accordance with the ethical standards of the Helsinki Declaration of 1975, as revised in 2000.

Measures

Dependent variables—HIV testing was done using fourth generation HIV enzyme immunoassays to test for HIV antibodies and antigens using enzyme Biomerieux Vironostika Uniform II Antigen / Antibody Microelisa system (BioMérieux, Marcy I'Etoile, France) and HIV 1/2 Combi Roche Elecys (Roche Diagnostics, Penzberg, Germany). Positive tests were confirmed with a Western-Blot (Biorad assay, Bio-Rad Laboratories, Redmond, WA 98052, USA). Viral load among HIV-positive participants was measured using Roche COBAS® AmpliPrep/COBAS® TaqMan® HIV-1 v2.0 assay (CAP/CTM HIV-1 V2.0). All serology and viral load tests were performed by an accredited laboratory (via the South African National Accreditation System) according to the manufacturers' manuals and were validated in the laboratories that were conducting the testing. Two binary dependent variables were created using laboratory data. The first identified individuals who tested HIV-positive, with the reference category representing all HIV-negative individuals. The second variable identified individuals who tested HIV-positive and had a viral load ≥1000 copies/ml, with the reference category representing HIV-negative individuals, and HIV-positive individuals who had a viral load <1000 copies/mL. A viral load of ≥1000 copies/mL was chosen as an indicator of individuals who pose an HIV-infection risk as male-to-female HIV transmission is rare below this level.[29,30]

Age-disparate variables—All sexually active respondents were asked the age of their first and three most recent sexual partners. Based on the UNAIDS definition,[31] and consistent with the literature,[4,7,9,10,32] age-disparate partnerships were identified as those in which the male partner was 5 or more years older. Partnerships in which women were >2 years older than their partner were rare (e.g., only 0.6% (n=9) of the most recent partnerships reported by 15–24 year old women) and were coded as age-similar partnerships since these partnerships are not assumed to carry additional risk for young women.

For the analyses of HIV risk among 15–24 year old women, three separate binary measures of age-disparate partnering were created. The first variable was created to identify women who reported age-disparity in their most recent partnership. As partnership age disparities in previous, partnerships may have influenced HIV risk, we expanded the definition of the first measure with a second variable that identified women who reported an age-disparity in any of their three most recent partnerships. Furthermore, a third age-disparate measure was created by included all available partnership data to identify woman who reported an age-disparity in their first-ever partnership or any of their three most recent partnerships. There is the potential for selection bias in analyses based on the third measure as a result of 414 (26%) participants missing data regarding first-ever partnerships, participants' age at first sex, or the partner's age.

For each measure of age-disparate partnering we excluded data among HIV-positive women on partnerships (n=142) in which the start date of the partnership occurred after the reported date of an HIV-positive test. These partnerships were unrelated to HIV infection. The age-disparate measures for these analyses were therefore based on data from all partnerships prior to a self-reported HIV-positive diagnosis.

Analysis

All analyses were weighted to take into account the complex multi-level study design of the survey and to adjust for non-response. We adjusted standard errors for clustering at the enumeration area level to account for all potential within-cluster error correlation.[33] All analyses were conducted using Stata 14 (Stata Corporation LP, College Station, TX).

HIV status among young women—Analyses of the association between age-disparate partnerships and HIV risk among young women were based on data collected from 15–24 year old women who provided information on at least one sexual partner. Differences in the prevalence of HIV by partnership type (age-similar vs age-disparate) were assessed in bivariate analysis using two-sample equality of proportions tests. Multiple logistic regression models (odds ratios presented) were used to assess the association between HIV status and age-disparate partnerships among 15–24 year old women. Separate models were created using the three age-disparate measures as the key independent variable of interest. All models controlled for factors that could be correlated with both the dependent variable and the formation or dissolution of age-disparate partnerships (past and present). We did not control for factors that theoretically may be influenced by age-disparate partnerships, such as condom use, but are unlikely to be a factor explaining the existence of these partnerships. Control variables in all models included age of the woman (years); education (Grade 12 completed or not); having always lived in the area; a household asset index (count of assets from 0–14); monthly household income; number of lifetime sexual partners; HIV-testing history (no, yes) and number of useful sources of HIV information exposed to during the previous 12 months (0–16).

