SEXUAL PARTNER TYPE AND RISK OF INCIDENT HIV INFECTION AMONG ADOLESCENT GIRLS AND YOUNG WOMEN IN RURAL SOUTH AFRICA

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ABSTRACT

Nadia Nguyen: Sexual Partner Type and Risk of Incident HIV Infection among Adolescent Girls and Young Women in Rural South Africa
(Under the direction of Audrey Pettifor)

Adolescent girls and young women (AGYW) in South Africa face an unparalleled HIV burden and are a key population in need of intervention. Sexual partners play a critical role in HIV transmission by exposing young women to HIV and by encouraging risk behaviors that increase the risk of infection. However, sexual partners have not been well characterized, and approaches that use pre-specified labels to categorize partners into main versus casual types may not capture important differences between sexual partner types that increase AGYW's risk of HIV infection.

Thus, the overall goal of this dissertation was to develop a better understanding of the different types of sexual partners among AGYW in rural South Africa, identify which partner types pose the greatest risk for HIV infection among AGYW, and identify AGYW-level risk factors which predict partner selection. We followed 1034 AGYW enrolled in a randomized controlled trial in South Africa and used latent class analysis (LCA) to identify sexual partner types based on reported partner sociodemographic and behavioral risk factors from 2968 reported partners over three years of follow up.

We identified six, distinct sexual partner types, which differed by age, school enrollment, concurrency, condom use, transactional sex, perceived HIV-status, and other risk factors. AGYW applied the label main partner/boyfriend broadly to describe a wide variety of partner types identified by LCA. Partner types identified by LCA strongly predicted incident HIV infection among AGYW, while partner types based on pre-specified labels were not significantly associated with HIV infection. AGYW who were not enrolled in school, reported

high risk sexual behaviors (young age at first sex and multiple sexual partners in the past year), and reported substance use were more likely to select high risk sexual partners associated with increased risk of HIV infection compared to AGYW who did not report these behaviors.

These results highlight the limitations of the main versus casual distinction as a proxy measure for other sociodemographic and behavioral differences between partners. Partner types based on explicit, reported partner characteristics offer an alternative model for measuring and targeting specific partner types for HIV research and intervention.

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LIST OF ABBREVIATIONS

ACASI	audio computer-assisted self-interview
AGYW	adolescent girls and young women
AIC	Akaike Information Criteria
BIC	Baysian Information Criteria
CI	confidence interval
DAG	directed acyclic graph
DF	degrees of freedom
GEE	generalized estimating equations
HDSS	health and demographic surveillance system
HIV	human immunodeficiency virus
HPTN	HIV Prevention Trials Network
HS	high school
IRR	incident rate ratio
IQR	interquartile range
LCA	latent class analysis
No.	number
Mo.	months
SD	standard deviation
RR	risk ratio (aRR = adjusted risk ratio)
STI	sexually transmitted infection

CHAPTER I: SPECIFIC AIMS

Adolescent girls and young women (AGYW) in South Africa face an unparalleled HIV burden and are a key population in need of intervention. Sexual partners play an important role in HIV transmission by exposing AGYW to HIV and by facilitating risk behaviors that increase the risk of infection. However, efforts to study and target specific sexual partner types for HIV prevention have been stymied by current measurement approaches which have primarily focused on partner risk factors individually without considering the sexual partner as a whole person.

Studies that examine the isolated effect of single partner risk factors on HIV risk, or that examine the effect of multiple factors in a single model holding other factors constant, do not capture the cumulative impact of partner risk factors on HIV risk and may not be realistic, as risk factors rarely exist in isolation. Risk scores consider multiple risk partner factors together, but treat them as exchangeable, thus they have not deepened our conceptual understanding of the different types of sexual partners. Studies that rely on people to categorize their sexual partners into types using pre-specified partner labels (e.g., main partner, casual partner) may not identify differences between partner types that are meaningful to HIV transmission because these labels are not explicitly tied to specific risk behaviors. To the extent that partner risk factors cluster to form distinct sexual partner risk types, targeting especially high risk sexual partner types, and AGYW with high risk partners, may be an effective strategy for preventing HIV infection.

The overall goal of this dissertation is to develop a more nuanced understanding of sexual partner types among AGYW, identify which types of sexual partners result in the highest risk of HIV infection for AGYW, and which AGYW-level risk factors predict sexual

partner selection. We used data from a randomized controlled trial of cash transfers for HIV prevention among 2533 AGYW, ages 13-20 at enrollment and living in rural, Agincourt South Africa. The trial collected self-reported data on AGYW's three most recent sexual partners and tested girls for HIV annually, at 12, 24, and 36 months. A richer understanding of which sexual partner types are most strongly associated with incident HIV infection among AGYW may improve the design and targeting of interventions to those at greatest risk

Aim 1: Identify sexual partner types among AGYW living in rural South Africa and AGYW-level of predictors of partner selection.

Hypothesis: Sexual partners are classifiable into distinct, identifiable types, and certain AGYW-level risk factors predict partner selection.

Methods: We measured sexual partner types using two approaches: 1) using conventional pre-specified partner labels (main partner/boyfriend, regular casual sex partner, non-regular casual sex partner), and 2) using a novel approach, latent class analysis (LCA), which identified underlying, latent sexual partner subtypes from a set of categorical partner factors self-reported by AGYW. After identifying sexual partner types, we used generalized estimating equations (GEE) with a robust variance estimator, exchangable correlation matrix, binomial distribution, and log link to estimate risk ratios (RR) and 95% confidence intervals (CIs) for the association between AGYW-level sociodemographic and behavioral risk factors and risk of AGYW having a specific partner type identified through LCA.

Aim 2: Estimate the association between sexual partner types (identified in Aim 1) and risk of incident HIV infection among AGYW living in rural South Africa.

Hypothesis: Certain sexual partner types are associated with increased risk of incident HIV infection among AGYW, while other types are protective.

Methods: We used generalized estimating equations (GEE) with a robust variance estimator, exchangable correlation matrix, binomial distribution, and log link to estimate risk

ratios (RR) and 95% confidence intervals (CIs) for the association between AGYW having a specific sexual partner type and risk of incident HIV infection.

CHAPTER II: BACKGROUND

1 Overview

HIV remains a significant public health problem throughout the world, particularly among adolescent girls and young women in sub-Saharan Africa. Adolescent girls and young women (AGYW) ages 15-24 are a key population in Southern Africa, contributing nearly 30 percent of all new infections (1-3) and seroconverting 5-7 years earlier than their male peers (3, 4). The burden of HIV is particularly acute among young women in South Africa, where 113,000 young women become HIV infected each year, a number more than four times that of their male peers (3). In this setting, HIV prevalence increases rapidly as young women transition from adolescence to adulthood, from 5.6% among women under 15, to 17.4% among women 15-19, to 28.4% among women 20-24 (3). Preventing HIV infection in this highly vulnerable population during this critical transition period is essential for both individual and public health.

Preventing HIV infection among AGYW requires looking beyond individual-level risk factors. Numerous studies have documented that age, gender, race, use of alcohol, number of sexual partners, STIs, patterns of condom use, and types of sexual acts are consistent individual-level risk factors for HIV infection among heterosexual youth in sub-Saharan Africa (5-7). These findings have motivated prevention efforts which have focused primarily on individual-level behavior change, including abstaining or delaying sex, consistent condom use with all partners, monogamy, and avoiding new and older multiple partners (8). However, sexual activity is not an individual attribute, but is a behavior that is negotiated between sexual partners and influenced by the characteristics of both partners and the resulting dynamics between them (9, 10). Studies suggest that AGYW with the highest risk

sexual partners, not just those with the riskiest sexual behaviors, are at greatest risk for HIV infection (11-13). Thus, it is important to consider the role of sexual partners, specifically risk characteristics of those partners, when developing effective HIV prevention programs targeted toward young people.

2 Limitations in sexual partner research

Sexual partners play a critical role in HIV transmission, yet there is limited understanding of how partner-level characteristics and partnership dynamics influence risk of infection. Sexual partners impact a person's risk of HIV infection by determining their position within a sexual network, by directly exposing people to HIV, and by facilitating risk behaviors that increase the risk of transmission. However, our understanding of how attributes of sexual partners and partnership dynamics influence risk of infection, particularly among AGYW in sub-Saharan Africa, is very limited (10). According to a recent review, the vast majority of studies examining the association between partner characteristics and risk of HIV infection have been conducted in high-income/developed countries rather than in countries with generalized HIV epidemics (12). Moreover, many of these studies have relied on self-reported HIV or STI status or prevalent HIV or STI infection to draw conclusions, rather than laboratory confirmed, incident HIV infection, which is necessary to establish a temporal relationship between sexual partner risk factors and HIV acquisition. These studies have also focused primarily on partner concurrency and partner age disparity over other potentially important partner characteristics and determinants of partnership dynamics, including power, intimacy, and communication within a partnerships (10). Lastly, when these partnership factors have been examined, it has been one at a time, often as determinants of condom use, without consideration for how they work together to increase risk of HIV infection (10). Preventing HIV infection requires understanding which types of sexual partners are likely to be infected, what partner-level characteristics and partnership

dynamics facilitate transmission, and importantly, how these factors work together to further exacerbate risk of infection.

3 Partner risk factors associated with HIV infection

Age and economic asymmetries, transactional sex, low relationship power, and intimate partner violence are closely related factors that individually increase the risk for HIV infection and may also interact to further increase the risk of infection. Nancy Luke, who has written extensively about the exchange of money and gifts within nonmarital sexual partnerships in sub-Saharan Africa has argued that "risky behaviors […] depend not only on the characteristics of the two individuals in the match but also the power differentials between them" (9). Age and economic asymmetries and intimate partner violence can fuel power imbalances, which can lead to risk behaviors associated with HIV infection, including low condom use and poor communication between partners.

3.1 Relationship power and intimate partner violence

The association between low relationship power, intimate partner violence, and HIV infection are well documented in South Africa. Low relationship power can increase the risk of HIV infection by reducing women's ability to negotiate sexual encounters, by exposing women to riskier sexual partners, and by making sexual experiences riskier (14). Intimate partner violence (IPV), in particular, is one way in which a sexual partner can exert power over their partner, leading to increased HIV risk. In a longitudinal study of young women living in the Eastern Cape province of South Africa who were enrolled in Stepping Stones (a randomized controlled trial of communication and relationship skills to prevent HIV/STIs), young women with low relationship power had 1.51 times the rate of HIV infection compared to young women who had high power at baseline (95% CI: 1.05, 2.17). This same study also found that young women who reported experiencing more than one episode of IPV were significantly more likely to be HIV infected compared to women who reported one or no episodes of violence (IRR: 1.51, 95% CI: 1.04, 2.21). Moreover, women with low power were

significantly more likely to have experienced physical or sexual IPV than women with high power (p=0.01) (14).

The association between low power, intimate partner violence, and HIV infection is also supported by earlier cross-sectional studies, including other studies in South Africa (15), Rwanda (16), Tanzania (17), and India (18). Partners who perpetrate intimate partner violence may be particularly high risk because they have more sexual partners (19-22), have sex more frequently (19, 23), and are more likely to be HIV infected (15, 24, 25). In addition, women who experience financial or physical abuse from a main partner are less likely to suggest condom use (26, 27). In contrast, partnerships with less relationship conflict and higher gender equity are associated with more consistent condom use (28).

Efforts to prevent HIV infection by improving women's empowerment and reducing intimate partner violence, however, have yielded mixed results. While a randomized controlled trial of microfinance (IMAGE trial) to prevent HIV infection in rural South Africa was effective at substantially reducing IPV, increasing progressive attitudes towards IPV, and decreasing controlling behaviors by sexual partners, it had no impact on incident HIV infection (29). These findings suggest that interventions that address economic and social empowerment of women can contribute to reductions in IPV (30) but the impact of such interventions on HIV infection may be more limited or may require a longer follow-up period to have an impact.

3.2 Age-disparate partnerships

Age-disparate partnerships are routinely named as an important driver of HIV infection, however the evidence supporting this association have been mixed. Age disparate partnerships, defined as partnerships in which the woman is five years or younger than her male partner, are thought to increase the risk of HIV infection because they facilitate risky sexual behavior, including unprotected sex (27, 31-33), transactional sex (9), and male partner concurrency (34); because they are associated with limited communication about

HIV (27, 32, 33, 35); and because they link young women to older men who are more likely to be HIV infected due to their age and number of lifetime sexual partners (9, 32, 34, 35). In particular, there has been concern that sexual behaviors may be especially risky among partnerships involving “sugar daddies”, which are characterized by an age difference of 10 years or greater (considered cross-generational), economic disparities, and transfers of cash and gifts (32, 36-39). Although true “sugar daddy” partnerships are quite rare (32), a review of over 45 studies of cross-generational and transactional sexual relationship in sub-Saharan Africa found that there is a widespread transactional component to sexual relations among adolescent girls who are not engaged in trafficking and prostitution (9).

The association between partner age difference and prevalent HIV infection has been demonstrated in several cross-sectional and ecological studies (6, 40, 41), however findings from longitudinal studies have been mixed. The first study was a population-based study of women ages 15-29 in rural KwaZulu-Natal, South Africa (42). Thirty-seven percent of women reported having a partner 5 or more years older, which is comparable with the South African average of 32.6% (6). Age disparity was not associated with incident HIV infection when measured continuously (Hazard Ratio (HR) for a 1-year increase in partner’s age (HR: 1.00, 95% CI: 0.97, 1.03) or categorically (HR for man ≥5 years older: 0.98, 95% CI: 0.81, 1.20; HR for a man ≥10 years older: 0.98, 95% CI: 0.67, 1.43) (42). The second study was among women ages 18-45 living in the Durban, Johannesburg, and Klerksdorp areas of South Africa and enrolled in the VOICE microbicide trial (43). Twenty-six percent of women reported having a male partner more than 5 years older and 5% reported having partners more than 10 years older. Age disparity was again not associated with incident HIV infection when measured continuously (HR: 1.01, 95% CI: 0.97, 1.05) or categorically (HR for a man >5 years older: 1.00, 95% CI: 0.74, 1.35; HR for a man >10 years older: 0.92, 95% CI: 0.74, 1.74), and results did not vary after stratifying by the woman’s age.

However, recent evidence from a phylogenetic study in KwaZulu-Natal, South Africa suggest a transmission cycle whereby AGYW ages 15-24 are HIV infected by older male sexual partners, who were infected by their same age female partners (44). The transmission cycle continues when current AGYW reach their 30s and become the next generation of women with high HIV prevalence. Researchers had hypothesized that one possible explanation for the lack of an association between older partner age and incident HIV infection among women may be that although older men are more likely to be HIV infected than younger men, in South Africa younger men are more likely to be recently infected and less likely to be on ART, making younger men potentially more infectious (45, 46). However, two recent studies examining the association between older partner age and HIV infection among AGYW in Zimbabwe from 1998-2013 (47) and in South Africa from 2002-2012 (48) found that this relationship did not vary during pre- versus post-ART eras. Moreover, data from the most recent South African National HIV survey (2012) suggest that men in age-disparate partnerships with women ages 15-24 are more likely to be HIV positive and ART-naïve than men in similar-age partnerships (49).

Other key factors that may explain these conflicting results is the fact that the population-based study limited reported partners to only the most recent sexual partner (which may have biased the sample towards longer partnerships), and the VOICE trial limited partners to only primary partners (which may have biased the sample toward safer, more socially acceptable partners). Thus, reported partners in these studies may not represent all sexual partners and may exclude the highest risk partners. The population-based study also used face-to-face interviews by fieldworkers from the local community, rather than more anonymous data collection methods, which may have resulted in social desirability bias. Third, participants in the VOICE trial were tested for HIV monthly, which may have had an unintended prevention effect.

3.3 Transactional sex

Financial and material exchange is commonly cited as a motivating factor driving sexual relationships in sub-Saharan Africa and may have implications for HIV transmission risk. Exchanges between sexual partners can take a variety of forms, from financial or material gifts which serve to express affection or strengthen the relationship, to entitlements such as child support, to financial or material transfers which come with an expectation of sexual access or other services in return for the transfer (50). Partnerships which fall into this latter category – in which sex is traded for money or goods (transactional sex) – are hypothesized to be particularly important for HIV risk for a number of reasons. First, transactional sex may result in power imbalances between sexual partners, which can interfere with the less powerful partner's ability to advocate for condom use (51, 52). For example, a study in Kenya found that the likelihood of condom use at last sex with a non-marital partner decreased as a man's financial and material contributions over the last month increased (32). Second, these partnerships may also incentivize women to have sex in situations where they might otherwise abstain and may provide an incentive for women to seek multiple sexual partners to fulfil different financial and material needs. Although transactional partnerships have traditionally been conceptualized as exploitative and oriented towards subsistence (e.g., food, shelter), more recent studies, including findings from our parent study, have demonstrated that materialism and a desire to increase one's social standing are also important drivers of transactional sex (9, 36, 50, 52-59). Third, transactional sex may increase women's vulnerability to gender-based violence and sexual exploitation because men expect that their contribution be reciprocated with sex (60, 61) and because women may also be more likely to tolerate physical and sexual violence in partnerships because they provide needed resources (60). Kirsten Dunkle and Rachel Jewkes have written extensively about the relationship between transactional sex, IPV, and rape in South Africa, and have argued that transactional sex is part of a broader pattern of

behaviors tied to views of masculinity, which can include IPV, rape, and substance use (60, 61). Specifically, they have conducted a number of studies that have linked transactional sex to intimate partner violence (61), rape, and having more sexual partners (62).

To our knowledge, only one longitudinal study has examined the association between transactional sex and incident HIV infection. The study was conducted among young women living in the Eastern Cape province of South Africa and found that HIV incidence was greatest among women who reported having transactional sex with a one off partner (IRR 3.29 95% CI 1.02, 10.55) and having transactional sex with an on-going, concurrent partner (IRR 2.05 95% CI 1.20, 3.52) compared to not having transactional sex with such a partner (63). In addition, they found that the impact of transactional sex on risk of HIV infection was independent of partner number; young women who reported having transactional sex and two or more sexual partners had significantly greater risk of HIV infection (IRR: 2.23 95% CI 1.28, 3.88) than young women who reported having two or more partners with no transactional component (IRR 1.20 95% CI 0.81, 1.77). The association between transactional sex, risky sexual behavior, and HIV infection has also been demonstrated in cross-sectional studies in South Africa (64), including one that found that partnerships with both age and economic differences, which typify “sugar daddy” partnerships, are associated with greater economic transfers and low condom use (35).

In summary, age and economic asymmetries, transactional sex, low relationship power, and intimate partner violence are closely related risk factors that may interact to increase the risk of HIV infection. While older partner age may not play as large a role in HIV transmission as previously thought, additional studies are needed that examine this association in other contexts and in conjunction with other partner risk factors that may interact. Sexual exchange plays a central role is the vast majority of partnerships in South Africa, though women engage in transactional sex for many different reasons, including voluntarily to access material comforts to relying on transactional sex for survival. At its most

extreme, transactional sex is part of a broad spectrum of risk behaviors which include IPV in which men exert control over women. There is strong evidence that both IPV and low relationship power increase risk of HIV infection, and men who perpetrate IPV may be particularly high risk because they have more sexual partners, have sex more frequently, and are more likely to be HIV infected. Collectively, these findings suggest that partner factors that influence decision making and power dynamics within partnerships not only co-vary but may work together to increase risk for HIV infection and should therefore be examined together along with other, important partner factors.

4 Predictors of condom use

Sexual behaviors – specifically condom use – are dictated by the nature and quality of the partnership, which include factors such as level of intimacy, familiarity, commitment, presumed fidelity, love, and trust. In studies of partnership dynamics, partner intimacy is most often studied in the context of its influence on condom use, however exactly how intimacy influences condom use and other sexual risk behaviors is still not well understood (10).

4.1 Partner intimacy

Partner intimacy is often measured using proxy measures like self-reported partnership type, partnership duration, coital frequency, and whether the partners cohabit, with the assumption that more frequent and sustained sexual contact implies greater intimacy and commitment. For example, casual partnerships are implicitly assumed to be less intimate than ‘main’ or ‘steady’ partnerships, and similarly newer partnerships are assumed to be less intimate than partnerships of longer duration. These studies have generally found that condom use is highest in newer or more casual partnerships than in more established partnerships. A study of urban adolescents in the US found that adolescents were more likely to report condom use at last sex with unfamiliar partners (defined as partners who were casual or with whom sex was unexpected) than with familiar

partners (65). Similarly, a study of South African adolescents enrolled in a cluster-randomized HIV prevention trial found that condom use was more common in casual partnerships and in partnerships where sex was less frequent (13). These findings are supported in other populations as well, including in Britain (66), Tanzania (67-69), and South Africa (13, 70, 71). At the same time, interpreting data on coital frequency and partnership duration may be more complicated in the South African context and other areas where it is common for men to engage in seasonal migrant work. As a result, partnerships among young people, particularly in rural areas, can be long in duration but also characterized by long periods of separation without any sexual activity, despite being described in highly romantic terms (72-74).

4.2 Trust, distrust, and partnership quality

Perceptions about trust and the quality of a partnership may also play a critical role in determining condom use. Studies routinely cite fear of implying distrust as a major barrier to using or even discussing condoms in more established sexual partnerships (51, 75-77). Yet exactly how trust influences condom use in South Africa is a complex issue, particularly among adolescents. Adolescents demonstrate that they highly value trust in their partnerships, but assign trust to partnerships that do not meet traditional definitions of trustworthiness (e.g., monogamy) (75, 76, 78). As a result, adolescents may report that they trust their partner despite knowing that their partner has other concurrent partners. They may also avoid using condoms with these partners because they do not want to imply distrust. For example, in a study of young, rural South African women, women who reported associating a lack of trust with condom use were less likely to report consistent condom use than women who did not make this association (28). In contrast, studies have demonstrated that the nonuse of condoms is associated with greater perception of relational intimacy, suggesting that couples may perceive the phasing out of condoms to be a signal of their level of commitment and trust (79, 80). At the same time, there is evidence that relationship

quality may increase condom use: among young women in rural South Africa, consistent condom use was associated with higher gender equity in partnerships with a male partner and less conflict, suggesting that gender equity, monogamy, and harmonious partnerships play a positive role on enabling condom use (28). Studies have also shown that partnerships in which partners have a child together may operate under a different set of partnership dynamics due to greater intimacy between partners and a motivation to engage in behaviors "for the good of the child." Specifically, both qualitative and quantitative studies have documented that contraceptive use and condom use are significantly lower when partners have parented a child together compared to partners who have not (81-86)

4.3 Contextual factors and evolving partnership dynamics

Condom use may also depend on other contextual factors, including total number of sexual partners and how the partnership relates to other, concurrent sexual partnerships. One study found women with only one sexual partner in the past year had three times the odds of reporting consistent condom use compared to women with more sexual partners, suggesting that while having multiple sexual partners can result in increased condom use due to risk compensation, consistent condom use may be facilitated by the greater relative stability of just having one partner (28). This same study also found that women with only one partner had much more equitable power distribution in their relationships than women with more partners, which may have contributed to more consistent condom use. In another study among men in Tanzania and Ghana who reported at least three sexual partners in the past three months, men were more likely to report condom use with a girlfriend if their other partner was a wife compared to if their other partner was a sex worker (69).