HIV prevalence and viral load among men in partnerships with young women —To assess whether older male partners of young women represent a higher infection risk, our second analysis used data on all ongoing partnerships (i.e., participants reported that the sexual relationship had not ended) men reported with a woman 15-to-24 years old. Given the HIPSS data are representative of the total sampled population, our assumption is that these partnerships represent all partnerships involving 15-to-24 year-old women in the study region. The men in these partnerships would therefore be a good proxy for the partners of all 15-to-24 year-old women in the area. In other words, each of the partnerships reported by men represents one 15-to-24 year-old women. Accordingly, using these partnerships as individual data for 15-to-24 year-old women, the laboratory data on the men in each partnership provide HIV data on each male partner of 15-to-24 year-old women.

Two-sample equality of proportions tests were used to compare the percentage of HIV-positive male partners, and HIV-positive male partners with a viral load ≥1000 copies/ml, in age-disparate and age-similar partnerships. Multiple logistic regression models were used to assess the association between partnership type and HIV status and viral load ≥1000 copies/mL of male partners, and controlled for the age of the female partner (in years from 15 to 24).

As intergenerational partnerships (i.e., those with an age-gap between partners of 10 or more years) have been a specific target of HIV prevention campaigns in South Africa,[34] we

repeated our analysis among men to compare HIV prevalence and viral load among age-similar male partners to two categories of age-disparate partners: 1) men 5–9 years older, and 2) men 10 or more years older.

Results

Sample of 15–24 year-old women

A total of 1459 women aged 15-to-24 years old provided data on at least one sexual partnership meeting the inclusion criteria for our analyses (see Table 1). The majority (69%) were 20–24 years old. Thirty-two percent reported that their most recent partnership involved a partner five or more years older than them (i.e., age-disparate). Forty-two percent reported at least one age-disparate partner either in any of their three most recent partnerships or in their first-ever partnership. HIV prevalence was 29% (95% CI: 26%-3%) among these women.

Sample of men in partnerships with 15–24 year-old women

A total of 1079 men reported ongoing partnerships with a woman 15–24 years old (see Table 1). The majority of men (63%) were under 25 years old and few were older than 34 (3.7%). HIV prevalence was 15% (95% CI: 12%–18%) among men in the study population. These men reported 1229 ongoing partnerships with a woman 15–24 years old, with 104 men reporting more than one ongoing relationship. Among these partnerships, 26% where characterised as age-disparate by study definitions. The male partner was 5–9 years older in 19% of partnerships and 10 or more years older in 7% of all partnerships.

HIV status among young women

For all age-disparate measures, bivariate and multiple logistic regression analyses (Table 2) showed that women who reported age-disparate partnerships were significantly more likely to have HIV than women who only reported age-similar partnerships. Bivariate analysis (Table 2, columns 1 and 2) indicated that HIV prevalence was 12 percentage points higher among women who reported an age-disparity in any of their three most recent partnerships (37% vs 25%; OR: 1.75, 95% CI: 1.35–2.28, $p<0.01$) compared to women who did not report an age-disparity with any partner. Results were substantively similar after controlling for potential confounders, such as number of lifetime sexual partners reported (Table 2, Column 3). According to data on the three most recent partnerships, the odds of a woman having HIV (aOR:1.58, 95% CI: 1.20–2.09, $p<0.01$) were greater in age-disparate partnerships.

HIV prevalence and viral load among men in partnerships with young women

Among the 1229 ongoing partnerships men reported with a woman 15–24 years old, unadjusted logistic regression analyses showed that age-disparate male partners were significantly more likely to be HIV-positive (27% vs 11%; OR: 2.97, 95% CI: 1.87–4.73, $p<0.01$) than age-similar male partners. Compared to age-similar partners, age-disparate male partners were also significantly more likely to be HIV-positive with a viral load ≥1000 (17% vs 9%; OR: 2.11, 95% CI: 1.35–3.30, $p<0.01$). Similar results were found in the multiple logistic regression analyses (Table 3, Models 1 and 3). Age-disparate male partners

of young women were more likely to be HIV-positive with a viral load ≥1000 copies/mL (aOR:2.05, 95% CI:1.30–3.24, p<0.01) compared to age-similar partners (Table 3, Model 3).

Models 2 and 4 (Table 3) display the associations between the outcome measures and two categories of age-disparate male partners: men 5–9 years older and men 10+ years older. Compared to male partners in the age-similar partnerships, men 5–9 years older (aOR:2.29, 95% CI:1.37–3.82, p<0.01) and men 10 or more years older (aOR:5.39, 95% CI:2.54–11.44, p<0.01) than their female partners were more likely to be HIV positive (Model 2). Compared to age-similar male partners, male partners in both categories of age-disparate partnerships were more likely to be HIV-positive with a viral load ≥1000 copies/mL (Model 4): men 5–9 years older (aOR:2.01, 95% CI:1.18–3.43, p=0.010); men 10+ years older (aOR:2.17, 95% CI:1.01–4.66, p=0.048).

The similar size of the odds ratios in Model 4 for men 5–9 years older and men 10+ years older than their partner indicates that HIV-risk within these different partnerships may be similar after taking ART into account. The reduction in the size of the coefficient for men 10+ years older than their partners from Models 2 to 4 (aOR:5.39 to 2.17) is consistent with additional study findings (see Table S2, Supplemental Digital Content 2) of a positive relationship between age among HIV-positive men and reporting being on ART (aOR:1.13, p<0.01). Moreover, among the HIV-positive men in our sample, only 22% of those who reported a partner 5–9 years younger than themselves had a viral load <1000 copies/mL compared to 50% of men who reported a partnership with a 10+ year age difference. These data indicate that older HIV-positive men were more likely to be on ART and virally suppressed.

Discussion

With persistent high HIV incidence among young women in sub-Saharan Africa there is a growing need to understand the factors that increase HIV risk among this population. In this article we provide evidence on the role age-disparate partnerships play in HIV-infection risk among 15–24 year old women in a high prevalence setting in South Africa. Consonant with other studies in Southern Africa,[9,10,16] a substantial proportion of women in this study had age-disparate partners. Based on all the measures of age-disparate partnering we employed, evidence indicates an elevated HIV risk among women in age-disparate partnerships.

Moreover, results indicate biological plausibility for a positive association between age-disparate partnerships and HIV-infection risk among young women. Older male partners of young women were not only more likely to be HIV-positive, but also more likely to be HIV-positive and have a viral load ≥1000 copies/ml – a marker of partners who pose an HIV-infection risk – compared to age-similar partners. These findings, in conjunction with several studies showing that age-disparate partnerships involve more risky sexual behaviour, [13,14,16,35,36] point to an increased HIV-infection risk for young women in age-disparate partnerships.

However, results provide evidence that current patterns of ART uptake among men in this population could mitigate HIV-infection risk for young (15-to-24 year-old) women in age-

disparate partnerships involving men 10 or more years older than their female partners (defined as intergenerational partnerships). Consistent with other studies,[23] our data indicated that older HIV-positive men in our sample were more likely to be on ART than younger HIV-positive men. Consequently, while intergenerational male partners of young women had the highest HIV prevalence, findings suggest that young women with intergenerational male partners had a similar likelihood of having an infectious HIV-positive partner (i.e. a partner with a detectable viral load) than young women with partners 5–9 years older than them. These findings suggest that while age-disparate partnerships in general may increase young women's HIV risk, ART could mitigate the additional biological risk posed by intergenerational partnerships. In other words, in terms of the biological risk of HIV infection, the distinction between different types of age-disparate partnerships could be less relevant.