Finally, it is important to recognize that sexual behaviors like condom use are likely to change over time as partnerships mature and evolve. Studies document that condom use behavior can change rapidly over a just short period of time as partners become more familiar and there are greater expectations of trust and fidelity (87). In a study of urban

adolescents in the US, rates of condom use between familiar and unfamiliar partnerships were indistinguishable after just 21 days (88), while among British adults, rates of condom use at last sex fell quickly and plateaued just six months after relationship formation (66).

4.4 Partner communication

Partner communication is an important precursor to condom use and may influence other sexual risk behaviors. Consistent condom use is the most effective strategy for preventing HIV infection among sexually active people; however, condom use requires communication and cooperation between both sexual partners and is highly dependent on partnership dynamics and contextual factors, such as the type and quality of the partnership. Several meta-analyses have examined the role of safer sexual communication and condom use, finding that sexual communication is moderately to strongly correlated with condom use, with estimates ranging from r=0.16 (89), to 0.22 (90), to 0.46 (91). The most recent meta-analysis examined 55 studies and stratified results by topic discussed, finding that the association between communication specifically about condom use (e.g., In the past 3 months, how often have you discussed condom use with a sexual partner?) to be the strongest predictor of actual condom use (r=0.25) when compared to communication about sexual history (r=0.23), and communication about safer sex generally (r=0.18) (90).

In South Africa, condom use at last sex is relatively low at only 48% for women and 57% for men, despite the fact that condoms are widely available for no cost (6), and are accepted among young South Africans as protective against HIV, STIs, and unwanted pregnancy (92). Studies in South Africa have also demonstrated that women who are unable to communicate with their partners are more likely to be involved in risky sexual behavior, though the relationship between partner communication and condom use has not been demonstrated among South African men (26, 75, 76, 93) This discrepancy may be explained by predominant gender norms in South Africa, which position men as the decision makers in sexual encounters. Thus, while women must communicate their desire to use a

condom, men have the “right” to make such a decision without discussion (15, 75, 76, 94). Encouraging partner communication about condom use, and further understanding factors that may encourage communication (e.g., education, equity) or impede communication about condom use (e.g., feeling like the relationship was not good) may be a key HIV prevention strategy (27).

5 Approaches for measuring sexual partner type

Sexual risk behaviors that impact HIV and STI transmission vary greatly by partnership type, however, efforts to study and target sexual partners for HIV prevention have been stymied by current partnership measurement approaches. To date, studies that have examined sexual partnerships have employed one of four approaches: 1) considering factors one at a time by estimating the isolated effect of a single partner risk factor on HIV risk and carefully controlling for confounding factors (“single risk factor approach”), 2) considering multiple partner factors in a single model but estimating the impact of each partner factor on HIV risk individually (“multiple risk factor approach”), 3) relying on participants to self-report their partnership type based on pre-specified labels (e.g., main partner, casual partner, sex work partner, one-time partner), or 4) constructing a risk index or algorithm designed to identify high risk sexual partners from a collection of risk factors. The first three approaches characterize sexual partnership risk types too simply and in ways that do not reflect real-world partnerships, while the fourth approach is an improvement on earlier methods but does not capture interactions between partner risk factors and does not differentiate between different types of sexual partnerships.

5.1 Multiple risk factor approach

A number of studies have utilized the multiple risk factor approach to examine potential associations between sexual partner risk factors and HIV/STI infection. This approach is most appropriate for exploratory analyses as it can allow one to examine multiple factors at one time and estimate the importance of each partner factor on HIV risk

holding the other risk factors constant. However, a key limitation of this approach is that it does not allow one to consider the cumulative impact of multiple partner factors on HIV risk, nor does it reflect how these risk factors are distributed in the real world (95).

Mathur et al used longitudinal data (2005-2001) from a population-based cohort of 2862 young people ages 15-24 in rural Uganda to identify partner characteristics associated with incident HIV acquisition (96). Participants were asked about partner-level characteristics (socio-demographic characteristics, sexual activity, and perceived HIV infection risk) for their four most recent sexual partners in the past year, but were not asked about partnership dynamics (e.g., transactional sex, power, communication). After controlling for individual-level characteristics associated with increase rate of HIV acquisition and stratifying by marital status (most were married or reported only one sexual partner), they found that being in a non-marital relationship with a sexual partner (IRR: 1.60, 95% CI: 1.11, 2.32), having a partner who drank alcohol before sex (IRR: 1.57, 95% CI: 1.11, 2.22), and having a partner who used condoms inconsistently (IRR: 1.99, 95% CI: 1.33, 2.98) were associated with higher rates of HIV acquisition, holding other partner characteristics constant. These findings confirm earlier findings that partner characteristics, the type of partnership, and the context of sexual activity are important determinants of HIV risk for female youth (5).

Hargreaves et al. examined the association between individual and partner-level characteristics on condom use at last sex and HIV infection with cross-sectional data from 1556 young people ages 14-35 enrolled in a cluster randomized trial (IMAGE trial) (13). Participants were asked to report on their three most recent non-spousal sexual partners in the past year, and were asked about partner type, partner marital status, time since first sex, coital frequency in the past year, age, age difference, resource exchange, belief that partner has other sexual partners, and perception of the partner's risk of infection. After controlling for individual-level factors, the authors found that condom use was more common in casual

partnerships and in partnerships where sex was less frequent, and that male partner age was a strong predictor of condom use, supporting earlier findings that men typically control sexual decision making. Coital frequency was the only significant predictor of HIV infection. The authors conclude that characteristics of sexual partners are associated with condom use and HIV infection even after controlling for individual-level risk factors.

5.2 Pre-specified partner labels approach

Studies using pre-specified partner type labels have consistently shown that risk behaviors vary by partner type, with the strongest and most consistent associations with condom use. However, a major limitation of this approach is that partner types are not linked to specific characteristics or risk behaviors, thus categorizations are subject to the participants own interpretation of the meaning of different partner types. For example, adolescents frequently describe hook-up partners as friends or ex-romantic partners (65, 97). Participants also vary in the attributes that they associate with main partnerships (98) and participant views may differ from that of researchers. For example, in a study of women who reported having sexual partnership of more than six months, only a portion of the women identified these partnerships as committed, even though this is what is typically assumed by researchers when referring to main partnerships partnership (99). There is also ambiguity among terms used across different studies, which include main/steady partner (60, 81), boyfriend/girlfriend (13, 69), cohabiting partner (66), casual partner (60, 65, 81, 100), “primary” partner (73, 100), regular partners (66), and marital partner (13, 66, 69, 96). Occasionally, studies will also include additional variations, including sex work or transactional partner, friends with benefits, baby daddies/baby mamas, or one time sexual partner (81, 101, 102). It is unclear the extent to which these terms map on to each other, thus limiting our ability to compare findings across studies.

An additional limitation of most partnership studies is that the partnership type categories offered by researchers may exclude potentially relevant partnership types, as

researchers typically do not consult participants prior to designating these types (102, 103). Moreover, the designation of partnerships types is not tied to specific risk factors that may influence HIV transmission, including frequency and type of sexual contact, and other potentially important measures of partnership dynamics (10, 103, 104). While there have been some efforts to qualitatively describe different sexual partnership types (104, 105), this work has not reached quantitative studies. Finally, some studies may only focus on a specific type of partner (e.g., primary partner) and will only elicit information on these types of partners (43).

5.3 Risk index approach

The risk index approach has been used in a number of studies to successfully identify high risk sexual partners associated with HIV/STI infection. However, a limitation of this approach is that it does not account for potential interactions between factors, and it cannot be used to identify specific types of high risk sexual partners, as a specific risk score could be achieved through a variety of risk factor combinations. Moreover, many risk indexes weigh risk factors equally despite the fact that different risk factors may be more or less important for transmission.

Crosby and Shrier constructed a simple risk index based on sexual partner characteristics to identify adolescents and young adults at risk for STIs (101). Respondent were recruited from three US cities and were asked to provide information on sexual partners from the past three months. The authors then constructed a modified risk index using cross-sectional data by defining exposure (“high risk”) as having sex with a newly released prisoner, having sex with a partner known or suspected of having an STI, or having sex with a partner who had other concurrent sexual partners, and found that scoring “high” on the risk index was associated with prevalent Chlamydia, gonorrhea, or trichomonas infection (OR=1.80, 95% CI: 1.27, 2.55). Key limitations of this study were that in most cases, partner concurrency was the only risk factor that that qualified a partner as high risk,

the authors assumed that all the risk factors were exchangeable by giving them all the same weight in the index, and the authors did not distinguish between infection by Chlamydia, gonorrhea, or trichomonas.

Kahle et al. developed a risk score algorithm to identify discordant couples at high risk for HIV-transmission, using data from 3408 couples enrolled in longitudinal studies of HIV serodiscordent couples from seven African countries (106). The authors selected risk factors that could be measured in standard research and clinical settings, and constructed a risk score algorithm consisting of demographic (age of the HIV uninfected partner, married and/or cohabitating, number of children), behavioral (unprotected sex), clinical (uncircumcised male HIV uninfected partner), and laboratory measures (plasma RNA in HIV infected partner). The risk score was obtained by modeling the risk factors together, dividing the beta coefficients for each risk factor by the lowest coefficient among all predictors, rounding to the nearest integer, and summing the individual risk factor values. Examining multiple risk factors in a single algorithm resulted in better predictive capability than examining single risk factors: unprotected sex predicted 55% of all HIV seroconversions, uncircumcised status of male uninfected partners predicted 63% of male HIV seroconversion, while couples with scores ≥6 accounted for 67% of transmissions despite constituting only 28% of the population. The couples examined in this study were generally older and in longer, more stable partnerships; similar studies are needed among younger people in less stable partnerships.

5.4 Latent class analysis approach

Partner factors should be examined together in a person-centered way that reflects real-world partnerships and that captures potentially important patterns of risk factors and their cumulative and potentially interactive effects on HIV infection. Partner factors do not exist in isolation and may co-occur in potentially important patterns that may magnify their impact on HIV risk. Studies have documented that HIV predictability improves greatly when

multiple partner characteristics are considered simultaneously (65, 101). To the extent that partner risk factors cluster to form distinct sexual partner risk types, targeting especially high risk sexual partner types, or people with high risk sexual partners, may be a highly effective strategy for preventing HIV/STI infection.

Latent class analysis (LCA) is a promising approach for identifying high risk sexual partner risk types. LCA is a latent variable model that identifies underlying, unobserved, latent subgroups (classes) in a population from a set of observed, categorical indicators. LCA has been used in a small number of HIV studies to identify different patterns of high risk sexual behavior (107-109); however, to our knowledge, no study has used LCA to identify sexual partner types that predict incident HIV infection.

Sandfort et al. conducted a cluster analysis to identify different types of sexual partnerships using cross-sectional data from 300 South African men who have sex with men (MSM) (110). Cluster analysis and LCA are similar in that they can both be used to identify groups of people who are similar across a set of measured indicators, however a key difference between these approaches is that in cluster analysis, people are assigned to clusters based on an algorithm that groups similar people together using distance measures or other predetermined metrics, whereas LCA identifies underlying latent subgroups using a model based approach (111). The model based approach has a number of advantages over cluster analysis, including the ability to use fit statistics to inform the number of risk groups, not having to standardize variables before including them, and the ability to use variables of different scales (dichotomous, nominal, continuous). Nonetheless, using the cluster analysis approach, they identified four distinct partnership types, which differed with respect to age, race, and economic disparities between partners, level of commitment, and familiarity, and found that partnership type was associated with transactional sex, alcohol or drug use before sex, and unprotected sex at last anal intercourse. Additionally, they found that a person's race, education level, residence in a township, level of social support, and HIV

prevention self-efficacy predicted partner selection. Unprotected anal sex was common among two of the four partnership types but for different reasons: among a high risk partnership type, unprotected anal sex may have been driven by low social support and low HIV prevention self-efficacy, while among a low risk partnership type, unprotected anal sex may have been attributable to a large proportion of respondents knowing that their partner was HIV-negative. These findings suggest that the same risk behaviors may have different implications for HIV transmission depending on the partner context and highlight the importance of developing more nuanced characterizations of sexual partner.

6 Predictors of sexual partner type

New HIV prevention strategies, including treatment as prevention (TasP) and pre-exposure prophylaxis (PrEP) offer the potential to markedly decrease HIV transmission. However, to have the greatest impact on preventing HIV transmission while containing costs, strategies are needed to most effectively target individuals at the highest risk of infection, including those with the highest risk sexual partners.

To date, studies examining predictors of having a high risk sexual partner have been limited by the fact that sexual partners themselves have not been well characterized, and have focused on partners who are older, transactional partnerships, and partnerships with low condom use. These studies have generated limited evidence that sociodemographic factors like schooling, household SES, food security, and orphan status, and behavioral risk factors like alcohol use or having many sexual partners may influence partner selection. Schooling is hypothesized to be protective because it contributes to girls' sexual and social networks and facilitates girls selecting partners who are peers (112-114). Household factors like household SES, food security, and orphan status are hypothesized to influence a girl's overall vulnerability to HIV and may influence her propensity to rely on sexual partners for survival (115, 116). Studies have tested this hypothesis through examining the influence of social protections programs like cash transfers on partner selection and there is limited

evidence that girls are less likely to select high risk partners when provided minimal financial support (117, 118). Lastly, girls who engage in risky behaviors like drinking alcohol, visiting alcohol establishments, or having many sexual partners may be at greater risk of having a high risk sexual partner both because this behavior may reflect a tendency toward risk seeking behavior and because it may also attract higher risk sexual partners (119-126). Studies are needed to better understand factors that make young women vulnerable to selecting high risk sexual partners and factors that simply predict which young women are likely to have high risk sexual partners so that we can more effectively target them for interventions.

CHAPTER III: RESEARCH DESIGNS AND METHODS

1 Overview

The overall goal of this dissertation was to understand how sexual partners influence incident HIV infection among rural, South African adolescent girls and young women (AGYW) and to identify predictors of sexual partner type. To answer this question, we used longitudinal data from the Effects of Cash Transfer for the Prevention of HIV in Young South African Women study (HPTN 068), a phase III, randomized controlled trial of cash transfers for HIV prevention in rural South Africa. The study collected data on adolescent girls ages 13-20 at enrollment and their three most recent sexual partners from March 2011 to March 2015. Using this data, we constructed a latent variable measure for sexual partner type by doing a latent class analysis using the following 10 partner indicators: partner age, school enrollment, children with AGYW, children with other women, cohabit with AGYW, sex only one time, always uses condoms, HIV-status, partner has other concurrent sexual partners, and transactional sex. We compared sexual partner types identified through latent class analysis (LCA) to those identified using pre-specified partner labels (main partner/boyfriend, regular casual sex partner, non-regular casual sex partner). Second, we identified AGYW-level sociodemographic and behavioral predictors of sexual partner type. Third, we estimated the association between partner risk type as identified by LCA and the pre-specified partner labels on incident HIV infection

2 Hypothesis

We hypothesized that sexual partners are classifiable into distinct, identifiable partner types that differ with respect to sociodemographic factors (age, school enrollment) as well as risk behaviors (condom use, coital frequency, concurrency, children with AGYW

and other women, cohabitation, transactional sex, and HIV status) and these partner types predict risk of incident HIV infection among AGYW. We further hypothesized that AGYW-level characteristics that have previously been shown to be associated with HIV infection also predict partner selection. For example, AGYW who were enrolled in school would be more likely to select partners who were similar in age and also enrolled in school; AGYW who reported engaging in high risk behavior like using alcohol or drugs would be more likely to select riskier sexual partners associated with increased risk of HIV infection among AGYW; and AGYW who reported food insecurity and being an orphan would be more likely to select partners who provided financial or other forms of support.

3 Data source and study population

3.1 Study area and intervention design

We used data from a phase III, randomized controlled trial of cash transfers for HIV prevention (HPTN 068: Effects of Cash Transfer for the Prevention of HIV in Young South African Women). AGYW enrolled in HPTN 068 were living in in rural Mpumalanga Province, South Africa and were recruited door to door by trained fieldworkers who approached all potentially eligible households. Households were primarily identified through the South African Medical Research Council and University of Witwatersrand Agincourt Health and Demographic Surveillance System (HDSS), a well-established census site which is characterized by high rates of poverty, unemployment, and circular labor migration (127). AGYW and their households randomized to the intervention each received a monthly cash transfer (R300) conditional on school attendance.

3.2 Study population

AGYW in the parent study were ages 13-20, enrolled in grades 8-11 at a participating public school, not married or pregnant by self-report at baseline, intended to live in the study site until the end of the study, were willing to consent/assent to all study procedures (including HIV and HSV-2 testing), were able to read sufficiently to self-

administer a computer assisted self-interview, had the documentation necessary to open a bank or post office account (e.g., birth certificate, South African identification book, passport, proof of residence), and lived with a parent/guardian willing to consent to all study procedures and who had documentation necessary to open a bank or post office account, at baseline. Only one AGYW per household was eligible to enroll in the study; if more than one AGYW was eligible, AGYWs in grade 9 and 10 were given preference and if there were more than two AGYWs in grades 9/10 in the household, the AGYW with the next birthday was enrolled.

3.3 Data collection and follow up

Questionnaires were administered to AGYW via audio computer assisted self-interview (ACASI) before testing for HIV and HSV-2. The AGYW ACASI questionnaire covered a range of topics, including demographics, partner/partnership characteristics, health and fertility, HIV knowledge, and mental health in the past year. AGYW could report on up to their three most recent sexual partners during each follow up period. Questions about condom use were partner specific (i.e. AGYW were asked about condoms at last sex for each reported sexual partner, up to three partners at each follow up period). Data on incident HIV infection were AGYW specific (i.e. we do not know which sexual partner infected the AGYW, only that she was infected during a specific follow up period). Questionnaires were administered to the parent/guardian by trained field workers using computer assisted personal interviewing (CAPI). The household CAPI questionnaire captured household characteristics, including consumption, asset ownership, and parent/guardian education in the past year.

AGYW were seen annually until the study completion date or their planned high school completion, whichever came first. Each annual study visit included an ACASI interview with the AGYW, pre- and post- test counseling, a blood draw, and HIV and HSV-2 testing for those who were not positive at the previous visit. A CAPI interview was also

completed annually with the parent/guardian. Follow up visits for the AGYW and the parent/guardians occurred annually at approximately 12, 24, and 36 months and the majority of visits were between 7 and 14 months apart. AGYW were additionally tested for HIV and HSV-2 around the time of the AGYW's graduation from high school toward the end of the calendar year ("graduation visit") if she missed her scheduled annual visit that year or if her last annual visit was prior to October 1st. AGYW did not complete the ACASI interview at this visit. The majority of graduation visits were between 4 and 6 months after the last ACASI study visit.

For this dissertation, we focused on the sub-cohort of 1034 sexually active AGYW who were HIV-negative at baseline and their three most recent male sexual partners following their baseline visit (reported at their 12, 24, 36 month visits) up until they tested HIV-positive. Given that not all AGYW were sexually active at the baseline, we only included data from visits where AGWY reported having sex with at least one sexual partner during the most recent follow up period (or within 12 months of the graduation visit) (Figure 3.1.)

4 Aim 1 analysis plan

4.1 Overview

The primary goal of Aim 1 was to identify sexual partner types among AGYW living in rural South Africa and AGYW-level of predictors of partner selection. To achieve this goal, we explored the use of two different approaches for measuring sexual partner type: 1) pre-specified partner labels (main partner/boyfriend, regular casual sex partner, non-regular casual sex partner), and 2) latent class analysis (LCA), which identified underlying, latent sexual partner subtypes from a set of categorical partner factors self-reported by AGYW. After identifying sexual partner types, we estimated the association between AGYW-level sociodemographic and behavioral risk factors and risk of AGYW having a specific partner type identified through LCA. Both AGYW-level sociodemographic and behavioral risk factors

and sexual partner type were assessed annually, thus AGYW-level factors reflect past-year predictors of past-year sexual partners.

4.2 Measures

4.2.1 Sexual partner type

AGYW categorized their sexual partners using the following partner type labels pre-specified in ACASI: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work client, or other. AGYW also reported on the following 10 partner factors for each sexual partner (up to the three most recent), which we used to construct a latent variable for sexual partner type: partner age, which we dichotomized into partner ≥5 years older (yes, no); partner enrolled in school (yes, no); children with AGYW (yes, no); partner has children with other women (yes, no, AGYW does not know); cohabit with AGYW (yes, no); sex only one time (yes, no); average condom use, which we dichotomized into always uses condoms (yes, no); partner is HIV-positive (yes, no, AGYW does not know); partner has other concurrent sexual partners (yes, no, AGYW does not know), and transactional sex with AGYW (yes, no). We defined transactional sex as feeling obligated to have sex with a partner after receiving money or gifts. All sexual partner measures, including partner HIV-status, are partner specific and based on the AGYW's self-report.

4.2.2 Predictors of sexual partner type

To understand potential AGYW-level predictors of partner selection, we examined the following AGYW-level sociodemographic and behavioral risk factors: age (continuous), enrolled in school (yes, no), ever repeated a grade in school (yes, no), food insecure (yes, no), double orphan (yes, no), depression (yes, no), early sexual debut (yes, no), more than one sexual partner in the past 12 months (yes, no), intimate partner violence (IPV) in the past 12 months (yes, no), low relationship power with most recent sexual partner (yes, no), visited an alcohol outlet in the past 6 months (yes, no), ever drank alcohol (yes, no), and ever used drugs (yes, no). Food insecurity was defined as ever worrying about having

enough food for oneself or family in the past 12 months. Double orphan was defined as having a deceased mother and father. Depression was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D) (128), and was defined as a score of 16 or higher. Early sexual debut was defined as vaginal or anal sex before age 15 (the median age at first sex in this study population). Intimate partner violence (IPV) was measured using the World Health Organization instrument (129) and was defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months. Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS) (15, 130); AGYW who scored in the lower 33% for answers regarding their most recent sexual partner were defined as having low power. Alcohol outlet was defined as a tavern or shebeen (informal tavern). AGYW-level sociodemographic and behavioral risk factors were assessed annually.

4.3 Statistical analysis

We generated descriptive statistics for AGYW and their sexual partners by estimating the relative frequency (categorical variables) and means and standard deviations (continuous variables) for AGYW-level variables at the first visit at which they reported a sexual partner, and sexual partner-level variables across all study visits.

4.3.1 Latent class analysis of sexual partner type

We used PROC LCA in SAS (Version 9.4, Cary, NC) (131) to identify sexual partner risk types using the 10 partner factors described above. LCA is a latent variable model that identifies underlying, unobserved, latent subgroups (classes) from a set of observed, categorical indicators. Latent classes identified in LCA are mutually exclusive and exhaustive and maximize similarities within classes while maximizing differences between other classes (132). The primary difference between LCA and other latent variable models, like factor analysis, is that LCA assumes that latent variables are categorical and measures these variables using categorical indicators. We take a categorical approach because we

hypothesize that there are distinct types/categories of sexual partners which influence HIV risk. Classes identified through LCA represent different sexual partner types.

The latent class model uses maximum likelihood to estimate two parameters which we used to identify, quantify, and interpret sexual partner types: 1) latent class prevalences (γ, gamma) and 2) item response probabilities (ρ, rho). Latent class prevalences refer to the prevalence of each latent class in the study population. Item response probabilities refer to the probability of a certain indicator response pattern given membership in a specific latent class. Item response probabilities are analogous to factor loadings in that they express the relation between observed indicator variables and latent variable; however, they are probabilities not weights.