These findings indicate how variation by age among men in the uptake of an intervention that reduces the probability of onward transmission of HIV could affect the dynamics between age-disparate partnering and HIV risk for young women. It is also theoretically possible that variation in age in the uptake of interventions that reduce the likelihood of HIV infection for men, such as voluntary medical male circumcision, will change the relative risk that age-disparate partnerships and intergenerational partnerships pose for young women. In contexts with a larger proportion of young men circumcised compared to older men, for example, the HIV risk associated with age-disparate partners may be large for young women. The potential for the relationship between age-disparate partnering and HIV risk for young women, and women of other ages, to vary according to differential uptake of HIV services by age among men indicates the importance of further research in different contexts. Given the potential for geographic and temporal variation, the external validity of findings on the relationship between age-disparate partnerships and HIV-infection risk should be considered carefully.

These results should be interpreted in the context of the study limitations. While the use of biomedical data reduces the potential for social desirability bias on the key dependent variables, it is possible that social desirability bias, recall bias and incorrect knowledge might have resulted in miss-reporting of partnerships,[37] and partner age.[38] There is also the potential for selection bias in the analysis of HIV-status among women that includes data on first-ever partnerships in the measure of age-disparate partnering. This is due to a large amount of missing data on first-ever partnerships, participants' age at first sex, or the partner's age. In addition, we do not have data on the timing of HIV-infection among women and, therefore, do not know in which partnership HIV-infections occurred. There is the potential that some women who had age-disparate partners also engaged in high-risk sex with age-similar partners, and the HIV risk was associated with the age-similar rather than the age-disparate partner.

In analyses using partnership data reported by men on ongoing partnerships with a 15–24 year-old women, we also do not have data on the timing of HIV-infection among HIV-positive men. Accordingly, we do not know which men acquired HIV from the young women reported in the partnerships. There is potential for bias in our analyses if the proportion of men who acquired HIV from the partnerships reported in our data differed

between men in age-similar and age-disparate partnerships. If for example, a greater percentage of men in the age-disparate partnerships compared to those in the age similar partnerships acquired HIV within the reported partnership, which is possible as condomless sex is often more common in age-disparate partnerships, then our findings provide an overestimation of young women's risk of HIV exposure from age-disparate partnerships. In addition, our analyses of male partners is based on the assumption that the partnerships reported by men in our sample represent all partnerships involving 15-to-24 year-old women in the study region. However, data on partnerships between 15-to-24 year-old women in the study region and men outside the study region are missing, and some partnerships reported by men are likely to be with young women from other regions. There is the potential for bias if the relationship between HIV-prevalence and age among male partners from other regions differs from that among the male partners living in the study region.

Overall, our results help to reduce the uncertainty in the literature by providing evidence to support the argument that age-disparate partnerships could elevate young women's HIV risk. Our results are consistent with a *phylogenetic transmission network analysis conducted using a sub-sample of participants from the HIPSS study that identified* a cycle of HIV transmission driven by high rates of new HIV infections in adolescent girls and young women from men who were on average eight years older.[39] The corollary of our findings, especially in high HIV-prevalence settings, is that interventions to reduce HIV infection risks associated with age-disparate partnerships may help to prevent new infections among young women and break this cycle of transmission. Our results highlight the importance of early diagnosis and treatment of HIV-positive men in age-disparate partnerships with young women as an integral component of the treat-all strategy for HIV prevention.[40]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank all the participants of the HIV Incidence Provincial Surveillance System (HIPSS), as well as HIPSS co-investigators and members of the HIPSS study team from the following organisations: Epicentre, CAPRISA, HEARD, NICD and CDC. We thank the HIPSS collaborating partners: The National Department of Health, Provincial KwaZulu-Natal Department of Health, uMgungundlovu Health District, the uMgungundlovu District AIDS Council, local municipal and traditional leaders, and community members for all their support throughout the HIPPS study. We are extremely grateful to Kassahun Ayalew, Karidia Diallo and Mary Glenshaw for valuable feedback on previous versions of this manuscript.