Our primary goal in using LCA was to develop a parsimonious but informative measure of sexual partner type which identified meaningful differences between sexual partners that could predict risk of HIV acquisition. We used conditional probabilities (ρ, rho) to inform indicator selection. Rho parameters close to 0 or 1 indicate high homogeneity within classes and indicators which yield these values were kept (i.e. given membership in a particular class, an individual has close to 0% or 100% probability of having a particular response). Rho parameters close to the marginal probability for that indicator (i.e. 0.50 for a 2-level variable, 0.33 for a 3-level variable) suggest that the indicator provided little information and thus were dropped.

We selected the number of latent classes to maximize heterogeneity between classes so that sexual partner risk types can be clearly distinguished from each other (known as latent class separation) and to maximize interpretability of classes, while balancing parsimony and sample size constraints. More classes can often produce better model fit; however, too many classes will result in sparse classes that cannot support later analyses and may yield classes that are not meaningfully different from an HIV prevention standpoint. We considered LCA models with two through eight classes and used model fit

statistics (Akaike Information Criterion, AIC; Bayesian Information Criterion, BIC; and G^2) and conditional probabilities (i.e., the probability of a specific response conditional on class membership) to select the best fitting and most interpretable model (133). We began by fitting a model with 2 latent classes and increasing class number until the BIC, AIC, and G^2 stop decreasing (smaller values indicate better model fit). We also examined posterior probabilities across models, and only considered models where the median posterior probability was greater than 0.70. Posterior probabilities are derived from the latent class model using Bayes' theorem, and are the probability of each AGYW's membership to a specific latent class (AGYW probabilities across all latent classes sum to 1). High posterior probabilities imply greater certainty of class membership. We selected the final model based on a combination of these fit statistics, posterior probabilities, as well as interpretability of the classes and their ultimate utility in targeting and designing HIV prevention interventions.

After determining the optimal number of latent classes, we assigned sexual partners to the latent class/sexual partner type for which they had the highest posterior probability of membership. We interpreted the sexual partner types using the conditional probabilities generated by the latent class model (133). We also calculated descriptive statistics for each sexual partner type. Sexual partner characteristic frequencies include all reported sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus, frequencies represent partner-reports, not distinct sexual partners.

4.3.2 AGYW-level predictors of sexual partner type

Next, to understand potential predictors of AGYW choosing specific partner types, we created an AGYW-level data set where each row of data was a year of AGYW follow-up, and created a visit-specific partner-exposure variable for each sexual partner type by looking across all sexual partners reported by AGYW at each study visit. AGYW were coded

as exposed to a specific partner type at a visit if any of their reported partners at that study visit included the partner type. Through this approach, we created two partner-exposure variables for pre-specified partner labels: 1) any regular casual sex partner(s), and 2) any non-regular casual sex partner(s). AGYW were coded as unexposed if they reported only having main partner(s)/boyfriend(s) (the referent level for the pre-specified partner label analysis). We created five partner-exposure variables for LCA-identified partner types: 1) any older out-of-school partner(s); 2) any unprotected peer partner(s); 3) any casual protected peer partner(s); 4) any anonymous out-of-school peer partner(s); and 5) any cohabiting with children peer partner(s)). AGYW were coded as unexposed if they reported only having monogamous HIV-negative peer partner(s) (the referent level for the LCA-identified partner type analysis). AGYW may have multiple observations due to repeated study visits; thus AGYW frequencies represent AGYW-visits, not distinct AGYW. If an AGYW reported more than one sexual partner at a single visit, we considered all sexual partner types provided that they were different types. Both AGYW-level sociodemographic and behavioral risk factors and sexual partner type were assessed annually; thus AGYW-level factors reflect past-year predictors of past-year sexual partners.

We then generated descriptive statistics for the AGYW by sexual partner type and used generalized estimating equations (GEE), with a robust variance estimator, exchangable correlation matrix, binomial distribution, and log link to estimate risk ratios (RR) and 95% confidence intervals (CIs) for the association between each AGYW-level characteristic and risk of an AGYW having a specific partner type compared to the referent level. Because AGYW could have multiple types of sexual partners at a visit (and thus exposure to sexual partner types were not mutually exclusive), we used a separate GEE model to examine each AGYW-level predictor to partner type relationship.

4.3.3 Comparison of sexual partner types identified by partner labels versus LCA

Pre-specified partner labels are often used to differentiate high risk from low risk partners (e.g., casual partners are usually assumed to be high risk, main partners are assumed to be low risk). However, these partner types are not explicitly linked to specific risk behaviors and respondents often assign these partner types without guidance on what the different types mean or what behaviors typify or distinguish them. To assess the utility of partner type labels in differentiating different partner types, we compared the distribution of sexual partner types identified by LCA to the distribution of sexual partner types categorized by AGYW using pre-specified partner labels using a chi-square test for difference in proportion. Because very few AGYW labeled their partners as sex work clients or "other", we limited this analysis to the three most common partner types: main partner/boyfriend, regular casual sex partner, and non-regular casual sex partner. Equal distribution of LCA partner-types across pre-specified partner labels would suggest that partner labels do not adequately differentiate sexual partners by sociodemographics or risk behaviors, while varied distribution would suggest that partner labels can identify these differences.

5 Aim 2 analysis plan

5.1 Overview

The primary goal of Aim 2 was to estimate the association between sexual partner types and risk of incident HIV infection among AGYW living in rural South Africa. To achieve this goal, we used generalized estimating equations (GEE) with a robust variance estimator, exchangable correlation matrix, binomial distribution, and log link to estimate risk ratios (RR) and 95% confidence intervals (CIs) to estimate the association between AGYW having a specific sexual partner type (identified in Aim 1) in the past 12 months (allowing this to vary at each study visit) and risk of incident HIV infection, compared to AGYW with the referent partner type. Both sexual partner type and incident HIV infection were assessed annually.

5.2 Measures

5.2.1 Sexual partner type

The exposure variable, sexual partner type, was measured using two approaches. In the first approach, AGYW categorized each of their sexual partners using the following pre-specified partner type labels: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work client, or other. Because sex work clients and other partners were rare, and no HIV infections occurred among AGYW with these partner types, we excluded these partner types from our analysis. In the second approach, we used latent class analysis (LCA) to identify sexual partner types (Aim 1). Sexual partner types, as defined by LCA, were based on the following partner characteristics self-reported by AGYW in a partner grid at each visit for the most recent three partners: partner age, school enrollment, children with AGYW, children with other women, cohabitation with AGYW, one-time sex, condom use, partner HIV-status, partner concurrency, and transactional sex.

Next, to understand the association between sexual partner type and incident HIV infection, we used the same visit-specific partner-exposure variable for each sexual partner type used in Aim 1 (for more details, please refer to section 4.3.2 AGYW-level predictors of sexual partner type). Using this approach, we looked across all sexual partners reported by an AGYW at each study visit. AGYW were coded as exposed to a specific partner type if any of their reported partners at that study visit included the partner type; AGYW were coded as unexposed if they reported only having main partners/boyfriends (the referent level for the pre-specified partner label analysis) or only having monogamous HIV-negative peer partners (the referent level of the LCA-identified partner type analysis). AGYW may have multiple observations due to repeated study visits; thus, AGYW frequencies represent AGYW-visits, not distinct AGYW. If an AGYW reported more than one sexual partner at a single visit, we considered all sexual partner types provided that they were different types.

5.2.2 Incident HIV infection

The outcome variable, incident HIV infection, was assessed at each follow-up visit. HIV screening was done with two HIV rapid tests completed in parallel (the Determine HIV-1/2 test [Alere Medical Co, Matsudo-shi, Chiba, Japan] and the US Food and Drug Administration [FDA]-cleared Uni-gold Recombigen HIV test [Trinity Biotech, Bray, County Wicklow, Ireland]). If both HIV rapid tests were non-reactive, no further testing was done at that study visit. If one or both tests were reactive or positive, confirmatory HIV testing was done with the FDA-cleared GS HIV-1 western blot assay (Bio-Rad Laboratories Inc, Redmond Redmond, WA, USA). If the western blot was positive or indeterminate, a new blood sample was drawn within 2 weeks of the first test result for repeat testing. If HIV status was not clear, further site testing was done with guidance from the HPTN Laboratory Center. Additional details about the HIV testing can be found elsewhere (134).

5.2.3 Confounders

We explored the influence of several key AGYW-level covariates. Age in years was coded as a continuous variable. School enrollment was coded as a dichotomous variable. Food insecurity was defined as ever worrying about having enough food for oneself or family in the past 12 months and was coded as a dichotomous variable. Early sexual debut was defined as vaginal or anal sex before age 15 (the median age at first sex in this study population) and coded as a dichotomous variable. Intimate partner violence was measured using the World Health Organization instrument (129) and was defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months. Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS) (15, 130); AGYW who scored in the lower 33% for answers regarding their most recent sexual partner were defined as having low power. Depression was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D) (128), and was defined as a score of 16 or higher. Alcohol consumption was

defined as ever drinking alcohol and coded as a dichotomous variable. Drug use was defined as ever using drugs and coded as a dichotomous variable. Number of sexual partners in the past 12 months was coded as a continuous variable.

5.3 Statistical analysis

Because AGYW could report more than one sexual partner type at a study visit, and therefore exposure to sexual partner types was not mutually exclusive, we generated separate statistical models to examine each AGYW partner type-incident HIV infection association. Specifically, for each sexual partner type identified through pre-specified partner labels and through latent class analysis, we used generalized estimating equations (GEE) with an exchangeable correlation matrix, binomial distribution, and log link to estimate risks, risk ratios (RR), and 95% confidence intervals (CI) for the association between AGYW having a specific sexual partner type and incident HIV infection compared to AGYW with the referent partner type (only main partner(s)/boyfriend(s) for the pre-specified partner label analysis, and only monogamous HIV-negative peer partner(s) for the LCA-identified partner type analysis). We used a robust variance estimator to account for potential correlation due to AGYW reporting multiple sexual partners over time.

To control for potential confounding, we constructed a directed acyclic graph (DAG; Figure 3.2) and identified the following minimally sufficient adjustment set: intervention arm, age, school enrollment, food insecurity, depression, low relationship power, intimate partner violence, alcohol consumption, drug use, early sexual debut, and number of sexual partners in the past 12 months. In addition, we controlled for days since last follow-up visit to account for AGYW who were seen slightly before or after their scheduled annual follow-up visit. All analyses were conducted using SAS (Version 9.4, Cary, NC).

We assessed statistical power using an expected data approach based on known number of events and person years of follow up from the parent study (135). The parent

study enrolled 2533 girls at baseline, 2328 of whom were HIV negative. Of these girls, 1208 were sexually active at baseline or became sexually active over the course of the follow up period, and contributed 1909 person years of follow up. Eighty-five girls became HIV infected.

To estimate power under a two tailed test with type 1 error set to 5%, we assumed two levels of exposure (high risk, low risk), assumed 35% of the population was exposed, and held the total number of HIV transmission events constant at 85 and total person time constant at 1909 person years. We then varied the number of events among the exposed and unexposed to generate different, feasible scenarios given our data and used SAS (Version 9.4, Cary, NC) to generate our power estimates and corresponding incident rate ratios (IRR) and 95% confidence intervals under these scenarios. We estimated that we had 84% power to detect an IRR of 1.90 (95% CI: 1.24, 2.91), 92% power to detect an IRR of 2.09 (1.37, 3.20), and 99% power to detect an IRR of 2.53 (06% CI: 1.64, 3.89) (Table 3.1, Figure 3.3). This calculation does not account for clustering (at the girl and partner level), which will reduce the power slightly. However, we believe that an effect size of 1.90 or larger is reasonable, given that the baseline study examined the association between a simple measure of sexual partner risk and found that girls who reported having a risky sexual partner (defined as a partner five or more years older, partner who had other concurrent sexual partners, or partnership involving transactional sex) had more than 3 times the odds of prevalent HIV infection than girls with non-risky partners.

5.4 Sensitivity analyses

A potential limitation of this analysis is that if an AGYW reported more than one sexual partner at a follow up visit and become HIV-infected, we are unable to identify which sexual partner infected her. To assess the potential impact of this limitation, we conducted the following two sensitivity analyses.

First, we limited the dataset to only AGYW who reported one sexual partner at a specific follow up visit. Thus, if an AGYW became HIV infected, we could be more certain about the partner who infected her. We then re-ran the analysis examining the association between sexual partner type and incident HIV infection. Because AGYW in this analysis reported only one sexual partner, we were able to examine the association between partner type and incident HIV infection association in a single model for pre-specified partner labels (with main partner/boyfriend as the referent level) and a single model for the LCA-identified partner types (with monogamous HIV-negative peer partner as the referent level).

Second, we identified the most common partner combinations with respect to pre-specified partner labels and LCA-identified partner type. We then examined the association between these partner combinations and incident HIV infection. For both sensitivity analyses, we used the same statistical analysis approach outlined in 5.3 Statistical analysis.

6 Tables and figures

Figure 3.1. Study participant inclusion flow chart

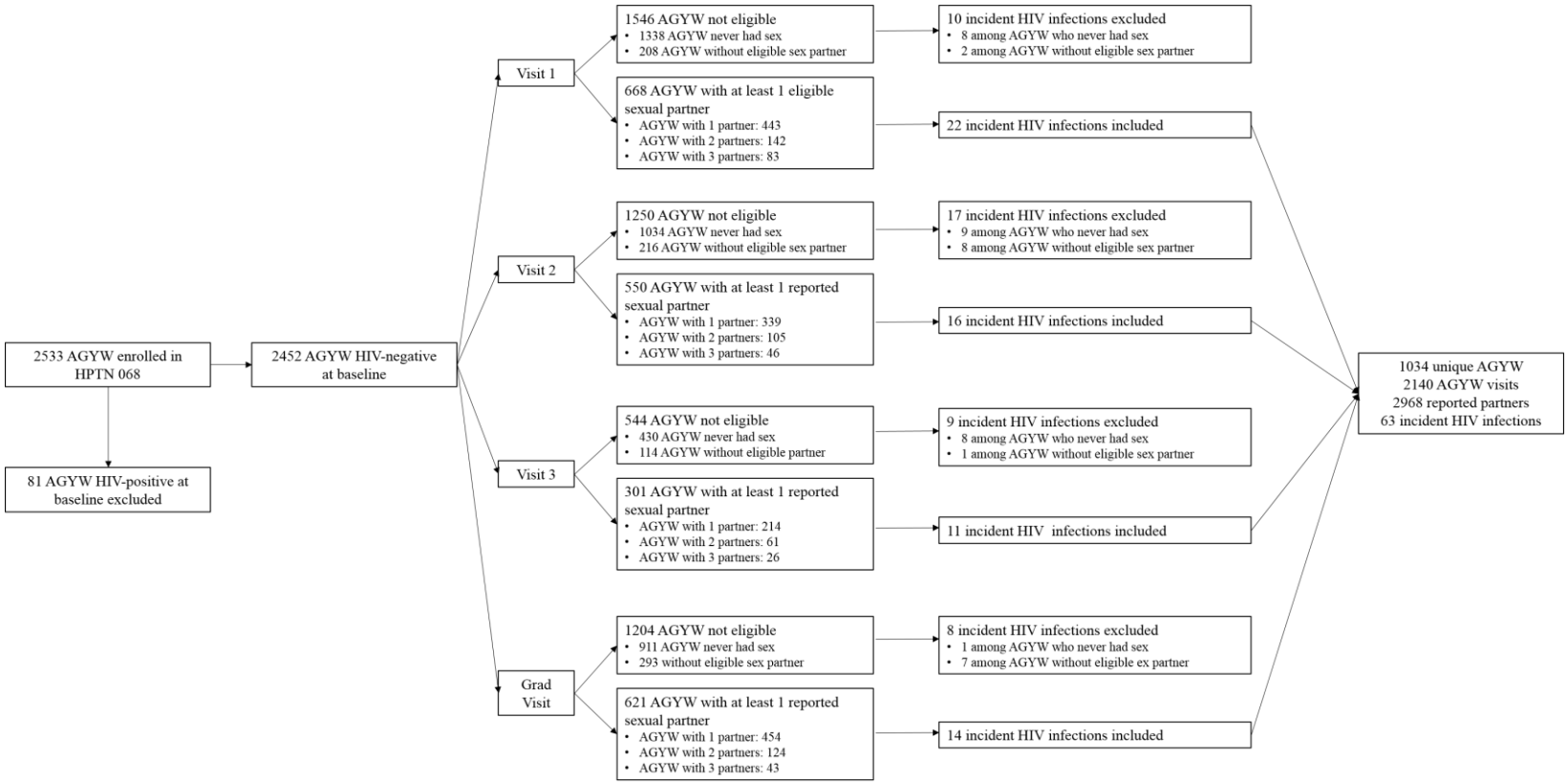
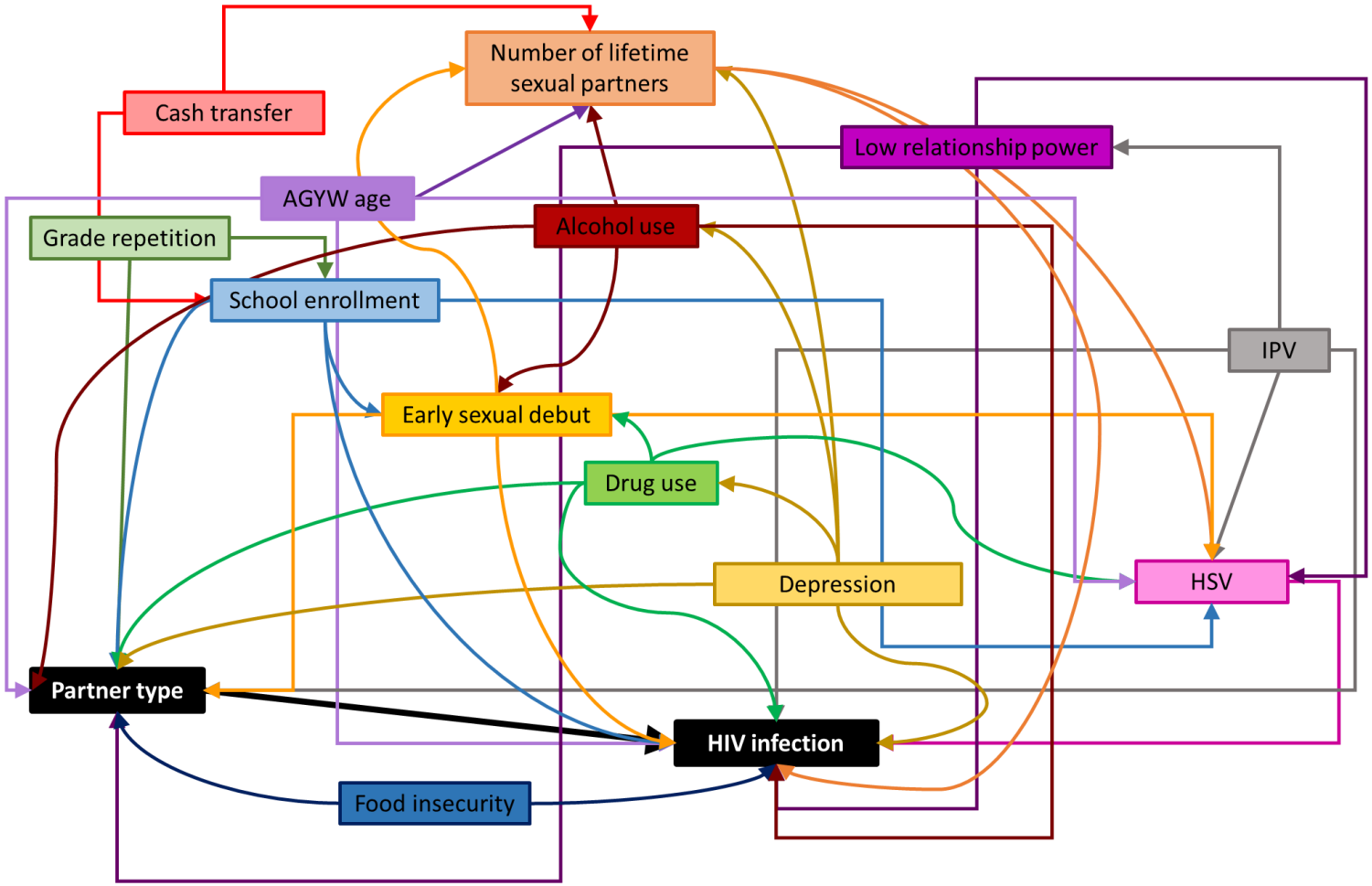


Figure 3.2. Directed Acyclic Graph (DAG) used to identify minimally sufficient adjustment set[a]



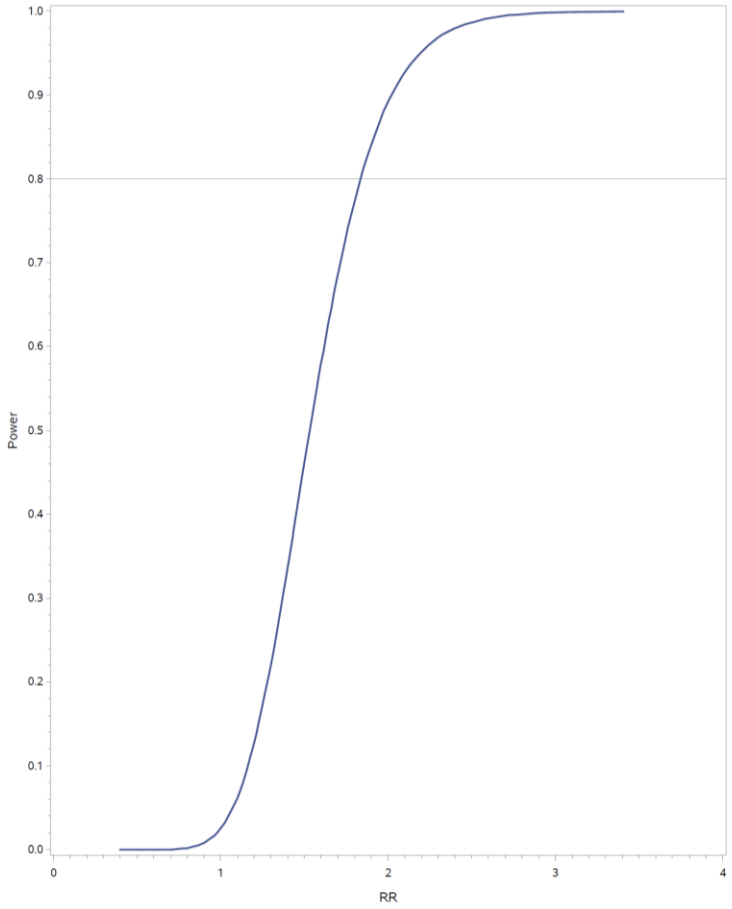
a Minimally sufficient adjustment set included the following variables: intervention arm, age, school enrollment, food insecurity, depression, low relationship power, intimate partner violence, alcohol consumption, drug use, early sexual debut, and number of sexual partners in the past 12 months. In addition, we controlled for days since last follow-up visit to account for AGYW who were seen slightly before or after their scheduled annual follow-up visit.

Table 3.1 Power to detect an association, assuming 35% of the population is exposed, 85 HIV seroconversions, 1909 total person years, and a 2-sided type 1 error of 5%

Power	IRR (95% CI)	Events among unexposed	Events among exposed	Rate among unexposed	Rate among exposed
1.00	2.79 (1.81, 4.30)	34	51	0.027	0.076
0.99	2.53 (1.64, 3.89)	36	49	0.029	0.073
0.97	2.30 (1.50, 3.52)	38	47	0.031	0.070
0.92	2.09 (1.37, 3.20)	40	45	0.032	0.067
0.84	1.90 (1.24, 2.91)	42	43	0.034	0.064
0.72	1.73 (1.13, 2.65)	44	41	0.035	0.061
0.55	1.58 (1.03, 2.41)	46	39	0.037	0.058

Note that because we held the total number of events and person time constant, and assumed that 35% of the population was exposed across all scenarios, we were not additionally able to hold the rate in the unexposed constant.

Figure 3.3 Power to detect an association, assuming 35% of the population is exposed, 85 HIV seroconversions, 1909 total person years, and a 2-sided type 1 error of 5%



CHAPTER IV: AIM 1: CHARACTERIZING SEXUAL PARTNER TYPES AMONG RURAL SOUTH AFRICAN ADOLESCENT GIRLS AND YOUNG WOMEN ENROLLED IN HPTN 068: A LATENT CLASS ANALYSIS

1 Introduction

Adolescent girls and young women (AGYW) in sub-Saharan Africa are disproportionately affected by HIV. AGYW account for 74% of all new infections among African adolescents, and AIDS is the leading cause of death among adolescents (136). The burden of HIV is particularly acute in South African where AGYW become newly infected with HIV at four times the rate of their male peers and HIV prevalence increases rapidly as AGYW transition from adolescence to adulthood (3). Sexual partners affect risk of HIV acquisition in AGYW by determining their position within a sexual network (40, 104, 137, 138), directly exposing AGYW to HIV (13), and facilitating risk behaviors that increase the risk of transmission (9, 10). Despite a great deal of prevention effort devoted to AGYW, the continued disproportionate incidence of HIV among this group suggests that different intervention approaches are needed.

We hypothesize that there are different, identifiable partner "types" (defined by different clusters of partner characteristics) that carry different levels of HIV risk, and require different intervention approaches. Yet, efforts to study and target specific sexual partner types for HIV prevention have been stymied by current measurement approaches, which have not shown clear associations with HIV acquisition, and do not provide clear guidance around the design of specific, targeted interventions to prevent HIV acquisition across different sexual partner types and contexts. Studies that examine the isolated effect of single

partner risk factors on HIV risk, or that examine the effect of multiple partner risk factors in a single model (holding all other factors constant) (13, 96), do not capture the cumulative impact of partner factors on HIV risk and may not be realistic, as partner factors rarely exist in isolation (10). Risk scores consider multiple partner factors together and have been used to identify people at greatest risk for HIV infection (101, 106, 139, 140). However, because these scores treat risk factors as exchangeable (a partner simply needs to meet a threshold to be considered “high risk”) and additive rather than potentially interactive, they have not deepened our conceptual understanding of the different types of sexual partners, and thus have not informed the design of targeted interventions. Risk scores also often incorporate both individual-level risk factors (e.g., age, number of sexual partners) with partner-level factors, thus they cannot be used to identify partner “types.” Studies that rely on people to categorize their sexual partners into types using pre-specified partner labels (e.g., main partner, casual partner) may not identify differences between partner types that are meaningful to HIV transmission because these labels are not explicitly tied to specific risk factors (10, 103, 104). As a result, how people apply these labels may vary across populations (65, 97, 98), and may also differ from how researchers conceptualize different partner types (65, 97, 99, 102, 103).

Latent class analysis (LCA) is a data-driven approach that uses correlated measures of partner factors to identify patterns across all these measures and classify people based on these patterns. LCA has been used to examine patterns of high risk sexual behavior (107-109), but its use in sexual partner research, and in particular among AGYW, has been limited (141). LCA has not been used explicitly to examine sexual partner types using factors from only the sexual partner with the goal of predicting HIV acquisition. We used LCA to identify underlying, latent sexual partner subtypes from a set of categorical partner factors self-reported by AGYW (95, 133). To the extent that partner risk factors cluster to form distinct sexual partner types, tailored intervention strategies designed to address

specific attributes of the different partner types may be an effective strategy for preventing HIV infection.

2 Methods

2.1 Study setting, population, and data collection

This secondary analysis uses longitudinal data from the HIV Prevention Trials Network (HPTN) 068 study, a phase III randomized controlled trial of cash transfers for HIV prevention among 2533 unmarried AGYW, ages 13-20 (134, 142). Data were collected between March 2011 and March 2015 from AGYW living in rural Mpumalanga Province, South Africa in households situated in the South African Medical Research Council and University of Witwatersrand Agincourt Health and Demographic Surveillance System (HDSS), a well-established census site (127).

AGYW were followed longitudinally and seen at baseline and annually at approximately 12, 24, and 36 months until the study completion date or their expected high school completion, whichever came first. Using audio computer-assisted self-interview (ACASI), AGYW reported their most recent sexual partners in the past 12 months (up to a maximum of three), and a range of other items, including sexual risk behavior, mental health, and substance use. If a graduating AGYW missed her scheduled visit that year, or if her previous visit that year was before October 1, an additional follow-up visit was scheduled around the time of her high school graduation (“graduation visit”). AGYW were tested for HIV but not interviewed at the graduation visit; ACASI data from the previous follow-up was used for these visits. To be eligible for the present analysis, AGYW had to: a) be HIV-negative at baseline, and b) report at least one sexual partner in the past twelve months.

Ethics approval for the parent study was obtained from the University of North Carolina Institutional Review Board (UNC IRB), the University of the Witwatersrand Human

Subjects Ethics Committee, and the Mpumalanga Departments of Health and Education. Assent and informed consent were obtained from the AGYW and their parent/legal guardian at study enrollment. In addition, the UNC IRB also approved this secondary analysis.

2.2 Measures

2.2.1 Sexual partner type

AGYW categorized their sexual partners using the following partner type labels pre-specified in ACASI: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work client, or other. AGYW also reported on the following 10 partner factors for each sexual partner (up to three), which we used to construct a latent variable for sexual partner type: partner age, which we dichotomized into partner ≥5 years older (yes, no); partner enrolled in school (yes, no); children with AGYW (yes, no); partner has children with other women (yes, no, AGYW does not know); cohabit with AGYW (yes, no); sex only one time (yes, no); average condom use, which we dichotomized into always uses condoms (yes, no); partner is HIV-positive (yes, no, AGYW does not know); partner has other concurrent sexual partners (yes, no, AGYW does not know), and transactional sex with AGYW (yes, no). We defined transactional sex as feeling obligated to have sex with a partner after receiving money or gifts.

2.2.2 Predictors of sexual partner type

To understand potential AGYW-level predictors of partner selection, we examined the following AGYW-level sociodemographic and behavioral factors, assessed annually: age (continuous), enrolled in school (yes, no), ever repeated a grade in school (yes, no), food insecure (yes, no), double orphan (yes, no), depression (yes, no), early sexual debut (yes, no), more than one sexual partner in the past 12 months (yes, no), intimate partner violence (IPV) in the past 12 months (yes, no), low relationship power with most recent sexual partner (yes, no), visited an alcohol outlet in the past 6 months (yes, no), ever drank alcohol (yes, no), and ever used drugs (yes, no). Food insecurity was defined as ever worrying about

having enough food for oneself or family in the past 12 months. Double orphan was defined as having a deceased mother and father. Depression was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D) (128), and was defined as a score of 16 or higher. Early sexual debut was defined as vaginal or anal sex before age 15 (the median age at first sex in this study population). Intimate partner violence (IPV) was measured using the World Health Organization instrument (129) and was defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months. Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS) (15, 130); AGYW who scored in the lower 33% for answers regarding their most recent sexual partner were defined as having low power. Alcohol outlet was defined as a tavern or shebeen (informal tavern).

2.3 Statistical analysis

Given that not all AGYW were sexually active at the baseline, we limited the analysis to visits where AGWY reported having sex with at least one sexual partner during the most recent follow up period (or within 12 months of the graduation visit).

We generated descriptive statistics for AGYW and their sexual partners by estimating the relative frequency (categorical variables) and means and standard deviations (continuous variables) for AGYW-level variables at the first visit at which they reported a sexual partner, and sexual partner-level variables across all study visits.

We used PROC LCA in SAS (Version 9.4, Cary, NC) (131) to identify sexual partner types using the 10 partner factors described above. Our primary goal in using LCA was to develop a parsimonious but informative measure of sexual partner type that identified meaningful differences between sexual partners that could predict risk of HIV acquisition. To ensure that we were able to capture a large number of classes (if apparent in the data), while also ensuring the interpretability and utility of results, we considered LCA models with two through eight classes. We used model fit statistics (Akaike Information Criterion, AIC;

Bayesian Information Criterion, BIC; and G^2), conditional probabilities (i.e., the probability of a specific response on a specific item conditional on class membership), and posterior probabilities (i.e., the probability of an AGYW belonging to a specific partner class) to select the best fitting and most interpretable model (133). We estimated mean and median posterior probabilities for each model and only considered models with mean and median posterior probabilities greater than 0.70 to ensure that class assignments were done with an adequate measure of certainty.

After determining the optimal number of latent classes, we assigned sexual partners to the latent class/sexual partner type for which they had the highest posterior probability of membership. Next, we calculated descriptive statistics of the partner indicators for each latent class/sexual partner type, which we then used along with the conditional probabilities to interpret and name the partner types. Specifically, we identified partner factors that differentiated the partner types by examining when the conditional probabilities were greater than the marginal probabilities (0.50 for a 2-level response, 0.33 for a 3-level response), and/or when the proportion of partners-reports for a specific partner factor within a specific partner type was greater than the overall distribution across all partner types. Notably, sexual partner characteristic frequencies calculated in the descriptive statistics include all reported sexual partners across all follow-up visits. Individual partners were not explicitly reported in a way that allowed them to be idnetified as the same partner across study visits; thus frequencies represent “partner-reports”, not distinct sexual partners.

Next, to understand potential predictors of AGYW choosing specific partner types and to inform the design and targeting of interventions for AGYW who select partner types associated with high versus low risk of HIV infection, we created an AGYW-level data set where each row of data was a year of AGYW follow-up. We created a visit-specific partner-exposure variable for each sexual partner type by looking across all sexual partners reported by AGYW at each study visit. AGYW were coded as exposed to a specific partner

type if any of their reported partners at that study visit included the partner type. For the pre-specified partner label analysis, AGYW were coded as unexposed if they reported only having main partner(s)/boyfriend(s) (referent level). For the LCA-identified partner type analysis, AGYW were coded as unexposed if they reported only having monogamous HIV-negative peer partner(s) (referent level). AGYW may have multiple observations due to repeated study visits; thus AGYW frequencies represent AGYW-visits, not distinct AGYW. If an AGYW reported more than one sexual partner at a single visit, we considered all sexual partner types. Both AGYW-level sociodemographic and behavioral risk factors and sexual partner type were assessed annually, thus AGYW-level factors reflect past-year predictors of past-year sexual partners.

We then generated descriptive statistics for the AGYW by sexual partner type and used generalized estimating equations (GEE), with a robust variance estimator, exchangable correlation matrix, binomial distribution, and log link to estimate risk ratios (RR) and 95% confidence intervals (CIs) for the association between each AGYW-level characteristic and risk of an AGYW having a specific partner type compared to the referent partner type.

Finally, we compared the distribution of sexual partner types identified by LCA to the distribution of sexual partner types categorized by AGYW using pre-specified partner labels using a chi-square test for difference in proportion. Because very few AGYW labeled their partners as sex work clients or “other”, we limited this analysis to the three most common partner types: main partner/boyfriend, regular casual sex partner, and non-regular casual sex partner. Equal distribution of LCA partner-types across pre-specified partner labels would suggest that partner labels do not adequately differentiate sexual partners by sociodemographics or risk behaviors, while varied distribution would suggest that partner labels can identify these differences.

3 Results

3.1 Description of adolescent girls and young women

Of the 2533 AGYW enrolled in HPTN 068, 1034 tested HIV-negative at baseline and reported having sex with at least one sexual partner during follow-up, making them eligible for this analysis. At the visit when an AGYW reported her first sexual partner, AGYW were 17 years of age on average, and most (94%) were enrolled in school (Table 4.1). Twenty-nine percent of AGYW reported food insecurity, 7% were double orphans, and 35% screened positive for depression. AGYW reported an average of 1.1 sexual partners in the past 12 months and only 6 AGYW reported more than three sexual partners in the past 12 months (0.06%), suggesting that the study captured the vast majority of AGYW's sexual partners by asking for AGYW's three most recent sexual partners.

3.2 Description of sexual partners

Over the course of follow up, these 1034 AGYW reported 2968 sexual partners. Nineteen percent of partner-reports involved partners who were five or more years older than AGYW and 53% were not enrolled in school (Table 4.2). With respect to children, 23% of partner-reports involved partners who had children with AGYW and 12% of partner-reports involved partners who had children with other women. Eleven percent of partner-reports were among partners who cohabited with AGYW, while 19% were one-time sexual encounters. AGYW reported always using condoms in 21% of partner-reports, and reported transactional sex in 22% of partner-reports. Twenty-two percent of partners-reports involved partners who were thought to have other concurrent sexual partners, but only 6% were thought to be HIV-positive.

3.3 Latent class analysis of sexual partner type

In our assessment of model fit, the BIC stopped decreasing after 6 classes, improvements to the AIC and G^2 decreased after 6 classes, and median posterior probabilities were greater than 0.70 for all models between 2 to 6 classes (see Appendix 4

and Appendix 5), suggesting that the six-class model provided the best balance of model fit and parsimony. Based on these findings, as well as the interpretability of the six-class model over larger models, we selected the six-class latent class model for sexual partner type.

These sexual partner types were distinct and differed across examined partner sociodemographic and behavioral risk factors (Table 4.2). The six sexual partner types, from most common to least common, were: monogamous HIV-negative peer partner (34% partner-reports); “unprotected peer partner (20% partner-reports); casual protected peer partner (19% of partner-reports); older out-of-school partner (13% partner-reports); anonymous out-of-school peer partner (9% partner-reports); and cohabiting with children peer partner (5% partner-reports). There was only one older partner type (older out-of-school partners) and two partner types were not enrolled in school (older out-of-school partners and anonymous out-of-school peer partners). Consistent condom use was low across all partner types, with the exception of casual protected peer partners. Transactional sex was present in nearly all partner types (about one-quarter of each partner type reported transactional sex) but was rare in casual protected peer partners and very common among cohabiting with children peer partners. Partner concurrency was not especially common in a specific partner type, but anonymous out-of-school peer partners and unprotected peer partners had the greatest proportion of partners whose concurrency status was unknown.

AGYW reported behaviors with monogamous HIV-negative peer partners that were consistent with monogamy – partners did not have children with other women (92%), most were not concurrent (72%), few AGYW reported always using a condom with these partners (13%), and most had sex with these partners more than once (92%). AGYW reported that these partners were HIV-negative (96%). Although the majority of these partners were similar in age (89%), half were not enrolled in school (56%). Transactional sex was present at 28% of these partners-reports.

Unprotected peer partners were primarily peers (96%), though 49% were not enrolled in school. AGYW reported partner behaviors that were consistent with a high risk of HIV-exposure –71% of these partners were thought to have other concurrent sexual partners or had unknown concurrency status, and 59% were thought to either be HIV-positive or have unknown HIV status, but AGYW reported consistent condom use at only 7% of partner-reports. Transactional sex was reported at 24% of these partners-reports.

Nearly all casual protected peer partners were similar in age to AGYW (95%) and enrolled in school (76%). AGYW reported having sex with these partners only one time (60%) and always used a condom (68%). In addition, almost none of these partners had children with AGYW (2%) or had children with other women (3%), very few engaged in transactional sex (8%), and the majority was believed to be HIV-negative (80%), with no concurrent sexual partners (51%).

Older out-of-school partners were five or more years older than the AGYW (87%) and were not enrolled in school (85%). About a third of these partners had children with AGYW (31%), had children with other women (28%), and were thought to have other concurrent sexual partners (28%). Transactional sex was slightly more common with these partners (36%) and consistent condom use was low (18%).

Anonymous out-of-school peer partners are notable for the fact that AGYW reported not knowing whether these partners had children with other women (61%), had other concurrent sexual partners (74%), or their HIV status (57%). Yet, only one-fifth of partner-reports involved consistent condom use (18%). Most of these partners were less than 5 years older (73%) but most were not enrolled in school (73%). Transactional sex was similar with other partner types (19%).

Lastly, most cohabiting with children peer partners cohabited with AGYW (84%), had children with AGYW (70%), and engaged in transactional sex (81%). In addition, about half of these partners also had children with other women (51%). Consistent condom use was very rare (3%) and most of these partners were thought to be HV-negative (76%) and not have other concurrent sexual partners (63%), though partner concurrency was most common among this partner type compared to all other types (31%). The majority of these partners were similar in age (78%) and enrolled in school (64%).

3.4 AGYW-level predictors of sexual partner type

Sociodemographic and behavioral characteristics across AGYW differed by sexual partner type (Table 4.3). AGYW's school enrollment, food security, number of sexual partners in the past year, intimate partner violence, relationship power, and drug and alcohol use were the strongest predictors of sexual partner type (Table 4.4). Overall, AGYW with casual protected peer partners appeared to be the least vulnerable and most risk adverse, reporting the fewest sociodemographic and behavioral risk factors for HIV infection, followed by AGYW with monogamous HIV-negative peer partners. AGYW with casual protected peer partners were significantly less likely to not be enrolled in school, ever repeat a grade in school, screen positive for depression, report more than one sexual partner in the past 12 months, and report low relationship lower compared to AGYW with only monogamous HIV-negative peer partner(s). In contrast, AGYW with cohabiting with children peer partners – though uncommon – were the most vulnerable and engaged in the most high-risk behaviors.

AGYW who were older and out of school were significantly more likely to have cohabiting with children peer partners and older out-of-school partners, while AGYW who were younger and in school were more likely to have casual protected peer partners, compared to having only monogamous HIV-negative peer partner(s). Specifically, AGYW who were not enrolled in school had four times the risk of having a cohabiting with children

peer partner compared to having only monogamous HIV-negative peer partner(s). Not being enrolled in school also increased the risk of an AGYW having an anonymous out-of-school peer partner.

With respect to household-level factors, food insecurity most strongly predicted AGYW having a cohabiting with children peer partner compared to having only monogamous HIV-negative peer partner(s) (RR=3.07, 95% CI: 1.88, 5.02). However orphan status did not strongly predict partner type.

AGYW with more than one sexual partners in the past 12 months were more likely to have cohabiting with children peer partners (RR=5.77, 95% CI: 3.28, 10.15), anonymous out-of-school partners (RR=5.32, 95% CI: 3.36, 8.41), unprotected peer partners (RR=3.87, 95% CI: 2.65, 5.65), older out-of-school partners (RR=3.39, 95% CI: 2.18, 5.28), and casual protected peer partners (RR=1.83, 95% CI: 1.19, 2.81) compared to having only monogamous HIV-negative peer partner(s).

AGYW who reported low relationship power with their most recent partner (RR=7.20, 95% CI: 4.34, 11.96) and intimate partner violence in the past 12 months (RR=2.12, 95% CI: 1.29, 3.49) were substantially more likely to have a cohabiting with children peer partner compared to having only monogamous HIV-negative peer partner(s). AGY who reported IPV in the past 12 months were also at increased risk of having an unprotected peer partner, while AGYW who had low relationship power with their most recent partner were more likely to have an anonymous out-of-school peer partner or an older out of-of-school peer partner compared to having only monogamous HIV-negative peer partner(s).

Drug and alcohol use was uncommon in this population – AGYW reported ever drinking alcohol at only 17% AGYW-visits ever using drugs at 7% of AGYW-visits, even though visiting an alcohol outlet in the past six months was reported at 42% AGYW-visits

(Table 4.2). AGYW with unprotected peer partners (RR=1.62, 95% CI: 1.20, 2.19) and AGYW with cohabiting with children peer partners (RR=3.95, 95% CI: 2.36, 6.61) were both significantly more likely to report visiting an alcohol outlet in the past six months than AGYW with only monogamous HIV-negative peer partners, but only AGYW with unprotected peer partners (RR=2.01, 95% CI: 1.37, 2.93) and anonymous out-of-school peer partners (RR=1.89, 95% CI: 1.14, 3.12) were at increased risk of ever drinking alcohol. Ever using drugs was strongly associated with having a cohabiting with children peer partner (RR=10.74, 95% CI: 5.78, 19.98).

3.5 Comparison of sexual partner types identified by partner labels versus LCA

Across all LCA-identified partner types, 67-78% of reported partners were labeled main partner/boyfriend, 10-25% were labeled regular casual sex partner, and 4-10% were labeled non-regular casual sex partner (Table 4.5). The label main partner/boyfriend was applied broadly across all LCA-identified partner types; however, the label regular casual sex partner was applied more frequently with older out-of-school partners than with other partner types. Although AGYW's application of pre-specified partner type labels did differ significantly across LCA-identified partner types, none of the labels provided a clear signal of sociodemographic or behavioral differences across partner types.

4 Discussion

Adolescent girls and young women (AGYW) are at incredibly high risk of HIV infection. Sexual partners play a critical role in determining HIV risk, but have not been well characterized in terms of unique profiles of risk factors which can influence risk of HIV infection and inform the design of targeted interventions for AGYW and their sexual partners. In light of this research gap, initiatives to reduce HIV incidence among adolescent girls and young women (AGYW), including DREAMS (143), have prioritized characterizing sexual partner differences to understand which partners pose the greatest risk for HIV acquisition, and what types of HIV-prevention messaging and services are most appealing

and effective across different partner contexts. We contribute to this important area of research by using rich, partner-level data, and a novel application of a data-driven approach (latent class analysis), to identify and characterize sexual partner types among AGYW living in rural Agincourt, South Africa. We imposed minimal restrictions on the number or types of sexual partners that AGYW could report, giving us a more complete, and potentially less biased picture of sexual partnerships among AGYW than studies that only capture the most recent or main sexual partner. Given that very few AGYW reported having more than three sexual partners, we had the rare opportunity to capture AGYW's complete sexual partner histories during a critical transition period when many AGYW are sexually debuting and are at risk of becoming rapidly HIV infected.

We identified six, distinct sexual partner types, which differed by age, school enrollment, concurrency, condom use, transactional sex, perceived HIV-status, and other risk factors. These partner types include one older partner type (older out-of-school partner), two out-of-school partner types (older out-of-school partner, anonymous out-of-school-partner), one cohabiting and transactional partner type (cohabiting with children peer partner), and one condom-using partner type (casual protected peer partner). Nearly all partner types involved some level of concurrency and transactional sex, while few partners were thought to be HIV-positive. We found that partner differences identified through LCA were obscured when sexual partners were categorized by AGYW using pre-specified partner labels. Specifically, AGYW applied the label main partner/boyfriend broadly to describe a wide variety of partner types identified by LCA, highlighting the limitations of the main versus casual distinction as a proxy measure for sociodemographic and behavioral differences between partners. This finding is supported by earlier research among adolescents and young people in KwaZulu-Natal, South Africa which identified two types of main partner – one that was a serious, committed relationship with a future goal of marriage,

and a second that was more for fun and less committed (72). These partner labels may be more useful for capturing relative time spent with each partner, specifically coital frequency and partnership duration (144). However, researchers should exercise caution when using these partner labels as proxies for the sociodemographic and behavioral differences identified in this study.