Source of funding

The HIV Incidence Provincial Surveillance System (HIPSS) is funded by a cooperative agreement (3U2GGH000372) between Epicentre and the Centers for Disease Control and Prevention (CDC). Support was provided to BMB by the National Research Foundation, South Africa, through the Research Career Advancement Fellowship. ABMK is supported by a joint South Africa–U.S. Program for Collaborative Biomedical Research, National Institutes of Health grant (R01HD083343). The content, findings and conclusions in this paper are those of the author(s) and do not necessarily represent the official views of the Centers for Disease Control and Prevention, or any other funder.

Abbreviations

aOR Adjusted Odds Ratio

ART	Antiretroviral Therapy
EA	Enumeration Area
HIPSS	HIV Incidence Provincial Surveillance System
HIV	Human Immunodeficiency Virus
OR	Odds Ratio
95%CI	95% Confidence Interval

References

1. Dellar RC, Dlamini S, Karim QA. Adolescent girls and young women: key populations for HIV epidemic control. J Int AIDS Soc. 2015; 18(Suppl 1):19408. [PubMed: 25724504]
2. UNAIDS. Global Report: UNAIDS Report on the Global AIDS Epidemic 2013. Geneva: UNAIDS; 2013.
3. Shisana, O., Rehle, T., Simbayi, L., et al. South African National HIV Prevalence, Incidence and Behaviour Survey, 2012. Cape Town: Human Sciences Research Council Press; 2014.
4. Gregson S, Nyamukapa C, Garnett G, et al. Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. Lancet. 2002; 359(9321):1896–1903. [PubMed: 12057552]
5. Katz I, Low-Beer D. Why Has HIV Stabilized in South Africa, Yet Not Declined Further? Age and Sexual Behavior Patterns Among Youth. Sex Transm Dis. 2008; 35(10):837–842. [PubMed: 18607312]
6. Kelly RJ, Gray RH, Sewankambo NK, et al. Age differences in sexual partners and risk of HIV-1 infection in rural Uganda. J Acquir Immune Defic Syndr. 2003; 32(4):446–451. [PubMed: 12640205]
7. Pettifor A, Rees H, 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(14):1525–1534. [PubMed: 16135907]
8. Chapman R, White RG, Shafer LA, et al. Do behavioural differences help to explain variations in HIV prevalence in adolescents in sub-Saharan Africa? Trop Med Int Health. 2010; 15(5):554–566. [PubMed: 20345559]
9. Balkus JE, Nair G, Montgomery ET, et al. Age-Disparate Partnerships and Risk of HIV-1 Acquisition Among South African Women Participating in the VOICE Trial. J Acquir Immune Defic Syndr. 2015; 70(2):212–217. [PubMed: 26049280]
10. Harling G, Newell M-L, Tanser F, et al. Do Age-Disparate Relationships Drive HIV Incidence in Young Women? Evidence from a Population Cohort in Rural KwaZulu-Natal, South Africa. J Acquir Immune Defic Syndr. 2014; 66(4):433–451.
11. Schaefer R, Gregson S, Eaton JW, et al. Age-disparate relationships and HIV incidence in adolescent girls and young women: evidence from Zimbabwe. AIDS. 2017; 31(10):1461–1470. [PubMed: 28426534]
12. Beauclair R, Helleringer S, Hens N, et al. Age differences between sexual partners, behavioural and demographic correlates, and HIV infection on Likoma Island, Malawi. Nature Publishing Group. 2016; 6:36121.
13. Beauclair R, Kassanjee R, Temmerman M, et al. Age-disparate relationships and implications for STI transmission among young adults in Cape Town, South Africa. Eur J Contracept Reprod Health Care. 2012; 17(1):30–39. [PubMed: 22239263]
14. Volpe E, Hardie T, Cerulli C, et al. What's Age Got to Do With It? Partner Age Difference, Power, Intimate Partner Violence, and Sexual Risk in Urban Adolescents. J Interpers Violence. 2013; 28:2068–2087. [PubMed: 23345572]

15. Malema BW. Determinants of Condom use in Botswana: An empirical Investigation of the Role of Gender. Botswana Journal of Economics. 2012; 10(14):59–78.
16. 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(8):e0159162. [PubMed: 27526116]
17. 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; 18:2469–2476. [PubMed: 25047687]
18. Maughan-Brown B, Lloyd N, Bor J, et al. Changes in self-reported HIV testing during South Africa's 2010/2011 national testing campaign: gains and shortfalls. J Int AIDS Soc. 2016; 19:20658. [PubMed: 27072532]
19. Venkatesh K, Madiba P, de Bruyn G, et al. Who Gets Tested for HIV in a South African Urban Township? Implications for Test and Treat and Gender-Based Prevention Interventions. J Acquir Immune Defic Syndr. 2011; 56(2):151–165. [PubMed: 21084993]
20. MacPhail C, Pettifor A, Moyo W, et al. Factors associated with HIV testing among sexually active South African youth aged 15–24 years. AIDS Care. 2009; 21(4):456–467. [PubMed: 19401866]
21. Peltzer K, Matseke G, Mzolo T, et al. Determinants of knowledge of HIV status in South Africa: results from a population-based HIV survey. BMC Public Health. 2009; 9:174. [PubMed: 19500373]
22. Whiteside YO, Cohen SM, Bradley H, et al. Progress along the continuum of HIV care among blacks with diagnosed HIV- United States, 2010. Morb Mortal Wkly Rep. 2014; 63(5):85–89.
23. Plazy M, Dray-Spira R, Orne-Gliemann J, et al. Continuum in HIV care from entry to ART initiation in rural KwaZulu-Natal, South Africa. Trop Med Int Health. 2014; 19(6):680–689. [PubMed: 24654990]
24. Naik R, Doherty T, Jackson D, et al. Linkage to care following a home-based HIV counselling and testing intervention in rural South Africa. J Int AIDS Soc. 2015; 18(1):1–9.
25. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. N Engl J Med. 2011; 365(6):493–505. [PubMed: 21767103]
26. Tanser F, Bärnighausen T, Grapsa E, et al. High Coverage of ART Associated with Decline in Risk of HIV Acquisition in Rural KwaZulu-Natal, South Africa. Science. 2013; 339(6122):966–971. [PubMed: 23430656]
27. Tanser F, Hosegood V, Bärnighausen T, et al. Cohort Profile: Africa Centre Demographic Information System (ACDIS) and population-based HIV survey. Int J Epidemiol. 2008; 37(5): 956–962. [PubMed: 17998242]
28. Kharsany AB, Cawood C, Khanyile D, et al. Strengthening HIV surveillance in the antiretroviral therapy era: rationale and design of a longitudinal study to monitor HIV prevalence and incidence in the uMgungundlovu District, KwaZulu-Natal, South Africa. BMC Public Health. 2015:1149. [PubMed: 26588902]
29. Quinn TC, Wawer MJ, Sewankambo N, et al. Viral load and heterosexual transmission of human immunodeficiency virus type 1. N Engl J Med. 2000; 342(13):921–929. [PubMed: 10738050]
30. Tovanabutra S, Robison V, Wongtrakul J, et al. Male viral load and heterosexual transmission of HIV-1 subtype E in northern Thailand. J Acquir Immune Defic Syndr. 2002; 29(3):275–283. [PubMed: 11873077]
31. UNAIDS. UNAIDS Terminology Guidelines. Geneva: UNAIDS; 2015.
32. Evans M, Risher K, Zungu N, et al. Age-disparate sex and HIV risk for young women from 2002 to 2012 in South Africa. J. Int. AIDS Soc. 2016; 19(1):1–16.
33. Cameron AC, Miller DL. A Practitioner’s Guide to Cluster-Robust Inference. J Hum Resour. 2015; 50(2):317–372.
34. KwaZulu-Natal Department of Health. Sugar Daddy Campaign. 2012. Available at: http://www.kznhealth.gov.za/sugardaddy.htm
35. Bankole A, Ahmed FH, Neema S, et al. Knowledge of correct condom use and consistency of use among adolescents in four countries in sub-Saharan Africa. Afr. J. Reprod. Health. 2007; 11(3): 197–220. [PubMed: 18458741]