We identified only one older sexual partner type and found that while older out-of-school partners had many characteristics associated with HIV risk (145, 146) – including having other concurrent sexual partners (34), unprotected sex (27, 32, 33), and transactional sex (9, 32, 36-38) – these characteristics were not unique to this partner type. Although much research attention has focused on the role of older sexual partners in potentially facilitating the rapid spread of HIV among AGYW (42-44, 48), targeting only older male partners as a proxy for other risk behavior may miss AGYW with other partner types who are also at high risk of HIV acquisition.

Consistent condom use was uniformly low across all but one partner type and lowest among cohabiting with children peer partners and unprotected peer partners, which were both same-age partner types. Casual protected peer partners was the only partner type with high consistent condom use, despite the fact that these partners were thought to be HIV-negative. This finding aligns with previous research documenting that condom use is most consistent in new or more casual partnerships and lowest in more established partnerships where there is a greater expectation of trust (13, 66, 67, 69, 71). Given that adolescents in South Africa highly value trust in their partnerships, but assign trust to partners who do not meet traditional definitions of trustworthiness (e.g., monogamy) (75, 76, 78), interventions must consider the partnership context when developing focused messaging to encourage greater condom use. Fear of implying distrust is a major barrier to using or discussing condoms in more established sexual partnerships (51, 75-77). Interventions that can

reframe condom use in a positive light for partnerships that continue past the nascent stage, and that can leverage values specific to different partner types may be especially effective in increasing condom use among AGYW.

Transactional sex was far less common among older partners than might be expected based on prior reports (9, 32, 36-39). Only about one-third of older out-of-school partners were characterized by transactional sex, which was only slightly higher than among unprotected peer partners and monogamous HIV-negative peer partners. In contrast, more than 80% of cohabiting with children peer partners reported transactional sex. Gift giving, sometimes in exchange for sex, is a central component of many sexual relationships in sub-Saharan Africa (9). AGYW may exchange sex to secure basic needs (e.g., food, shelter, transportation) or to improve their social status (e.g., through makeup, clothes, perfume). In other partner contexts, gifts can express love and may not necessarily imply greater HIV risk (9, 36, 50, 52-57). These different transactional sex contexts likely influence both the riskiness of transactional sex and the types of interventions and prevention messaging which will be most effective to reduce this practice, when appropriate. Future studies should consider transactional sex within the broader partnership context, rather than as an isolated risk behavior, and should also explore potential differences in transactional sex practices and expectations by sexual partner type beyond just main versus casual partner classifications (60) and beyond just older sexual partners (32).

School enrollment was an important, modifiable risk factor that strongly predicted sexual partner type. AGYW not enrolled in school were nearly three times as likely to have an older out-of-school partner and four times as likely to have a cohabiting with children peer partner, while AGYW enrolled in school were significantly more likely to have a casual protected peer partner compared to having only monogamous HIV-negative peer partner(s). School enrollment is hypothesized to protect against HIV acquisition by restricting AGYW's

sexual network to partners who are similar in age (112-114), and by imposing time constraints which may discourage risky sexual behavior (147). Indeed, this appears to be true in our study population. AGYW who remained enrolled in school longer (134) and who had high attendance (148) were significantly less likely to become HIV infected. In contrast, AGYW who had low school attendance had a higher risk of having an older sexual partner and more sexual partners compared to AGYW who attended more school (148). In addition, we know from our baseline data that AGYW who were enrolled in school had lower pregnancy rates than AGYW who dropped out of school, and among those AGYW enrolled in school, pregnancy occurred less often during the school term than during school holidays (147). Although the cash transfer intervention tested in the parent study did not increase school attendance and thus did not decrease risk of HIV infection (potentially due to higher than expected school attendance across arms and lower than expected HIV incidence) (134), these findings nonetheless collectively point to the critical role that schooling plays in keeping AGYW safe. Efforts to prevent HIV infection among AGYW must find ways to keep AGYW in school, while providing opportunities for AGYW who have dropped out of school.

Notably, AGYW with cohabiting with children peer partners were rare but appeared to be highly vulnerable and warrant further investigation. These AGYW were overwhelmingly more likely to be food insecure, depressed, report IPV in the past 12 months, and report low relationship power with their most recent sexual partner, in addition to the risk factors discussed above. Although many characteristics reported about these partners are factors commonly associated with marriage or long-term committed partnerships, we did not collect detailed information about marital status or cohabitation because only AGYW who were unmarried and lived with their parent/guardian could enroll in HPTN 068. Marriage among young people in South Africa may be protective against HIV (149) but is uncommon due to entrenched labor migrations and demographic trends (73), while cohabitation has been shown to be associated with increased risk of HIV infection. Pregnancy may be an important

catalyst of risk for these AGYW, particularly if it led to school dropout or cohabitation. Future studies should investigate what factors are driving this confluence of vulnerability and how best to intervene among AGYW with this partner type.

AGYW who engaged in high-risk sexual behavior and reported substance use were more likely to have sexual partner types who also reportedly engaged in high-risk behavior. AGYW who reported young age at first sex and who reported multiple sexual partners in the past year were more likely to have cohabiting with children peer partners and older out-of-school partners compared to AGYW with monogamous HIV-negative peer partners. These AGYW may be risk seekers who are drawn to riskier sexual partners, and engage in high risk behaviors that in turn attract higher risk partners. AGYW may also seek multiple sexual partners to meet their different emotional, financial, and material needs, which may explain why AGYW with more sexual partners were more likely to have partner types where transactional sex was most common. Alcohol use was concentrated among AGYW with unprotected peer partners, while drug use was highly concentrated among AGYW with cohabiting with children peer partners, and AGYW with both partner types were more likely to report visiting an alcohol outlet in the past six months compared to AGYW with only monogamous HIV-negative peer partner(s). Alcohol and drug use can lead to risk inhibition and impaired decision-making, which may facilitate risker sexual behavior, including unprotected sex and transactional sex (119, 125, 150-153). AGYW may also be meeting their sexual partners in settings where drugs or alcohol are sold or consumed. Structural interventions that can address environmental factors that facilitate risky behavior (e.g., density of alcohol outlets in a community) (154), and that support safer behaviors (e.g., cash transfer, jobs programs, or other social protections programs that support AGYW financially) (117, 155), are critically important.

Adolescent girls and young women in South Africa are at extraordinarily high risk for HIV infection and desperately need effective prevention options. Because sexual risk

behaviors are dependent on the characteristics of both sexual partners and the resulting dynamics between them (9, 10), to be most effective, HIV prevention strategies must be tailored to the specific, contextual needs of AGYW and their sexual partners. Sexual partner types identified through latent class analysis are based on explicit, reported partner characteristics and offer an alternative model for measuring and targeting specific partner types for HIV research and prevention efforts. This and other studies that develop richer understanding of differences across sexual partner types can greatly improve the design and targeting of interventions for those at greatest risk of HIV infection.

5 Tables

Table 4.1 Characteristics of HIV-negative, sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015 (N=1034 AGYW)[a,b]

	N	%
Intervention arm	523	50.6
Mean age (SD)	17.5	1.5
Enrolled in school	987	94.5
Mean grade (SD)	10.8	1.05
Ever repeated grade	427	41.3
Food insecure[c]	293	28.7
Double orphan[d]	74	7.2
Depression[e]	360	35.0
Age at first sex, mean (SD)[f]	15.2	3.4
Currently has a boyfriend	856	83.1
Mean number of sexual partners in past 12 months (SD)[g]	1.1	0.7
Mean number of sexual partners in lifetime (SD)	2.0	3.2
Visited alcohol outlet in past 6 months[h]	445	44.1
Ever drank alcohol	171	16.6
Ever used drugs	68	6.6

a Data are from the first study visit at which the adoelscent girls and young woman (AGYW) reported having sex with a partner in the past 12 months.
b Missing: Intervention arm 0; Age 0; Enrolled in school 0, Grade 3; Ever repeated grade 0; Food insecure 14; Double orphan 4; Depression 4; Age at first sex 10; Currently has a boyfriend 4; Number of sexual partners in past 12 months 29; Number of sexual partners in lifetime 11; Visited alcohol outlet in past 6 months 24; Ever drank alcohol 5; Ever used drugs 1.
c Food insecurity defined as AGYW worrying about having enough food for oneself or family in the past 12 months.
d Double orphan defined as having deceased mother and father.
e Depression assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). AGYW who scored 16 or higher screened positive for depression.
f Age at first sex defined as the age at first reported vaginal or anal sex.
g At this first visit, only 6 AGYW (0.06%) reported >3 sexual partners in past 12 months.
h Alcohol outlet defended as a tavern or shebeen (informal tavern)

Table 4.2 Characteristics of sexual partner types identified by latent class analysis among sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015 (N=2968 partner-visits)[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Sexual Partner Characteristics														
Partner ≥5 years older														
Yes	557	18.8	138	11.3	20	3.8	25	4.9	278	86.6	65	26.5	31	22.5
No	2404	81.2	1084	88.7	507	96.2	483	95.1	43	13.4	180	73.5	107	77.5
Partner enrolled in school														
Yes	1393	47.0	535	43.7	270	51.3	385	76.1	48	15.0	66	27.0	89	63.6
No	1569	53.0	690	56.3	256	48.7	121	23.9	273	85.0	178	73.0	51	36.4
Children with AGYW														
Yes	669	23.0	343	28.5	86	16.6	9	1.8	99	31.1	41	17.2	91	70.0
No	2238	77.0	860	71.5	431	83.4	492	98.2	219	68.9	197	82.8	39	30.0
Partner has children with other women														
Yes	368	12.4	57	4.7	117	22.2	16	3.2	88	27.5	19	7.7	71	50.7
No	2229	75.2	1126	92.0	321	60.9	454	89.6	191	59.7	78	31.7	59	42.1
Don't know	367	12.4	41	3.3	89	16.9	37	7.3	41	12.8	149	60.6	10	7.1

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cohabit with AGYW														
Yes	338	11.4	113	9.2	25	4.8	3	0.59	45	14.0	35	14.2	117	84.2
No	2628	88.6	1113	90.8	501	95.2	505	99.41	276	86.0	211	85.8	22	15.8
Sex with AGYW only once														
Yes	557	18.9	98	8.0	59	11.2	303	60.1	46	14.3	46	18.9	5	3.6
No	2398	81.1	1124	92.0	466	88.8	201	39.9	275	85.7	197	81.1	135	96.4
Always use condoms with AGYW														
Yes	642	21.8	161	13.2	34	6.5	342	67.6	57	17.8	44	18.1	4	2.9
No	2309	78.2	1058	86.8	488	93.5	164	32.4	264	82.2	199	81.9	136	97.1
Partner HIV-status														
Positive	188	6.4	14	1.1	81	15.4	25	4.9	36	11.2	8	3.3	24	17.1
Negative	2204	74.4	1167	95.5	214	40.8	406	79.9	213	66.6	97	39.4	107	76.4
Don't know	569	19.2	41	3.4	230	43.8	77	15.2	71	22.2	141	57.3	9	6.4
Partner has other concurrent sexual partners														
Yes	640	21.6	231	18.9	156	29.7	89	17.5	89	27.7	31	12.7	44	31.4
No	1551	52.4	882	72.1	150	28.6	257	50.6	142	44.2	32	13.0	88	62.9
Don't know	772	26.0	111	9.1	219	41.7	162	31.9	90	28.1	182	74.3	8	5.7

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Transactional sex with partner[c]														
Yes	766	25.8	328	26.8	124	23.5	40	7.9	114	35.5	46	18.7	114	81.4
No	2202	74.2	898	73.2	403	76.5	468	92.1	207	64.5	200	81.3	26	18.6

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Partner ≥5 years older 7; Partner enrolled in school 6; Children with AGYW 61; Partner has children with other women 4; Cohabit with AGYW 2; Sex with AGYW only once 13; Always use condoms 17; Partner HIV status 10; Partner has other concurrent sexual partners 9; Transactional sex 0.

c Transactional sex defined as feeling obligated to have sex with a partner after receiving gifts or money.

Table 4.3 Characteristics of sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa by sexual partner type identified by latent class analysis, from March 2011 to March 2015 (N=2140 AGYW-visits)[a,b]

	AGYW-Visits by Sexual Partner Type													
	All AGYW-visits		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
AGYW Characteristics														
Mean Age (SD)														
	17.7	(1.4)	17.8	(1.4)	17.8	(1.4)	17.3	(1.3)	18.0	(1.5)	17.8	(1.4)	18.2	(1.4)
Enrolled in school														
Yes	2013	94.	992	95.1	438	95.0	443	98.7	240	87.6	184	90.2	93	82.3
No	127	5.9	51	4.9	23	5.0	6	1.3	34	12.4	20	9.8	20	17.7
Ever repeated a grade														
Yes	862	40.3	453	43.4	187	40.6	122	27.2	121	44.2	84	41.2	75	66.4
No	1278	59.7	590	56.6	274	59.4	327	72.8	153	55.8	120	58.8	38	33.6
Food insecure[c]														
Yes	590	27.9	270	26.1	140	30.9	112	25.2	79	29.3	52	25.9	57	51.4
No	1524	72.1	764	73.9	313	69.1	333	74.8	191	70.7	149	74.1	54	48.6
Double orphan[d]														
Yes	158	7.4	77	7.4	44	9.5	24	5.4	18	6.6	10	4.9	12	10.7
No	1977	92.6	963	92.6	417	90.5	424	94.6	255	93.4	194	95.1	100	89.3
Depression[e]														
Yes	718	33.7	352	33.8	171	37.3	111	24.9	110	40.4	88	43.1	54	47.8
No	1412	66.3	689	66.2	287	62.7	334	75.1	162	59.6	116	56.9	59	52.2

AGYW-Visits by Sexual Partner Type														
	All AGYW-visits		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Early sexual debut[f]														
Yes	959	45.1	468	45.1	211	45.9	174	39.4	158	58.9	102	50.2	65	58.0
No	1168	54.9	570	54.9	249	54.1	268	60.6	115	42.1	101	49.8	47	42.0
>1 Sexual partner in past 12 months														
Yes	381	18.1	170	16.6	133	29.5	73	16.5	73	26.8	73	36.5	43	39.4
No	1724	81.9	855	83.4	318	70.5	370	83.5	199	73.2	127	63.5	69	61.6
>1 Sexual partner in lifetime														
Yes	1137	53.5	549	52.8	312	68.0	207	46.8	209	76.3	171	84.2	87	77.0
No	990	46.5	491	47.2	147	32.0	235	53.2	65	23.7	32	15.8	26	23.0
Intimate partner violence (IPV) in the past 12 months[g]														
Yes	608	28.5	281	27.0	171	37.2	90	20.0	90	32.9	64	31.4	48	42.5
No	1527	71.5	759	73.0	288	62.8	359	80.0	184	67.1	140	68.6	65	57.5
Low relationship power with most recent sexual partner[h]														
Yes	500	23.4	232	22.3	111	21.2	48	10.7	82	30.0	62	30.5	75	66.4
No	1634	76.6	810	77.7	348	75.8	400	89.3	191	70.0	141	69.5	38	33.6
Visited an alcohol outlet in past 6 months[j]														
Yes	876	41.8	176	40.7	79	69.9	413	39.9	80	40.0	117	43.8	219	48.8
No	1222	58.2	257	59.3	34	30.1	623	60.1	120	60.0	150	56.2	230	51.2

	AGYW-Visits by Sexual Partner Type													
	All AGYW-visits		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Ever drank alcohol														
Yes	358	16.8	161	15.5	106	23.3	77	17.3	49	18.0	45	22.2	19	16.8
No	1773	83.2	881	84.5	350	76.7	369	82.7	223	82.0	158	77.8	94	83.2
Ever used drugs														
Yes	147	6.9	58	5.6	37	8.1	17	3.8	23	8.4	13	6.4	42	37.2
No	1989	93.1	985	94.4	422	91.9	430	96.2	251	91.6	191	93.6	71	62.8

a Sexual partner types were identified using data on sexual partner characteristics self-reported by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits; thus numbers here represent AGYW-visits, not distinct AGYW. Partners were not followed longitudinally and the same partner could be reported at multiple study visits. We created AGYW partner-exposure variables for each sexual partner type by looking across all sexual partners reported by AGYW at each study visit. AGYW were coded as exposed to a specific partner type if any of their reported partners at that study visit included the partner type. Percentages are column percents by partner type. Row numbers may not add up to total AGYW-visits because AGYW could have more than 1 partner type per AGYW-visit.
b Missing: Age 0; Not enrolled in school 0; Food insecure 26; Double orphan 5; Depression 10; Early sexual debut 10; Partners in past 12 months 35; Partner in lifetime 13; IPV in past 12 months 5; Relationship power 6; Ever drank alcohol 9; Visited alcohol outlet in past 6 months 42; Ever used drugs 4.
c Food insecurity defined as worrying about having enough food for oneself or family in the past 12 months.
d Double orphan defined as reporting that both mother and father had died.
e Depression assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). AGYW who scored 16 or higher on the CES-D screened positive for depression.
f Early sexual debut defined as first sex before age 15.
g Intimate partner violence was measured using the World Health Organization instrument and is defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months.
h Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS). AGYW who scored in the lower 33% for answers regarding their most recent sexual partner are defined as having low power.
i Alcohol outlet defended as a tavern or shebeen (informal tavern).

Table 4.4 Risk Ratios (RRs) and 95% Confidence Intervals (CIs) for the association between adolescent girls and young women (AGYW) with different sexual partner types identified by latent class analysis and characteristics of sexually active AGYW ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015 (N=2140 AGYW-visits)[a,b]

	AGYW-Visits by Sexual Partner Type					
	Only Monogamous HIV-Negative Peer Partner	Unprotected Peer Partner	Casual Protected Peer Partner	Older Out-of-School Partner	Anonymous Out-of-School Peer Partner	Cohabiting with Children Peer Partner
	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]
AGYW Characteristics						
>18 years of age vs. ≤18	1.	1.02 (0.92, 1.12)	0.78 (0.70, 0.87)	1.14 (1.02, 1.28)	1.03 (0.90, 1.17)	1.26 (1.07, 1.48)
Not enrolled in school vs. enrolled	1.	1.06 (0.54, 2.07)	0.27 (0.10, 0.76)	2.85 (1.48, 5.48)	2.19 (1.03, 4.66)	4.33 (2.05, 9.14)
Ever repeated a grade vs. never repeated	1.	0.95 (0.70, 1.28)	0.52 (0.37, 0.72)	1.10 (0.76, 1.59)	0.97 (0.65, 1.46)	2.74 (1.59, 4.73)
Food insecure[d] vs. not food insecure	1.	1.30 (0.95, 1.78)	0.98 (0.70, 1.37)	1.20 (0.82, 1.76)	1.02 (0.65, 1.58)	3.07 (1.88, 5.02)
Double orphan[e] vs. not double orphan	1.	1.27 (0.77, 2.10)	0.68 (0.37, 1.26)	0.85 (0.42, 1.72)	0.62 (0.28, 1.36)	1.44 (0.60, 3.50)
Depressed[f] vs. not depressed	1.	1.27 (0.94, 1.71)	0.71 (0.51, 0.98)	1.44 (1.00, 2.09)	1.61 (1.08, 2.41)	1.95 (1.15, 3.30)
Early sexual debut[g] vs. not early debut	1.	1.11 (0.82, 1.50)	0.85 (0.62, 1.16)	1.80 (1.24, 2.61)	1.32 (0.88, 1.98)	1.81 (1.06, 3.08)

	AGYW-Visits by Sexual Partner Type					
	Only Monogamous HIV-Negative Peer Partner	Unprotected Peer Partner	Casual Protected Peer Partner	Older Out-of-School Partner	Anonymous Out-of-School Peer Partner	Cohabiting with Children Peer Partner
	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]	RR (95% CI)[c]
>1 partners in past 12 months vs. 1 partner	1.	3.87 (2.65, 5.65)	1.83 (1.19, 2.81)	3.39 (2.18, 5.28)	5.32 (3.36, 8.41)	5.77 (3.28, 10.15)
>1 partner in lifetime vs. 1 partner	1.	3.09 (2.29, 4.18)	1.28 (0.95, 1.73)	4.69 (3.08, 7.13)	7.79 (4.69, 12.93)	4.88 (2.76, 8.63)
IPV in the past 12 months vs. no IPV in past 12 months[h]	1.	1.71 (1.26, 2.32)	0.72 (0.51, 1.03)	1.41 (0.96, 2.05)	1.31 (0.87, 1.98)	2.12 (1.29, 3.49)
Low relationship power vs. high power[i]		1.16 (0.83, 1.62)	0.44 (0.28, 0.68)	1.57 (1.06, 2.31)	1.60 (1.03, 2.50)	7.20 (4.34, 11.96)
Visited alcohol outlet in past 6 months vs. no alcohol outlet visit[j]	1.	1.62 (1.20, 2.19)	1.16 (0.86, 1.58)	1.33 (0.93, 1.89)	1.13 (0.76, 1.68)	3.95 (2.36, 6.61)
Ever drank alcohol vs. never drank alcohol	1.	2.01 (1.37, 2.93)	1.38 (0.91, 2.09)	1.46 (0.93, 2.28)	1.89 (1.14, 3.12)	1.34 (0.68, 2.63)
Ever used drugs vs. never used drugs	1.	1.59 (0.90, 2.83)	0.72 (0.35, 1.47)	1.66 (0.85, 3.26)	1.26 (0.55, 2.76)	10.74 (5.78, 19.98)

a Sexual partner types were identified using data on sexual partner characteristics self-reported by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits; thus numbers here represent AGYW-visits, not distinct AGYW. Partners were not followed longitudinally and the same partner could be reported at multiple study visits. We created AGYW partner-exposure variables for each sexual partner type by looking across all sexual partners reported by AGYW at each study visit. AGYW were coded as exposed to a specific partner type if any of their reported partners at that study visit included the partner type.
b Missing: Age 0; Enrolled in school 0; Food insecure 39; Double orphan 25; Depression 12; Early sexual debut 24; Partners in past 12 months 68; Partner in lifetime 22; IPV in past 12 months 116; Relationship power 8; Ever drank alcohol 16; Visited alcohol outlet in past 6 months 83; Ever used drugs 7.
c Risk Ratios (RR) and 95% confidence intervals for the association between AGYW-characteristics and sexual partner type were estimated using generalized estimating equations (GEE), with a robust variance estimator, exchangable correlation matrix to account for correlation, and binomial distribution with a log link. Each AGYW-characteristic (exposure) to sexual partner type (outcome) association was estimated in a separate statistical model, which compared the risk of having each specific partner type to the risk of having a monogamous HIV-negative peer partner (referent level).
d Food insecurity defined as worrying about having enough food for oneself or family in the past 12 months.
e Double orphan defined as reporting that both mother and father had died.
f Depression assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). AGYW who scored 16 or higher on the CES-D screened positive for depression.
g Early sexual debut defined as first sex before age 15.
h Intimate partner violence was measured using the World Health Organization instrument and is defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months.
i Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS). AGYW who scored in the lower 33% for answers regarding their most recent sexual partner are defined as having low power.
j Alcohol outlet defended as a tavern or shebeen (informal tavern).

Table 4.5 Comparison of sexual partner types identified by latent class analysis versus pre-specified partner labels among sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015 (N=2968 partner-reports)[a,b]

	Sexual Partner Type Identified by LCA											
	Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%
Pre-specified Partner Label												
Main Partner/Boyfriend	873	71.3	406	77.6	395	77.8	215	67.0	180	73.5	96	69.1
Regular Casual Sex Partner	232	18.9	79	15.1	67	13.2	79	24.6	25	10.2	24	17.3
Non-Regular Casual Sex Partner	84	6.9	29	5.5	26	5.1	12	3.7	25	10.2	13	9.4
Sex Work Client	1	0.1	4	0.8	3	0.6	5	1.6	4	1.6	1	0.7
Other[c]	35	2.9	5	1.0	17	3.4	10	3.1	11	4.5	5	3.6

a Adolescent girls and young women (AGYW) could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner types were identified using partner-level data self-reported by AGYW. Sexual partner frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by LCA identified sexual partner type.

b Pre-specified partner label missing for 7 partners. Chi-square p value for difference in proportions = 0.001 (excludes sex work clients and other partners due to small sample size).

c Other pre-specified partner label include lover, child's father, friend, and cases of rape/incest.

CHAPTER V: AIM 2: SEXUAL PARTNER TYPE AND RISK OF INCIDENT HIV INFECTION AMONG RURAL SOUTH AFRICAN ADOLESCENT GIRLS AND YOUNG WOMEN ENROLLED IN HPTN 068

1 Introduction

HIV remains a significant public health problem throughout the world, particularly among adolescent girls and young women (AGYW) in sub-Saharan Africa. The burden of HIV is particularly acute in South Africa, where 113,000 AGYW are infected each year at a rate that is four times their male peers (3). In this hyper-endemic setting where HIV prevalence increases rapidly as AGYW transition from adolescence to adulthood, sexual partners play a key role in driving AGYW's risk of HIV infection by determining their position within a sexual network, directly exposing AGYW to HIV, and facilitating risk behaviors that increase the risk of transmission (9, 10, 13). To be most effective, HIV prevention efforts must identify AGYW at greatest risk of HIV infection and provide targeted interventions that address the specific risks posed by their sexual partners.

Efforts to target the highest risk AGYW and their sexual partners for HIV prevention have been limited by a lack of understanding of the different types of sexual partners among AGYW and which sexual partners – not just which risk factors – pose the greatest risk for HIV infection. Longitudinal studies that have focused on specific partner risk factors individually have identified transactional sex (63), low relationship power (14) intimate partner violence (14), partner concurrency (40, 104, 137, 138), and potentially older partner age (42-44, 47, 48) as key factors which significantly increase women's risk of HIV infection. However, a critical limitation of these approaches is that they do not address how partner risk factors co-vary across actual sexual partners or account for how these risk factors work together to increase HIV risk. Risk scores have also been shown to be an effective method

for identify partners at high risk of transmitting HIV or other STIs but have not furthered understanding of actual types of sexual partners, as risk factors are exchangeable when calculating a score (101, 106, 139, 140). Categorizing sexual partner types using partner labels based on main/primary/boyfriend versus casual status to examine how risk behaviors and HIV and STI risk vary by partner type also presents challenges because these labels are not explicitly tied to specific risk factors shown to increase risk of infection and may mask important differences between partner types (102, 103, 141, 144, 149, 156-159).

To address these key research gaps, in a previous analysis, we used Latent Class Analysis (LCA) to identify sexual partner types based on sexual partner characteristics and risk factors self-reported by AGYW living in rural Agincourt, South Africa. We identified six distinct sexual partner types consisting of one older sexual partner, two out-of-school partners, one transactional sex and cohabiting partner, and one condom using partner, but found that these partner differences were obscured when AGYW categorized their sexual partners into pre-specified partner types commonly used in HIV studies (e.g., main partner/boyfriend, regular casual partner, non-regular casual partner). In this paper, we examine how these different sexual partner types impact AGYW's risk of HIV infection to provide a more nuanced understanding of which sexual partners are most important for HIV transmission.

2 Methods

2.1 Study setting, population, and data collection

This secondary analysis uses longitudinal data from the HIV Prevention Trials Network (HPTN) 068 study, a phase III randomized controlled trial of cash transfers for HIV prevention among 2533 unmarried AGYW, ages 13-20 (134, 142). Data were collected between March 2011 and March 2015 from AGYW living in rural Mpumalanga Province, South Africa in households situated in the South African Medical Research Council and

University of Witwatersrand Agincourt Health and Demographic Surveillance System (HDSS), a well-established census site (127).

AGYW were followed longitudinally and seen at baseline and annually at approximately 12, 24, and 36 months until the study completion date or their expected high school completion, whichever came first. Using audio computer-assisted self-interview (ACASI), AGYW reported their most recent sexual partners in the past 12 months (up to a maximum of three), and a range of other items, including sexual risk behavior, mental health, and substance use. If a graduating AGYW missed her scheduled visit that year, or if her previous visit that year was before October 1, an additional follow-up visit was scheduled around the time of her high school graduation ("graduation visit"). AGYW were tested for HIV but not interviewed at the graduation visit; ACASI data from the previous follow-up was used for these visits. To be eligible for the present analysis, AGYW had to: a) be HIV-negative at baseline, and b) report at least one sexual partner in the past twelve months.

Ethics approval for the parent study was obtained from the University of North Carolina Institutional Review Board (UNC IRB), the University of the Witwatersrand Human Subjects Ethics Committee, and the Mpumalanga Departments of Health and Education. Assent and informed consent were obtained from the AGYW and their parent/legal guardian at study enrollment. In addition, the UNC IRB also approved this secondary analysis.

2.2 Measures

The exposure variable, *sexual partner type*, was measured using two approaches. In the first approach, AGYW categorized each of their sexual partners using the following pre-specified partner type labels: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work client, or other. Because sex work clients and other partners

were rare, and no HIV infections occurred among AGYW with these partner types, we excluded these partner types from our analysis.

In the second approach, we used latent class analysis (LCA) to identify the following six distinct sexual partner types: older out-of-school partners, unprotected peer partners, anonymous out-of-school peer partners, casual protected peer partners, monogamous HIV-negative peer partners, and cohabiting with children peer partners. The LCA was described in Chapter IV (Aim 1).

Next, to understand the association between sexual partner type and incident HIV infection, we created an AGYW-level data set where each row of data was a year of AGYW follow-up. We created a visit-specific partner-exposure variable for each sexual partner type by looking across all sexual partners reported by AGYW at each study visit. AGYW were coded as exposed to a specific partner type if any of their reported partners at that study visit included the partner type. For the pre-specified partner label analysis, AGYW were coded as unexposed if they reported only having main partner(s)/boyfriend(s) (referent level). For the LCA-identified partner type analysis, AGYW were coded as unexposed if they reported only having monogamous HIV-negative peer partner(s) (referent level). AGYW may have multiple observations due to repeated study visits; thus AGYW frequencies represent AGYW-visits, not distinct AGYW. If an AGYW reported more than one sexual partner at a single visit, we considered all sexual partner types.

The outcome variable, *incident HIV infection*, was assessed at each follow-up visit. HIV screening was done with two HIV rapid tests completed in parallel (the Determine HIV-1/2 test [Alere Medical Co, Matsudo-shi, Chiba, Japan] and the US Food and Drug Administration [FDA]-cleared Uni-gold Recombigen HIV test [Trinity Biotech, Bray, County Wicklow, Ireland]). If both HIV rapid tests were non-reactive, no further testing was done at that study visit. If one or both tests were reactive or positive, confirmatory HIV testing was

done with the FDA-cleared GS HIV-1 western blot assay (Bio-Rad Laboratories Inc, Redmond Redmond, WA, USA). If the western blot was positive or indeterminate, a new blood sample was drawn within 2 weeks of the first test result for repeat testing. If HIV status was not clear, further site testing was done with guidance from the HPTN Laboratory Center. Additional details about the HIV testing can be found elsewhere (134).

We also explored the influence of several key AGYW-level covariates. *Age in years* was coded as a continuous variable. *School enrollment* was coded as a dichotomous variable. *Food insecurity* was defined as ever worrying about having enough food for oneself or family in the past 12 months and was coded as a dichotomous variable. *Early sexual debut* was defined as vaginal or anal sex before age 15 (the median age at first sex in this study population) and coded as a dichotomous variable. *Intimate partner violence* was measured using the World Health Organization instrument (129) and was defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months. *Relationship power* was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS) (15, 130); AGYW who scored in the lower 33% for answers regarding their most recent sexual partner were defined as having low power. *Depression* was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D) (128), and was defined as a score of 16 or higher. *Alcohol consumption* was defined as ever drinking alcohol and coded as a dichotomous variable. *Drug use* was defined as ever using drugs and coded as a dichotomous variable. *Number of sexual partners* in the past 12 months was coded as a continuous variable.

2.3 Statistical analysis

Because AGYW could report more than one sexual partner type at a study visit, and therefore exposure to sexual partner types was not mutually exclusive, we generated separate statistical models to examine each AGYW partner type-incident HIV infection

association. Specifically, for each sexual partner type identified through pre-specified partner labels and through latent class analysis, we used generalized estimating equations (GEE) with an exchangeable correlation matrix, binomial distribution, and log link to estimate risks, risk ratios (RR), and 95% confidence intervals (CI) for the association between AGYW having a specific sexual partner type and incident HIV infection compared to the referent partner type (only main partner/boyfriend(s) for the pre-specified partner label analysis, and only monogamous HIV-negative peer partner(s) for the LCA-identified partner type analysis). We used a robust variance estimator to account for potential correlation due to AGYW reporting multiple sexual partners over time.

To control for potential confounding, we constructed a directed acyclic graph (DAG) and identified the following minimally sufficient adjustment set: intervention arm, age, school enrollment, food insecurity, depression, low relationship power, intimate partner violence, alcohol consumption, drug use, early sexual debut, and number of sexual partners in the past 12 months. In addition, we controlled for days since last follow-up visit to account for AGYW who were seen slightly before or after their scheduled annual follow-up visit. All analyses were conducted using SAS (Version 9.4, Cary, NC).

A potential limitation of this analysis is that if an AGYW reported more than one sexual partner at a follow up visit and become HIV-infected, we are unable to identify which sexual partner infected her. To assess the potential impact of this limitation, we conducted the following two sensitivity analyses.

First, we limited the dataset to only AGYW who reported one sexual partner at a specific follow up visit. Thus, if an AGYW became HIV infected, we could be more certain about the partner who infected her. We then re-ran the analysis examining the association between sexual partner type and incident HIV infection. Because AGYW in this analysis reported only one sexual partner, we were able to examine the association between partner

type and incident HIV infection association in a single model for pre-specified partner labels (with main partner/boyfriend as the referent level) and a single model for the LCA-identified partner types (with monogamous HIV-negative peer partner as the referent level).

Second, we identified the most common partner combinations with respect to pre-specified partner labels and LCA-identified partner type. We then examined the association between these partner combinations and incident HIV infection. For both sensitivity analyses, we used the same statistical analysis approach outlined in the main analysis.

3 Results

Of the 2533 AGYW enrolled in HPTN 068, 1034 tested HIV-negative at baseline and reported having sex with at least one sexual partner during follow-up, making them eligible for this analysis. At the visit when AGYW reported her first sexual partner, AGYW were 17 years of age on average, and most (94%) were still enrolled in school (Table 5.1). Twenty-nine percent of AGYW reported food insecurity, 7% were double orphans, and 35% screened positive for depression. AGYW reported an average of 1.1 sexual partners in the past 12 months and only 6 AGYW reported more than three sexual partners in the past 12 months (0.06%), suggesting that the study captured the vast majority of AGYW's sexual partners by asking for AGYW's three most recent sexual partners. AGYW were on average 15.2 years old at first sex and a little more than a quarter of AGYW (28%) of AGYW reported IPV in the past 12 months and a quarter reported low relationship power with their most recent sexual partner. Alcohol and drug use were relatively uncommon, with 17% reporting ever consuming alcohol and 7% reporting ever using drugs.

Over the course of 2140 AGYW-visits, 1034 AGYW reported 2968 sexual partners (Table 5.2). With respect to pre-specified partner type labels, most AGYW reported having only main partner(s)/boyfriend(s) (reported at 69% of AGYW-visits), followed by regular casual sex partners (20% of AGYW-visits), and finally non-regular casual sex partners (8%

of AGYW-visits). With respect to the LCA-identified sexual partner type, most AGYW reported having only monogamous HIV-negative peer partner(s) (reported at 39% of AGYW-visits), followed by unprotected peer partners (22% of AGYW-visits), casual protected peer partners (21% of AGYW-visits), older out-of-school partner (13% of AGYW-visits), anonymous out-of-school peer partners (10% of AGYW-visits), and finally cohabiting with children peer partners (5% of AGYW-visits).

Sixty-three AGYW (6%) became HIV infected over the course of follow-up (Table 5.3). With respect to partner type identified using the pre-specified partner labels, compared to AGYW with only main partner/boyfriend(s), AGYW with regular casual sex partners (aRR: 1.14, 95% CI: 0.63, 2.072) and AGYW with non-regular casual sex partners (aRR: 0.97, 0.41, 2.28) were not at substantially higher risk of incident HIV infection.

Examining sexual partner types identified through LCA, we found that AGYW with older out-of-school partners had more than three times the risk of incident HIV infection (aRR: 3.35, 95% CI: 1.43, 7.85), while AGYW with an unprotected peer partner had more than two times the risk of incident HIV infection (aRR: 2.45, 95% CI: 1.11, 5.44) compared to AGYW with only monogamous HIV-negative peer partners, independent of individual-level risk factors. Having a casual protected peer partner (aRR: 1.80 (0.74, 4.37) or an anonymous out-of-school peer partner (aRR: 1.92 (0.68, 5.39) was also associated with an increased risk of incident HIV infection compared other LCA-identified partner types; however, these findings were imprecise due to the small number of incident HIV infections observed in AGYW with these partner types (13 and 7, respectively). In contrast, AGYW with cohabitating with children peer partners had less than half the risk of incident HIV infection compared to AGYW with only monogamous HIV-negative peer partners (aRR: 0.33, 95% CI: 0.065, 1.65).

The results from the LCA-identified partner type analysis were consistent, though attenuated, when we limited the analysis to AGYW who reported only one sexual partner (sensitivity analysis 1) and when we examined the most common partner combinations among AGYW (sensitivity analysis 2). As with the main analysis, AGYW with older, out-of-school peer partners had the highest risk of incident HIV-infection, followed by unprotected peer partners, anonymous out-of-school peer partners, casual protected peer partners, and finally cohabiting with children peer partners. The results from the pre-specified partner label analysis were consistent when examining common partner combinations: compared to having only main partner(s)/boyfriend(s), having only regular casual sex partners, or having only non-regular casual sex partners was not associated with an increased risk of incident HIV-infection. However, the results were less robust among AGYW who reported only one sexual partner. In this subset of AGYW, having a regular casual sex partner was associated with a slight but non-significant decrease in risk of HIV infection compared to AGYW with a main partner/boyfriend (aRR: 0.67, 95% CI: 0.26, 1.74).

4 Discussion

Adolescent girls and young women in South Africa are at extraordinarily high risk of HIV infection and urgently need targeted HIV prevention strategies that account for AGYW's sexual partners. In this study, we used rich, partner-level information on AGYW's three most recent sexual partners to examine how sexual partners impact AGYW's risk of HIV infection, starting from when many AGYW are having sex for the first time and following AGYW for up to three years. We found that sexual partner types – identified using latent class analysis and based on explicit, partner characteristics self-reported by AGYW – predicted risk of incident HIV infection independent of individual-level risk factors. Specifically, AGYW with older out-of-school partners and AGYW with unprotected peer partners were significantly more likely to acquire HIV, compared to AGYW with only monogamous HIV-negative peer partner(s). In contrast, partner types identified using main partner versus casual partner

labels – which obscure key differences between partner types identified through LCA – were not significantly associated with incident HIV infection. These findings highlight the urgent need for targeted interventions that account for contextual differences between sexual partner types and that address the specific prevention needs and risks posed by different partners.

Our findings support the hypothesis that age-disparate partnerships contribute to the rapid spread of HIV infection among young women in Southern and Eastern Africa (44). The association between partner age and incident HIV infection has recently been called into question by two longitudinal studies both conducted in South Africa: a population-based study of women ages 15-29 in rural KwaZulu-Natal (42), and a study of women ages 18-45 primarily from the Durban area and enrolled the VOICE microbicide trial (43). These studies found that having an older sexual partner was not associated with incident HIV infection, even among younger women. However, several key factors may explain these conflicting findings. First, we considered all reported sexual partners (up to three partners per visit), while the KwaZulu-Natal study limited reported partners to only the most recent sexual partner (which may have biased the sample towards longer partnerships), and the VOICE trial limited partners to only primary partners (which may have biased the sample toward safer, more socially acceptable partners). Thus, reported partners in these studies may not represent all sexual partners and may exclude the highest risk partners. Second, we used ACASI to collect sexual partner information to minimize social desirability bias (160-162), while the KwaZulu-Natal study used face-to-face interviews by fieldworkers from the local community. Third, participants in the VOICE trial were tested for HIV monthly, which may have had an unintended prevention effect. Recent studies also provide counter-evidence against the hypothesis that the lack of association between partner age and incident HIV infection is due to the rapid scale up of ART and greater uptake of treatment among older men. Two studies examining the association between older partner age and HIV infection

among AGYW in Zimbabwe from 1998-2013 (47) and in South Africa from 2002-2012 (48) found that this relationship did not vary during pre- versus post-ART eras. Moreover, data from the most recent South African National HIV survey (2012) suggests that men in age-disparate partnerships with women ages 15-24 are more likely to be HIV positive and ART-naive than men in similar-age partnerships (49). Given mounting evidence that older sexual partners substantially increase AGYW's risk of HIV infection – including phylogenetic evidence linking older male sexual partners to incident HIV infection among AGYW (44) – combination prevention efforts must address the factors that lead AGYW to select older sexual partners as well as provide a menu of prevention strategies for AGYW with older sexual partners.

At the same time, we found that AGYW's sexual partners were not substantially older – most partners were only 2-3 years older than AGYW and older out-of-school partners were on average only 6 years older than AGYW. Thus efforts to prevent HIV infection must look beyond just partner age, and beyond any single partner risk factor, to consider how these risk factors co-vary and work together to increase risk of HIV infection. Such insight is critical for the design and targeting of prevention messages and interventions that are sensitive to specific population needs and the partnership context. AGYW with unprotected peer partners, casual protected peer partners, or anonymous out-of-school peer partners were at increased risk of HIV infection compared to AGYW with only monogamous HIV-negative peer partners. Although these estimates were imprecise due to the limited number of HIV infections among AGYW with these partner types, they highlight the fact that partner types other than older sexual partners also drive HIV transmission among AGYW and should be included in HIV prevention efforts.

We found that condom use was low across all partner types except for casual protected peer partners. However, risk of incident HIV infection varied substantially by LCA-identified partner type. AGYW reported low condom use with unprotected peer partners and

anonymous out-of-school peer partners even though they had unknown HIV status/were thought to be HIV-positive, and had unknown concurrency status/were thought to have other concurrent sexual partners. Unsurprisingly, AGYW with these partner types had a higher risk of HIV infection. In contrast, monogamous HIV-negative peer partner practiced behaviors consistent with stable, monogamous partnerships (i.e., no children with other women, no concurrent sexual partners), and were thought to be HIV-negative. AGYW with only monogamous HIV-negative peer partner had a lower risk of HIV infection compared to AGYW with other partner types. These findings suggest that while AGYW may be able to accurately judge which sexual partners engage in high risk sexual behavior, AGYW do not act on this knowledge by using condoms more consistently with higher risk partners. Adolescents in South Africa highly value trust in their partnerships, but assign trust to partners who they acknowledge may not be monogamous (75, 76, 78). Numerous studies have documented that condom use quickly declines as sexual partnerships become more established and as expectations of trust and intimacy increase (13, 66, 67, 69, 71). In contexts where consistent condom use is incompatible with partnership norms, alternative AGYW-controlled prevention strategies, including pre-exposure prophylaxis (PrEP), should be offered to AGYW as a prevention strategy. AGYW with casual protected peer partners were the only AGYW to report consistent condom, despite the fact that these partners were thought to be HIV-negative. Although having a casual protected peer partner was not associated with incident HIV infection, to the extent that these partnerships continue beyond the initial sexual encounter, interventions that can extend condom will be important for preventing HIV infection.

Partnership context is also important for understanding how transactional sex may increase an AGYW's risk of HIV infection. Exchanges between sexual partners can take a variety of forms – from gifts to express affection, to entitlements like child support, to explicit financial or material transfers with expectations of sex (9, 36, 50, 52-57). These differences

likely influence both the riskiness of transactional sex and the types of interventions and prevention messaging which will be effective to reduce this practice. In our study population, transactional sex was most common among cohabiting with children peer partners (80% of reported partnerships) followed by older out-of-school partners (36%). Yet, having a cohabiting with children peer partner appeared to be protective against HIV, while having an older out-of-school partner was associated with an increased risk of HIV infection. We did not assess whether partners provided items like housing or child support; thus future studies should examine transactional sex practices in these partnership types to understand how they may vary, and how these differences influence HIV risk. To our knowledge, only one longitudinal study, conducted among young women living in the Eastern Cape province of South Africa, has examined the association between transactional sex and incident HIV infection (63). The study found that transactional sex was associated with increased risk of HIV infection independent of partner number, and that young women who had transactional sex with a one-off partner had a greater risk of HIV infection than young women who reported transactional sex with an ongoing, concurrent partner. We found that transactional sex was nearly non-existent among AGYW with casual protected peer partners (who were notable for the fact that they had sex with AGYW only once). Nonetheless, these findings suggest that HIV risk relating to transactional sex may be highly dependent on contextual factors and highlight the importance of considering transactional sex within the context of sexual partnerships, rather than as an isolated risk behavior.

Lastly, cohabitating with children peer partners were rare, but warrant further investigation. AGYW with these partners reported a number of concerning high risk behaviors at both the individual (e.g., low relationship power, intimate partner violence, drug use, not enrolled in school) and partner level (low condom use, partner having children with other women, transactional sex), thus it is surprising that these AGYW had the lowest risk of incident HIV infection. It is possible that cohabiting and having a child together is a marker of

a more committed, monogamous partnership. Notably, AGYW reported that cohabiting partners did not have other concurrent sexual partners and were HIV-negative despite having children with other women; however, HIV incidence may rise in in these peer partners over time as they become older and particularly if they continue to engage in high risk behaviors associated with HIV infection and transmission. Compared to partners who deny parental responsibility, these partner types may be more likely to be monogamous and HIV-negative (73, 144). We did not assess marital status; however, all AGYW were unmarried at baseline, and the most recent South African HIV Prevalence Incidence, and Behavior Survey found that very few young people (ages 16-24) reported being married and living with their partner (4.6%) compared to cohabiting (9.2%), being single, divorced or widowed (29.0%), or going steady (56.6%) (149). Thus although marriage has been shown to be protective against incident HIV infection in some settings, while cohabiting without marriage has been shown to increase risk of HIV infection at the national level in South Africa, these findings may not be generalizable to young women in rural South Africa (149). Future studies that can further characterize cohabitating with children peer partners will shed light on how these partnerships function and whether these very vulnerable AGYW are at risk for HIV infection in the long term.