36. Ritchwood TD, Hughes JP, Jennings L, et al. Characteristics of Age-Discordant Partnerships Associated With HIV Risk Among Young South African Women (HPTN 068). J Acquir Immune Defic Syndr. 2016; 72(4):423–429. [PubMed: 26977748]

37. Maughan-Brown B, Venkataramani A. Measuring concurrent partnerships: potential for underestimation in UNAIDS recommended method. AIDS. 2011; 25(12):1549–1551. [PubMed: 21617519]

38. Harling G, Tanser F, Mutevedzi T, et al. Assessing the validity of respondents' reports of their partners' ages in a rural South African population-based cohort. BMJ Open. 2015; 5:e005638.

39. de Oliveira T, Kharsany ABM, Gräf T, et al. Transmission networks and risk of HIV infection in KwaZulu-Natal, South Africa: a community-wide phylogenetic study. The Lancet HIV. 2017; 4(1):e41–e50. [PubMed: 27914874]

40. WHO. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection. Geneva: WHO; 2016.

Table 1

Characteristics of 15–24 year old women in the study population and of men who reported at least one ongoing partnership with a 15–24 year old woman

	Women 15–24 years old who reported a sexual partnership (N=1459)	Men in partnerships with 15–24 year old women (N=1079)
Individual level data		
Black African	100%	100%
Age (mean)	20.7 [20.6–20.9]	23.5 [23.1–23.8]
Age categories		
15–19	31% [28–34]	20% [17–23]
20–24	69% [66–72]	43% [39–47]
25–29	-	27% [24–31]
30–34	-	6% [4–8]
35–39	-	3% [1–4]
40–49	-	0.7% [0.2–1]
Secondary school complete	56% [53–60]	54% [49–58]
Household monthly income		
<R500	16% [13–20]	18% [14–21]
R501–R2500	49% [45–53]	44% [39–48]
Age-disparate (5+ year gap)[#]		
Last partner[1]	32% [28–35]	na [Φ]
Any of last 3 partners[2]	36% [32–40]	na [Φ]
1st or any of last 3 partners[^,3]	42% [37–46]	na [Φ]
HIV+	29% [26–32]	15% [12–18]
Partnership level data		N=1229
Age-disparate (5+ age gap)	na	26% [22–30]
Age-disparate (5–9 year gap)	na	19% [16–23]
Age-disparate (10+ year gap)	na	7% [4–9]

95% Confidence Intervals in brackets.
na: Not applicable for this analysis.

[Φ] This figure has not been calculated as our data on men are restricted to those that reported an ongoing partnership with a 15–24 year old woman and data on partners older than 24 are therefore excluded.

[^] n = 1072 for this variable due to missing data on age at first sex or the age of participants' first partner.

[#] The three, separate age-disparate measures for young women are not mutually exclusive. They all include data on most recent partnerships.

[1] The first age-disparate measure identifies women who reported an age-disparity in their most recent partnership.

[2] The second age-disparate measure identifies women who reported an age-disparity in any of their three most recent partnerships, including their first.

[3] The third age-disparate measure identifies woman who reported an age-disparity in their first-ever partnership or any of their three most recent partnerships.

Table 2

The association between the three measures of age-disparate partnerships and HIV status among 15–24 year old women in bivariate and multiple logistic regression analyses.