In conclusion, adolescent girls and young women (AGYW) in South Africa face an unparalleled HIV burden and are a key population in need of intervention. Sexual partners play an important role in HIV transmission but have been characterized simply and in ways that do not facilitate the development of targeted interventions to prevent HIV infection among AGYW. In this study, we developed a richer understanding of which sexual partner types are most strongly associated with incident HIV infection among AGYW and how risk factors unique to each partner type drive or protect AGYW against HIV infection. New HIV prevention strategies, including pre-exposure prophylaxis (PrEP), offer the potential to

markedly decrease HIV transmission among AGYW (163, 164). However, to have the greatest impact on HIV prevention while containing costs, combination prevention efforts must target people at greatest risk of infection and account for contextual differences between sexual partner types to address the specific needs and risks posed by different partners.

5 Tables

Table 5.1 Characteristics of HIV-negative, sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa at study entry, from March 2011 to March 2015 (N=1034 AGYW)[a,b]

	N	%
Intervention arm	523	50.58
Sociodemographics		
Mean age (SD)	17.5	(1.5)
Enrolled in school	987	94.5
Mean grade (SD)	10.5	1.1
Food insecure[c]	293	28.7
Double orphan[d]	74	7.2
Depression[e]	360	35.0
Sexual risk		
Age at first sex, mean (SD)[f]	15.2	(3.4)
Mean number of sexual partners in past 12 months (SD)	1.1	0.7
Mean number of sexual partners in lifetime (SD)	2.0	(3.2)
Intimate partner violence in past 12 months[g]	292	28.3
Low relationship power with most recent sexual partner[h]	258	25.0
Substance use		
Visited alcohol outlet in past 6 months[i]	445	44.1
Ever consumed alcohol	171	16.6
Ever used drugs	68	6.6

a Data are from the first study visit at which the adoelscent girls and young woman (AGYW) reported having sex with a partner in the past 12 months.
b Missing: Intervention arm 0; Age 0; Enrolled in school 0, Grade 3; Ever repeated grade 0; Food insecure 14; Double orphan 4; Depression 4; Age at first sex 10; Currently has a boyfriend 4; Number of sexual partners in past 12 months 29; Number of sexual partners in lifetime 11; Intimate partner violence in past 12 months 68; Low relationship power with most recent sexual partner 5; Visited alcohol outlet in past 6 months 24; Ever drank alcohol 5; Ever used drugs 1.
c Food insecurity defined as AGYW worrying about having enough food for oneself or family in the past 12 months.
d Double orphan defined as having deceased mother and father.
e Depression assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). AGYW who scored 16 or higher screened positive for depression.
f Age at first sex defined as the age at first reported vaginal or anal sex.
g Intimate partner violence was measured using the World Health Organization instrument and was defined as any violence by a partner (e.g., slapped, pushed, shoved, hit, kicked, threatened with a weapon) in the past 12 months.

h Relationship power was assessed using the South African adaptation of the Sexual Relationship Power Scale (SRPS); AGYW who scored in the lower 33% for answers regarding their most recent sexual partner were defined as having low power.
i Alcohol outlet defended as a tavern or shebeen (informal tavern)

Table 5.2 Distribution of sexual partner types among sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015[a,b]

	Sexual partner types by AGYW-visits (N=2140)[c]	
	Number of AGYW-visits	% of AGYW-visits
Pre-specified partner type labels		
Only main partner/boyfriend	1471	68.7
Any regular casual sex partner	436	20.4
Any non-regular casual sex partner	171	8.0
LCA-identified sexual partner type		
Only monogamous HIV-negative peer partner	824	38.5
Any older out-of-school partner	274	12.8
Any unprotected peer partner	461	21.5
Any casual protected peer partner	449	21.0
Any anonymous out-of-school peer partner	204	9.5
Any cohabitating with kids peer partner	113	5.3

a Sexual partner type was measured using three approaches. Pre-specified partner type labels: Adolesecnt girls and young wome (AGYW) were asked to categorize each of their sexual partners using the following labels: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work partner (data not shown), and other partner (data not shown). Older sexual partner: We created a simple measure of older sexual parter based on the partner's age: partner <5 years older, partners ≥5 years older. LCA-identified sexual partner type: we used latent class analysis (LCA) to identify six distinct sexual partner types: older out-of-school partners, high HIV-exposure risk peer partners, anonymous out-of-school peer partners, casual protected peer partners, monogamous HIV-negative peer partners, and cohabiting with kids peer partners. In all cases, sexual partners were identified based on partner characteristics self-reported by the AGYW.
b Missing: Self-reported partner type 4; Older sexual partner 3; LCA-identified sexual partner type 0.

c AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Frequencies under the header “sexual partner types by AGYW-visits” represent how often a specific sexual partner type was reported at a specific study visit. Frequencies add up to more than 2140 because AGYW could report more than one sexual partner type at a visit. Partners were not followed longitudinally, thus the same partner could be reported at multiple study visits. If two of the same type of sexual partner was reported at a single visit, this partner type was only counted once.

Table 5.3 Unadjusted and adjusted risk ratios (RR) and 95% confidence intervals (CI) for the association between sexual partner type and incident HIV infection among sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from April 2012 to March 2015 (N=2140 AGYW-visits)[a,b]

	HIV infections	AGYW-visits[c]	Risk (95% CI)	RR (95% CI)[d]	aRR (95% CI)[e]
Pre-specified partner type labels					
Main analysis: Separate model for each partner type (common referent)					
Regular casual sex partner					
Any regular casual sex partner	16	436	0.038 (0.023, 0.063)	1.27 (0.70, 2.27)	1.14 (0.63, 2.072)
Only main partner/boyfriend	43	1471	0.030 (0.022, 0.041)	1.	1.
Non-regular casual sex partner					
Any non-regular casual sex partner	6	171	0.036 (0.016, 0.083)	1.21 (0.50, 2.91)	0.97 (0.41, 2.28)
Only main partner/boyfriend	43	1471	0.030 (0.022, 0.041)	1.	1.
Sensitivity analysis 1: AGYW with only 1 reported sexual partner					
Regular casual sex partner	5	254	0.020 (0.0082, 0.049)	0.76 (0.29, 2.00)	0.67 (0.26, 1.74)
Non-regular casual sex partner	3	107	0.029 (0.0091, 0.092)	1.10 (0.32, 3.70)	0.95 (0.35, 2.58)
Main partner/boyfriend	38	1093	0.026 (0.018, 0.038)	1.	1.
Sensitivity analysis 2: Most common partner combinations					
Only main partners	43	1471	0.030 (0.022, 0.041)	1.	1.
Only regular casual sex partner(s)	9	297	0.031 (0.016, 0.061)	1.038 (0.50, 2.16)	0.98 (0.47, 2.029)
Only non-regular casual sex partner(s)	3	116	0.027 (0.0084, 0.084)	0.88 (0.27, 2.91)	0.89 (0.32, 2.48)
Main partner/boyfriend and regular casual sex partner(s)	5	109	0.048 (0.019, 0.12)	1.60 (0.61, 4.15)	1.50 (0.54, 4.12)

	HIV infections	AGYW-visits[c]	Risk (95% CI)	RR (95% CI)[d]	aRR (95% CI)[e]
LCA-identified sexual partner type					
Main analysis: Separate model for each partner type (common referent)					
Older out-of-school partner					
Any older out-of-school partner(s)	17	274	0.066 (0.040, 0.11)	3.83 (1.86, 7.89)	3.35 (1.43, 7.85)
Only monogamous HIV-negative peer partner(s)	14	824	0.017	1.	1.
Unprotected peer partner					
Any unprotected peer partner(s)	19	461	0.043 (0.027, 0.068)	2.49 (1.23, 5.021)	2.45 (1.11, 5.44)
Only monogamous HIV-negative peer partner(s)	14	824	0.017	1.	1.
Casual protected peer partner					
Any casual protected peer partner(s)	13	449	0.030 (0.017, 0.052)	1.73 (0.80, 3.71)	1.80 (0.74, 4.37)
Only monogamous HIV-negative peer partner(s)	14	824	0.017	1.	1.
Anonymous out-of-school peer partner					
Any anonymous out-of-school peer partner	7	204	0.036 (0.017, 0.076)	2.056 (0.082, 5.18)	1.92 (0.68, 5.39)
Only monogamous HIV-negative peer partner(s)	14	824	0.017	1.	1.
Cohabiting with children peer partner					
Any cohabiting with children peer partner	2	113	0.018 (0.0044, 0.074)	1.043 (0.23, 4.70)	0.33 (0.065, 1.65)

	HIV infections	AGYW-visits[c]	Risk (95% CI)	RR (95% CI)[d]	aRR (95% CI)[e]
Only monogamous HIV-negative peer partner	14	824	0.017	1.	1.
Sensitivity analysis 1: AGYW with only 1 reported sexual partner					
Older out-of-school partner	7	150	0.049 (0.023, 0.11)	2.81 (1.08, 7.29)	2.26 (0.78, 6.52)
Unprotected peer partner	7	221	0.033 (0.016, 0.069)	1.88 (0.73, 4.82)	2.079 (0.78, 5.52)
Casual protected peer partner	7	302	0.024 (0.011, 0.50)	1.36 (0.53, 3.50)	1.89 (0.69, 5.17)
Anonymous out-of-school peer partner	2	76	0.027 (0.0068, 1.11)	1.55 (0.34, 6.88)	1.30 (0.38, 5.98)
Cohabiting with children peer partner	1	60	0.017 (0.0023, 0.12)	0.97 (0.0.12, 7.69)	0.54 (0.06, 4.87)
Monogamous HIV-negative peer partner	12	701	0.017 (0.0098, 0.031)	1.	1.
Sensitivity analysis 2: Most common partner type combinations					
Only monogamous HIV-negative peer partner(s)	14	824	0.017 (0.010, 0.029)	1.	1.
Only casual protected peer partner(s)	9	346	0.027 (0.014, 0.052)	1.55 (0.66, 3.61)	2.025 (0.081, 5.042)
Only unprotected peer partner(s)	10	254	0.041 (0.022, 0.077)	2.37 (1.04, 5.40)	2.65 (1.12, 6.29)
Only older out-of-school partner(s)	11	179	0.066 (0.035, 0.12)	3.79 (1.67, 8.55)	3.094 (1.31, 7.31)
Only anonymous out-of-school peer partner	2	94	0.022 (0.0055, 0.086)	1.26 (0.29, 5.51)	1.15 (0.27, 4.99)
Only monogamous HIV-negative peer partner(s) and unprotected peer partner(s)	4	91	0.046 (0.017, 0.13)	2.66 (0.85, 8.36)	1.92 (0.56, 6.53)
Only cohabiting with children peer partner(s)	1	75	0. 014 (0.0019, 0.098)	0.78 (0.10, 6.088)	0.49 (0.063, 3.84)

a Sexual partner type was measured using three approaches. Pre-specified partner type labels: Adolesecnt girls and young wome (AGYW) were asked to categorize each of their sexual partners using the following labels: main partner/boyfriend, regular casual sex partner, non-regular casual sex partner, sex work partner (data not shown), and other partner (data not shown). Older sexual partner: We created a simple measure of older sexual parter based on the partner's age: partner <5 years older, partners ≥5 years older. LCA-identified sexual partner type: we used latent class analysis (LCA) to identify six distinct sexual partner types: older out-of-school partners, high HIV-exposure risk peer partners, anonymous out-of-school peer partners, casual protected peer partners, monogamous HIV-negative peer partners, and cohabiting with kids peer partners. In all cases, sexual partners were identified based on partner characteristics self-reported by the AGYW.

b Missing: Self-reported partner type 4; Older sexual partner 3; LCA-identified sexual partner type 0.

c AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Frequencies represent how often a specific sexual partner type was reported at a specific study visit. Partners were not followed longitudinally, thus the same partner could be reported at multiple study visits. If two of the same type of sexual partner was reported at a single visit, this partner type was only counted once.

d Risk ratios (RR) and 95% confidence intervals for the association between AGYW having a specific sexual partner type and incident HIV infection were estimated using generalized estimating equations (GEE), with a robust variance estimator and exchangable correlation matrix to account for correlation, and a binomial distribution with a log link. Each sexual partner type (exposure) to incident HIV infection (outcome) association was estimated in a separate statistical model, which compared the risk of having each specific partner type to the risk of not having that partner type.

e Models were adjusted for the following confounders to estimate adjusted risk ratios (aRR): intervention arm, age, school enrollment, food insecurity, depression, low relationship power, intimate partner violence, alcohol consumption, drug use, early sexual debut, number of sexual partners in the past 12 months, and days since last follow-up visit.

CHAPTER VI: DISCUSSION

Adolescent girls and young women in South Africa are at extraordinarily high risk of HIV infection and urgently need targeted HIV prevention strategies that look beyond individual level risk factors. Sexual behavior is negotiated between sexual partners and influenced by the characteristics of both partners and the resulting dynamics between them (9, 10), thus efforts to prevent HIV infection in this highly vulnerable population must address the critical role of sexual partners when designing and targeting interventions for AGYW.

Previous studies on sexual partners have primarily focused on partner risk factors individually without considering the sexual partner as a whole person. Thus, the overall goal of this dissertation centered around developing a better understanding of the different types of sexual partners among AGYW in rural South Africa, and identifying how sociodemographic and behavioral differences across partner types could be used to not only identify the highest risk sexual partners but also to develop more effective and targeted interventions that leverage strengths within partnerships as well as address vulnerabilities that increase AGYW's risk of HIV infection. As part of this work, we also identified AGYW-level risk factors that predicted partner selection, as these factors could be could also provide complementary contextual information to identify the most vulnerable AGYW as well as design targeted interventions to prevent HIV infection.

We hypothesized that sexual partners are classifiable into distinct, identifiable partner types that differ with respect to sociodemographic factors (age, school enrollment) as well as risk behaviors (condom use, concurrency, children with AGYW and other women,

transactional sex, and HIV status) and these partner types predict risk of incident HIV infection among AGYW. We further hypothesized that AGYW-level characteristics that predict risk of HIV infection also predict partner selection. Specifically, AGYW who were enrolled in school would be more likely to select partners who were similar in age and also enrolled in school; AGYW who reported engaging in high risk behavior like using alcohol or drugs would be more likely to select riskier sexual partners who were associated with increased risk of HIV infection among AGYW; and AGYW who reported food insecurity and being an orphan would be more likely to select partners who provided financial or other forms of support.

1 Summary of findings

For both Aim 1 and Aim 2, we used data from a randomized controlled trial of cash transfers for HIV prevention among 2533 AGYW, ages 13-20 at enrollment and living in rural, Agincourt, South Africa. The trial collected self-reported data on AGYW's three most recent sexual partners and tested girls for HIV annually, for up to three years of follow-up. Overall, we found support for our hypothesis that distinct sexual partner types could be identified based on sociodemographic and behaviors risk factors self-reported by AGYW. Partner types identified by LCA predicted incident HIV infection among AGYW, while partner types based on pre-specified labels were not significantly associated with HIV infection. As hypothesized, AGYW who were not enrolled in school, reported high risk sexual behaviors (young age at first sex and multiple sexual partners in the past year), and reported substance use were more likely to select high risk sexual partners associated with increased risk of HIV infection compared to AGYW who did not report these behaviors.

In Aim 1, our analysis focused on identifying sexual partner types among AGYW and AGYW-level of predictors of partner selection. We measured sexual partner types using pre-specified partner labels (main partner/boyfriend, regular casual sex partner, non-regular

casual sex partner) and using latent class analysis (LCA) to identify underlying, latent sexual partner subtypes from a set of categorical partner factors self-reported by AGYW. We identified six distinct sexual partner types which differed by age, school enrollment, concurrency, condom use, transactional sex, perceived HIV-status, children, and cohabitation. The sexual partner types, from most common to least common, were: monogamous HIV-negative peer partner (34% partner-reports); unprotected peer partner (20% partner-reports); casual protected peer partner (19% of partner-reports); older out-of-school partner (13% partner-reports); anonymous out-of-school peer partner (9% partner-reports); and cohabiting with children peer partner (5% partner-reports). There was only one older partner type (older out-of-school partners) and two partner types were not enrolled in school (older out-of-school partners and anonymous out-of-school peer partners). Consistent condom use was low across all partner types, with the exception of casual protected peer partners who had sex with AGYW only once. Transactional sex was present in nearly all partner types (about one-quarter of each partner type reported transactional sex) but was rare in casual protected peer partners and very common among cohabiting with children peer partners. There was not one concurrent partner type; however, anonymous out-of-school peer partners and unprotected peer partners had the greatest proportion of partners whose concurrency status was unknown. We found that partner differences identified through LCA were obscured when sexual partners were categorized by AGYW using pre-specified partner labels. Specifically, AGYW applied the label “main partner/boyfriend” broadly to describe a wide variety of partner types identified by LCA, highlighting the limitations of the main versus casual distinction as a proxy measure for sociodemographic and behavioral differences between partners.

School enrollment was an important, modifiable risk factor that strongly predicted sexual partner type. AGYW not enrolled in school were nearly three times as likely to have

an older out-of-school partner and more than four times as likely to have a cohabiting with children peer partner, while AGYW enrolled in school were significantly more likely to have a casual protected peer partner, compared to having only monogamous HIV-negative peer partners. AGYW who engaged in high-risk sexual behavior and reported substance use were more likely to have sexual partner types who also reportedly engaged in high-risk behavior. AGYW who reported multiple sexual partners in the past year were more likely to have cohabiting with children peer partners and older out-of-school partners than only monogamous HIV-negative peer partners. AGYW who reported ever drinking alcohol were significantly more likely to report having an unprotected peer partner or an anonymous out-of-school peer partners, while AGYW who reported ever using drugs were more than 10 times as likely to report having a cohabiting with children peer partner, compared to having only a monogamous HIV-negative peer partner. Lastly, AGYW with cohabiting with kids peer partners were rare but appeared to be highly vulnerable and warrant further investigation. These AGYW were overwhelmingly more likely to be food insecure, depressed, report IPV in the past 12 months, and report low relationship power with their most recent sexual partner, in addition to the risk factors discussed above.

In Aim 2, we estimated the association between sexual partner types (identified in Aim 1) and risk of incident HIV infection among AGYW. We found that AGYW with older out-of-school partners had more than three times the risk of incident HIV infection compared to AGYW with only monogamous HIV-negative peer partners, independent of individual-level risk factors (aRR: 2.66, 95% CI: 1.28, 5.53). This finding lends support to the hypothesis that age-disparate partners contribute to the rapid spread of HIV infection among AGYW. Having an unprotected peer partner (aRR: 2.45 (1.11, 5.44) or an anonymous out-of-school peer partner (aRR: 1.80 (0.74, 4.73) was also associated with an increased risk of incident HIV infection compared to having only monogamous HIV-negative peer partner(s); however,

these findings were imprecise due to the small number of incident HIV infections observed in AGWY with these partner types. In contrast, AGYW with cohabitating with kids peer partners had less than half the risk of incident HIV infection (aRR: 0.33, 95% CI: 0.065, 1.65).

Partner types identified using the pre-specified labels were not significantly associated with incident HIV infection. Having a regular casual sex partner (aRR: 1.14, 95% CI: 0.63, 2.072) or a non-regular casual sex partner (aRR: 0.97, 95% CI: 0.41, 2.28) did not appear to substantially raise AGYW's risk of incident HIV infection, compared to AGYW who reported only main partners/boyfriends.

2 Contributions

This dissertation contributes to burgeoning knowledge on sexual partnerships by using rich, partner-level data, and a novel, data-driven approach (latent class analysis), to better characterize and capture the full range and complexity of sexual partnerships among rural South African adolescent girls and young women at a critical transition period. To date, the vast majority of studies examining sexual partners have been conducted in high-income/developed countries rather than in countries with generalized HIV epidemics (12) and have focused on examining partner risk factors individually rather examining sexual partners as a whole to consider how different attributes of sexual partners interact to drive risk of HIV infection among AGYW (10). In light of this research gap, initiatives to reduce HIV incidence among girls and women, including DREAMS (143), have prioritized characterizing sexual partners to understand which partners pose the greatest risk for HIV transmission, and what types of HIV-prevention messaging and services are most appealing and effective among different partner types.

We demonstrate that commonly used approaches for capturing sexual partner types, which categorize sexual partners into main versus casual partner types, mask important

differences between partner types. Moreover, we provide evidence that HIV prevention efforts that exclude AGYW with main partners may be missing AGYW at high risk for HIV infection. This may be especially true in the South African context and other areas where it is common for men to engage in seasonal migrant work and where partnerships among young people, particularly in rural areas, can be long in duration and described in highly romantic terms but be characterized by long periods of separation without any sexual activity (72-74). Partner types based on explicit, reported partner characteristics offer an alternative model for measuring and targeting specific partner types for HIV research and intervention.

We provide strong evidence that older sexual partners play a key role in increasing risk of HIV infection among AGYW and address important limitations of earlier longitudinal studies (42, 43) by considering a broader range of sexual partners rather than limiting reported partners to primary partners or most recent partners, which may not represent all sexual partners and may exclude the highest risk partners. However, we also highlight the importance of looking beyond partner age, and beyond any single partner risk factor, to understand the broader partner context. Considerably research attention has focused on determining whether older sexual partners facilitate HIV transmission (44). However, we identified three partner types – unprotected peer partners, anonymous out-of-school peer partners, and casual protected peer partners – that were similar in age with AGYW but which were associated with increased risk of infection. Moreover, we found that characteristics commonly associated with older partner age and HIV risk (145, 146) – including having other concurrent sexual partners (34), unprotected sex (27, 32, 33), and transactional sex (9, 32, 36-38) – were not unique to older partners. Thus targeting only older sexual partners as a proxy for other risk behavior may exclude AGYW with other partner types who are also at high risk of HIV infection. Insight into sexual partners as a

whole, rather than specific partner risk factors, is critical for the design and targeting of prevention messages and interventions that are sensitive to specific population needs and the partnership context.

Our findings highlight the urgent need for better messaging and context- and partner-specific interventions directed at increasing condom use among AGYW. Condom use was low across all partner types except for casual protected peer partners, with whom AGYW had sex with only one time and reported very little transactional sex. Previous studies have found that condom use decreases with increasing partnership duration and coital frequency (13, 79, 80) and when transactional sex is involved (32, 51, 52). However, our results highlight the widespread nonuse of condoms among AGYW in rural South Africa across very different partner types. We also demonstrated that although AGWY may be able to accurately report sexual partner characteristics that place them at great risk for HIV infection (e.g., partner concurrency, partner HIV status), this knowledge does not translate into more consistent condom use. In South Africa, only 48% for women and 57% for men reported using condoms at last sex, despite the fact that condoms are widely available at no cost (6), and are accepted among young South Africans as protective against HIV, STIs, and unwanted pregnancy (92). Consistent condom use is the most effective strategy for preventing HIV infection among sexually active people; however, condom use requires communication and cooperation between both sexual partners and is highly dependent on partnership dynamics and contextual factors. Interventions that address barriers to condom use, including concerns about implying mistrust in a partnership (51, 75-77), and that can reframe condom use in a positive, pro-relationship light in the context of long-term partnerships will be critical for ensuring that AGYW are protected against HIV infection. At the same time, prevention strategies must also account for predominant gender norms in South Africa, which position men as the decision makers in sexual encounters and give men

the “right” to make such a decision without discussion (15, 75, 76, 94). In these situations, where condom use is incompatible with certain partner contexts, AGYW-controlled prevention options like PrEP are critical (163, 164).