	(1) HIV+ % [95%CI]	(2) HIV+ OR [95%CI]	(3) HIV+ aOR [95%CI]
Data included in analysis			
Last partner (N=1438)[a]			
Age-similar	25 [22–29]	ref	ref
Age-disparate[1]	36 [31–41]	1.62*** [1.26–2.09]	1.51*** [1.15–1.99]
Difference[^]	11***		
Last 3 partners (N=1459)[b]			
Age-similar	25 [22–28]	ref	ref
Age-disparate[2]	37 [32–42]	1.75*** [1.35–2.28]	1.58*** [1.20–2.09]
Difference[^]	12***		
1st or last 3 partners (N=1072)[c]			
Age-similar	22 [18–26]	ref	ref
Age-disparate[3]	35 [32–42]	1.92*** [1.41–2.61]	1.56** [1.08–2.26]
Difference[^]	13***		

Notes:

*** p<0.01,

** p<0.05,

* p<0.1.

[a] The sample size of N=1438 was reached after the following exclusions had been made from the HIPPS sample of 2224 women aged 15-to-24 years old: 667 women reported never having had sex; 1 woman was missing data on her partner's age; 118 women reported a recent partnership in which the start date of the partnership occurred after the reported date of an HIV-positive test.

[b] The sample size of N=1459 was reached after the following exclusions had been made from the HIPPS sample of 2224 women aged 15-to-24 years old: 667 women reported never having had sex; 1 woman was missing data on her partner's age; 97 women reported only a partnership(s) in which the start date of the partnership(s) occurred after the reported date of an HIV-positive test.

[c] The sample size of N=1072 was reached after the following exclusions had been made from the HIPPS sample of 2224 women aged 15-to-24 years old: 667 women reported never having had sex; 414 participants were missing data on first-ever partnerships, participants' age at first sex, or the partner's age; 71 women reported only a partnership(s) in which the start date of the partnership(s) occurred after the reported date of an HIV-positive test.

[1] The first age-disparate measure identifies women who reported an age-disparity in their most recent partnership.

[2] The second age-disparate measure identifies women who reported an age-disparity in any of their three most recent partnerships, including their first.

[3] The third age-disparate measure identifies woman who reported an age-disparity in their first-ever partnership or any of their three most recent partnerships.

[^] p-values for the differences reported in column 1 are based on two sample equality of proportions tests.

aOR: Adjusted odds ratios from multiple logistic regression models controlling for age of the woman (years); education (Grade 12 completed or not); having always lived in the area; household asset index (count of assets from 0–14); monthly household income; number of lifetime sexual

partners; HIV-testing history (no, yes) and number of useful sources of HIV information exposed to during the previous 12 months (0–16). 95%CI: 95% Confidence interval.
ref: the reference category in all logistic regression analyses is age-similar partnerships (i.e., partnership age-difference ≤4 years).

See Supplemental Digital Content 1, Table S1, for the full multiple logistic regression models presented in column 3, including coefficients for the control variables in each model.

Table 3

Multiple logistic regression models of HIV status and detectable HIV viral load among men in partnerships with 15–24 year old women.

	(1)	(2)	(3)	(4)
	HIV+	**HIV+**	**HIV+ with viral load≥1000 copies/mL**	**HIV+ with viral load≥1000 copies/mL**
	aOR (95%CI)	**aOR (95%CI)**	**aOR (95%CI)**	**aOR (95%CI)**
Partnership age-gap (ref:≤4 yrs)				
≥5 years	2.92***	na	2.05***	na
	(1.83 – 4.67)	na	(1.30 – 3.24)	na
5–9 years	na	2.29***	na	2.01**
	na	(1.37 – 3.82)	na	(1.18 – 3.43)
10+ years	na	5.39***	na	2.17**
	na	(2.54 – 11.44)	na	(1.01 – 4.66)
Age of female partner (years)^	1.17***	1.17***	1.20***	1.20***
	(1.08 – 1.26)	(1.08 – 1.26)	(1.10 – 1.30)	(1.10 – 1.30)
Observations	1,229	1,229	1,229	1,229

Notes:

*** p<0.01,

** p<0.05,

* p<0.1.

Adjusted odds ratios with 95% CI in parentheses.
Robust standard errors, clustered at the enumeration area level.

^ The age of women in the reported partnerships is measured in years (15–24).