We believe this work offers an important complement to previous qualitative research on sexual partners (104, 105). Our identified partner-types are based on partner characteristics and risk factors that “hang” together statistically. Although our results are data-driven, they are based on statistical correlations, and must be validated through qualitative studies, which can provide further context and richness. Importantly, we identified a potentially concerning and previously undescribed partner type – cohabiting with children peer partners. AGYW with these partners were rare but appeared to be highly vulnerable and warrant further investigation. These AGYW were overwhelmingly more likely to be not enrolled in school, food insecure, depressed, report IPV in the past 12 months, and report low relationship power with their most recent sexual partner. In addition, AGYW reported living with these partners, having children together, and engaging in transactional sex. Yet, paradoxically, these AGYW had a lower risk of HIV infection compared to AGYW without this partner type. Qualitative studies are needed to investigate whether these partner types truly exist and if so, what factors are driving this confluence of vulnerability among AGYW.

Finally, we identify a number of AGYW-level risk factors which should remain the focus of ongoing HIV prevention interventions, including school enrollment, early sexual debut, high partner number, and substance use. To date, studies examining predictors of having a high risk sexual partner have been limited by the fact that sexual partners themselves have not been well characterized. Thus efforts to prevent HIV infection have focused on preventing partnerships with older partners, transactional partners, and partnerships with low condom use. However, as we have demonstrated, HIV prevention efforts that focus solely on single partner risk factors (e.g., age) may miss other vulnerable

AGYW at high risk of HIV infection. Future prevention efforts should focus on reducing partnerships with the riskiest sexual partners, not just avoidance of specific partner risk factors.

3 Strengths and limitations

We used an innovative approach from developmental psychology to identify different sexual partner risk types and address shortcomings of other, commonly used methods for measuring sexual partners, which characterize partners simply and fail to capture the full complexity of adolescent sexual partnerships. In using latent class analysis (LCA), we address the limitations of the single variable and multiple risk factor approaches because we capture the cumulative and interactive effects of multiple partner risk factors as they occur together in sexual partners. The LCA approach improves on the risk score approach because it allows us to identify and differentiate *specific sexual partner risk types* rather than just identifying high risk versus low risk partners, and accounts for interaction between risk factors. The LCA approach improves on the pre-specified partner type approach because the LCA identifies partner types based *reported patterns of partner factors* rather than ambiguous labels. LCA is rarely used in the field of epidemiology; however, this approach lends itself to HIV research because it allows us to examine multiple risk factors together in a cohesive model. As a result, LCA has increasingly been used by researchers in other disciplines to examine processes related to HIV/STI risk, including the association between risky sexual behaviors and STI infection (109), and the association between timing of vaginal, oral-genital, and anal sex initiation and STI infection (108, 165). This study is the first to use LCA to identify sexual partner types associated with incident HIV infection and offers an alternative model for measuring and targeting specific partner types for HIV research and intervention.

We used rich, partner-level data collected from a large, rigorously conducted randomized controlled trial (HPTN 068). Data from this large study allowed us to better characterize sexual partners and address important methodological challenges. HIV studies rarely collect sexual partner data beyond basic demographic characteristics, such as partner age, or risk factors, such as partner concurrency or condom use. We used data on a wide range of sexual partner risk factors for HIV infection, including factors that influence partnership dynamics, including having children together and cohabitation. This data allowed us to develop a richer, more comprehensive, and more specific measure of sexual partner type. We also used longitudinal data collected from multiple sexual partners and laboratory confirmed incident HIV infection. The vast majority of partner studies have relied on prevalent, often self-reported HIV and STI data or behavioral outcomes as a proxy for HIV risk. Longitudinal data from this cohort study allows us to draw stronger conclusions about the temporal relationship between exposure to a high risk sexual partner and subsequent, incident HIV infection among AGYW.

We imposed minimal restrictions on the number or types of sexual partners that AGYW could report, giving us a more complete and potentially less biased picture of sexual partnerships among AGYW. Previous studies have only collected data from AGYW's most recent sexual partner (which may bias the sample towards longer partnerships) or main partners (which may bias the sample toward safer, more socially acceptable partners). In contrast, we considered AGYW's three most recent sexual partners and did not limit responses to a specific partner type, thereby minimizing selection bias. Given that the vast majority of AGYW reported fewer than three sexual partners over each follow-up period, we likely captured AGYW's full sexual partner history over the course of follow up, and for AGYW who sexually debuted over the course of follow-up, we captured their entire sexual partner history to date.

One potential limitation of our approach is that the partner data from which we derived our sexual partner types are based on the AGYW's self-report. We did not interview sexual partners or test them for HIV, thus these data thus may be subject to misclassification, recall, and/or social desirability bias, and may not reflect the true characteristics of AGYW's sexual partners. However, we believed we minimized this limitation in the following ways. We used ACASI to minimize social desirability bias in reporting with respect to specific partner characteristics as well as overall completeness of reported sexual partners in the past year (160-162). We minimized recall bias by asking AGYW for only their three most recent sexual partners in the past year, and only included sexual partners for which there was evidence that the AGYW had sex with this partner in the past year (based on date of first and most recent sex). We note that in most clinical and research settings, AGYW are assessed for HIV risk without their sexual partners present using information from self-report, thus our approach reflects real-world application.

We also note that we did not link HIV infection among AGYW to a specific partner type. Thus, if an AGYW reported multiple sexual partners over a follow-up period and became HIV infected, we were not able to attribute this infection to a specific sexual partner. However, we believe that our treatment of multiple reported sexual partners is preferable to approaches which simply limit analyses to only one sexual partner per respondent, or which look across all reported sexual partners and generate a partner measure based on the highest risk characteristics across all partners (e.g., HIV risk is based on having any older partners, any transactional partners). In contrast, we carefully structured our analysis to account for the fact that AGYW may report more than one sexual partner over a follow up period. We believe that this is the most appropriate approach absent a costly phylogenetic analysis to link HIV infection among AGYW to specific sexual partners. Moreover, we found

that our LCA results were robust in sensitivity analyses when we limited our sample to AGYW who reported only one sexual partner.

We focused on rural South African school girls, a population at extremely high risk for HIV infection. AGYW are a key population in southern Africa who contribute nearly 30 percent of all new HIV infections (1-3). In South Africa, AGYW ages 15-24 account for 113,000 new HIV infections each year, which is more than four times the number among young men the same age (3). Despite their extremely high risk for HIV infection, there are very few evidenced-based interventions available to this population. Most prevention efforts have focused on individual behavior change, however the utility and effectiveness of these approaches have been severely limited by the large, underlying age/gender power differentials between young women and their male partners, which prevent young women from utilizing many of these prevention strategies (166). AGYW in this region desperately need more effective prevention options that take into account contextual barriers to HIV prevention, including their sexual partners.

Importantly, our findings may not be generalizable to other populations, regions, or contexts. However, this is not necessarily a limitation of this study. Increasingly, we are learning that to be most effective, interventions must be highly targeted to the needs of the population at risk and the local context in which HIV transmission is occurring. We provide highly specific information about partners associated with the greatest risk of HIV infection for AGYW as well AGYW-level risk factors which predict sexual partner type. Our analysis yielded practical and actionable findings which can be used to design more effective, tailored, and partner-focused interventions that target specific combinations of factors that make partners high risk. Findings can also be used to identify AGYW at particularly high risk for HIV infection and their sexual partners. Effective targeting may be especially important

for highly effective but resource-intensive interventions such as pre-exposure prophylaxis (PrEP) for high-risk girls and treatment as prevention (TaSP) for their HIV-infected partners.

4 Conclusions

Adolescent girls and young women in South Africa are at extraordinarily high risk of HIV infection and urgently need targeted HIV prevention strategies that account for AGYW's sexual partners. In this study, we found that sexual partner types – identified using latent class analysis and based on explicit, partner characteristics self-reported by AGYW – strongly predicted risk of incident HIV infection independent of individual-level risk factors. Moreover, we found that school enrollment, early sexual debut, multiple sexual partners in the past year, and substance use strongly predicted AGYW selecting sexual partners associated with increased risk of incident HIV infection among AGYW. Results of this study highlight the urgent need for targeted interventions that account for contextual differences between sexual partner types and that address the specific prevention needs and risks posed by different partners.

APPENDIX 1: NUMBER OF PARTNERS IN THE PAST 12 MONTHS BY STUDY VISIT[a,b]

	Number of partners in the past 12 months[a,b]									
	0 partners		1 partner		2 partners		3 partners		>3 partners	
	N	%	N	%	N	%	N	%	N	%
All visits	91	4.3	1633	77.6	261	12.4	82	3.9	38	1.8
Visit 1	66	10.3	504	78.4	56	8.7	14	2.2	3	0.5
Visit 2	9	1.7	401	73.7	86	15.8	30	5.5	18	3.3
Visit 3	6	2.0	238	79.3	40	13.3	12	4.0	4	1.3
Graduation Visit	10	1.6	490	79.23	79	12.8	26	4.2	13	2.1

a Response to question “How many sexual partners have you had in the past 12 months”. Answers were captured as a continuous variable and then categorized into the following categories: 0 partners, 1 partner, 2 partners, 3 partners and >3 partners. Participants who reported having 0 partners in the past 12 months still reported having sex with at least 1 partner since the most recent follow up period or within 12 months of the graduation visit.
b Missing: 35

APPENDIX 2: AVERAGE NUMBER OF DAYS BETWEEN STUDY VISITS[a]

	N	Mean	Standard deviation	Median	25%	75%
All visits	2140	316.9	130.9	342	203	405
Visit 1	668	416.8	43.4	413	400	433
Visit 2	550	348.1	113.2	322	302	350
Visit 3	301	368.3	97.6	355	349	358
Graduation Visit[a]	621	157.1	51.6	160	119	189

a Adolescent girls and young women (AGYW) were seen annually until the study completion date or their planned high school completion, whichever came first. Follow up visits for the AGYW and the parent/guardians occurred annually at approximately 12, 24, and 36 months and the majority of visits were between 7 (203 days) and 14 months (405 days) apart.

APPENDIX 3: NUMBER OF VISITS COMPLETED BY EACH STUDY PARTICIPANT[a]

Number of study visits	N	%
1 Visit	322	31.1
2 Visits	388	37.5
3 Visits	254	24.6
4 Visits	70	6.8

a Adolescent girls and young women (AGYW) were seen annually until the study completion date or their planned high school completion, whichever came first. Follow up visits for the AGYW and the parent/guardians occurred annually at approximately 12, 24, and 36 months and the majority of visits were between 7 (203 days) and 14 months (405 days) apart.

APPENDIX 4: FIT STATISTICS COMPARING 2-8 CLASS LATENT CLASS MODELS OF SEXUAL PARTNER TYPE AMONG SEXUALLY ACTIVE ADOLESCENT GIRLS AND YOUNG WOMEN (AGYW) AGES 13-23 IN AGINCOURT, SOUTH AFRICA MARCH 2011 TO MARCH 2015 (N=2968 PARTNERS-REPORTS)[a,b]

Classes	DF	G^2	AIC	BIC
1				
2	3428	3737.4	3791.4	3960.1
3	3414	2979.8	3061.8	3318.0
4	3400	2715.7	2825.7	3169.4
5	3386	2520.8	2658.8	3090.0
6	3372	**2322.4[b]**	**2488.4[b]**	**3007.0**
7	3358	2212.3	2406.3	3012.4
8	3344	2117.9	2339.9	3033.5

a Adolescent girls and young women (AGYW) could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner types were identified using partner-level data self-reported by AGYW.
b The Baysian Information Criteria (BIC) and Akaike Information Criteria (AIC) measure relative model fit, while G^2 measures absolute model fit. For all three fit indices, lower values indicate better model fit. The G^2 and AIC did not stop decreasing even after 8 classes; however, change in G^2 and AIC between classes decreased considerably after 6 classes suggesting diminishing benefit with each class added after 6. G^2 decreased by 195 points from 4 classes to 5; 198 points from 5 classes to 6; 110 points from 6 classes to 7; and 94 points from 7 classes to 8. AIC decreased by 167 points from 4 classes to 5; 170 points from 5 classes to 6, 82 points from 6 classes to 7; and 66 points from 7 classes to 8.

APPENDIX 5: DESCRIPTIVE STATISTICS OF POSTERIOR PROBABILITIES COMPARING 2-8 CLASS LATENT CLASS MODELS OF SEXUAL PARTNER TYPE AMONG SEXUALLY ACTIVE ADOLESCENT GIRLS AND YOUNG WOMEN (AGYW) AGES 13-23 IN AGINCOURT, SOUTH AFRICA MARCH 2011 TO MARCH 2015 (N=2968 PARTNERS-REPORTS)[a,b]

Classes	Mean	Median	25%	75%	Minimum	Maximum
1						
2	0.92	0.98	0.91	0.99	0.50	1.00
3	0.81	0.88	0.69	0.96	0.36	1.00
4	0.82	0.87	0.68	0.96	0.35	1.00
5	0.77	0.79	0.63	0.90	0.34	1.00
6	0.72	0.71	0.56	0.86	0.32	1.00
7	0.68	0.68	0.52	0.83	0.30	1.00
8	0.67	0.68	0.54	0.78	0.27	0.99

a Adolescent girls and young women (AGYW) could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner types were identified using partner-level data self-reported by AGYW.

b We compared latent class models ranging from 2 classes up to 8 classes using the BIC, AIC and G2 fit indices, conditional probabilities, and posterior probabilities. Moderls with 6 classes or fewer have medn and median posterior probabilities greater than 0.70.

APPENDIX 6: CONDITIONAL PROBABILITIES FOR A 6-CLASS LATENT CLASS MODEL OF SEXUAL PARTNER TYPE AMONG SEXUALLY ACTIVE ADOLESCENT GIRLS AND YOUNG WOMEN (AGYW) AGES 13-23 IN AGINCOURT, SOUTH AFRICA, FROM MARCH 2011 TO MARCH 2015 (N=2968 PARTNER-REPORTS)[a,b]

	Latent class partner types					
	Monogamous HIV-Negative Peer Partner	Unprotected Peer Partner	Casual Protected Peer Partner	Older Out-of-School Partner	Anonymous Out-of-School Peer Partner	Cohabiting with Children Peer Partner
Conditional probabilities[b]						
Partner ≥5 years older	0.12	0.013	0.045	**0.78**	0.24	0.22
Partner not enrolled in school	0.56	0.47	0.27	**0.88**	0.73	0.29
Children with AGYW	0.30	0.20	0.014	**0.32**	0.050	**0.75**
Children with other women: yes	0.041	0.17	0.030	0.31	0.005	**0.52**
Children with other women: don't know	0.0044	0.11	0.076	0.096	**0.84**	0.028
Cohabit with AGYW	0.093	0.067	0.0061	0.13	0.11	**0.77**
Sex with AGYW only once	0.080	0.12	**0.54**	0.12	0.23	0.024
Always uses a condom with AGYW	0.14	0.079	**0.62**	0.15	0.20	0.001
Partner HIV-status: positive	0.0040	0.12	0.053	0.12	0.038	**0.16**
Partner HIV-status: don't know	0.0015	0.34	0.16	0.21	**0.75**	0.024
Partner has other concurrent sexual partners: yes	0.16	**0.36**	0.16	0.28	0.047	0.31
Partner has other concurrent sexual partners: don't know	0.085	0.31	0.29	0.26	**0.94**	0.026
Transactional sex with partner[c]	0.26	0.25	0.081	0.34	0.18	**0.79**

a Adolescent girls and young women (AGYW) could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner types were identified using partner-level data self-reported by AGYW. Sexual partner prevalences include all sexual partners across all follow-up visits.
b Bold values indicate the highest conditional probability for a particular partner indicator

APPENDIX 7: PARTNER AGE DIFFERENCE BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

The following tables describe additional characteristics of sexual partner types identified by latent class analysis among sexually active adolescent girls and young women (AGYW) ages 13-23 in Agincourt, South Africa, from March 2011 to March 2015 (N=2968 partner-visits)

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partner ≥5 years older (presented in Aim 1 Table 4.2)														
Yes	557	18.8	138	11.3	20	3.8	25	4.9	278	86.6	65	26.5	31	22.5
No	2404	81.2	1084	88.7	507	96.2	483	95.1	43	13.4	180	73.5	107	77.5
Partner age difference														
Mean (SD)	2.8	(3.3)	2.5	(2.3)	2.1	(1.8)	1.9	(2.0)	6.1	(2. 9)	3.5	(6.5)	3.1	(6.2)
Median (IQR)	2	(1, 4)	2	(1, 4)	2	(1, 3)	2	(1, 3)	6	(5, 7)	3	(1, 5)	2	(0, 4)

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Partner ≥5 years older 7; Partner age difference 7

APPENDIX 8: PARTNER EDUCATION BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partner enrolled in school (presented in Aim 1 Table 4.2)														
Yes	1393	47.0	535	43.7	270	51.3	385	76.1	48	15.0	66	27.0	89	63.6
No	1569	53.0	690	56.3	256	48.7	121	23.9	273	85.0	178	73.0	51	36.4
Highest education obtained by partner														
No school	158	5.32	58	4.73	24	4.55	10	1.97	11	3.43	14	5.69	41	29.29
Some primary	246	8.29	105	8.56	52	9.87	40	7.87	27	8.41	11	4.47	11	7.86
Completed primary	334	11.25	157	12.81	71	13.47	28	5.51	41	12.77	20	8.13	17	12.14
Some high school (HS)	765	25.77	318	25.94	136	25.81	186	36.61	54	16.82	42	17.07	29	20.71
Completed HS	708	23.85	324	26.43	117	22.2	102	20.08	85	26.48	61	24.8	19	13.57
University or technikon	481	16.21	186	15.17	65	12.33	94	18.5	76	23.68	46	18.7	14	10
Don't know	268	9.03	75	6.12	59	11.2	47	9.25	27	8.41	51	20.73	9	6.43

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Highest education obtained by partner (some categories collapsed)														
No school	158	5.32	58	4.73	24	4.55	10	1.97	11	3.43	14	5.69	41	29.29
Some schooling	580	19.54	262	21.37	123	23.34	68	13.38	68	21.18	31	12.60	28	20.00
Some HS	765	25.77	318	25.94	136	25.81	186	36.61	54	16.82	42	17.07	29	20.71
Completed HS	708	23.85	324	26.43	117	22.2	102	20.08	85	26.48	61	24.8	19	13.57
University or technikon	481	16.21	186	15.17	65	12.33	94	18.5	76	23.68	46	18.7	14	10
Don't know	268	9.03	75	6.12	59	11.2	47	9.25	27	8.41	51	20.73	9	6.43

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Partner enrolled in school 6; Highest education obtained by partner 8.

APPENDIX 9: PREGNANT BY PARTNER OR HAVE CHILDREN WITH PARTNER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Pregnant by partner														
No	1993	68.6	762	63.3	381	73.7	473	94.4	191	60.0	163	68.5	23	17.7
Yes	914	31.4	441	36.7	136	26.3	28	5.6	127	40.0	75	51.5	107	82.3
Children with AGYW (presented in Aim 1 Table 4.2)														
Yes	669	23.0	343	28.5	86	16.6	9	1.8	99	31.1	41	17.2	91	70.0
No	2238	77.0	860	71.5	431	83.4	492	98.2	219	68.9	197	82.8	39	30.0

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Pregnant by partner 61; Children with AGYW 61.

APPENDIX 10: WHERE PARTNER LIVES BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partner lives														
Same village as AGYW	1727	58.2	771	62.9	301	57.1	266	52.4	182	56.7	123	50.0	84	60.0
Another village in Bushbuckridge	740	25.0	277	22.6	129	24.5	151	29.7	82	25.6	72	29.3	29	20.7
Another area in Mpumalanga	312	10.5	114	9.3	68	12.9	54	10.6	28	8.7	33	13.4	15	10.7
Another province in SA	79	2.7	32	2.6	9	1.7	22	4.3	9	2.8	4	1.6	3	2.1
Outside SA	67	2.3	23	1.9	12	2.3	8	1.6	12	3.7	4	1.6	8	5.7
Don’t know	41	1.4	9	0.7	7	1.3	7	1.4	8	2.5	10	4.1	0	0
Partner lives (some categories collapsed)														
Same village as AGYW	1727	58.2	771	62.9	301	57.2	266	52.4	182	56.7	123	50.0	84	60.4
Another village in Bushbuckridge	740	25.0	277	22.6	129	24.5	151	29.7	82	25.6	72	29.3	29	20.9
Outside Bushbuckridge	458	15.4	169	13.8	89	16.9	84	16.5	49	15.2	26	18.7	26	18.7
Don’t know	41	1.4	9	0.7	7	1.3	7	1.4	8	2.5	10	4.1	0	0

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type. b Missing: Where partner lives 2.

APPENDIX 11: COHABITATION WITH PARTNER AND NIGHTS SPENT TOGETHER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Cohabit with AGYW (presented in Aim 1 Table 4.2)														
Yes	338	11.4	113	9.2	25	4.8	3	0.59	45	14.0	35	14.2	117	84.2
No	2628	88.6	1113	90.8	501	95.2	505	99.41	276	86.0	211	85.8	22	15.8
Length of time cohabiting														
Do not live together	2360	88.6	1113	90.8	502	95.3	505	99.4	276	86.0	211	85.8	23	16.4
<6 months	194	6.5	54	4.4	11	2.1	3	0.6	27	8.4	22	8.9	77	55.0
6 months – 1 year	56	1. 9	28	2.3	6	1.1	0	0	3	0.9	5	2.0	14	10.0
>1 year	88	3.0	31	2.5	8	1.5	0	0	15	4. 7	8	3.3	26	18.6
Nights spent together														
No nights	1346	45.80	482	39.74	246	47.04	315	62.01	133	41.82	127	52.05	43	32.33
1-2 nights	1040	35.39	470	38.75	184	35.18	154	30.31	102	32.08	74	30.33	56	42.11
3-4 nights	344	11.70	173	14.26	54	10.33	27	5.31	59	18.55	18	7.38	13	9.77
5 or more nights	209	7.11	88	7.25	39	7.46	12	2.36	24	7.55	25	10.25	21	15.79

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the

same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Cohabit with AGYW 2; Length of time cohabiting 0; Nights spent together 29.

APPENDIX 12: COITAL FREQUENCY WITH PARTNER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Sex with AGYW only once (presented in Aim 1 Table 4.2)														
Yes	557	18.9	98	8.0	59	11.2	303	60.1	46	14.3	46	18.9	5	3.6
No	2398	81.1	1124	92.0	466	88.8	201	39.9	275	85.7	197	81.1	135	96.4
Coital frequency														
≥Once a day	1678	56.8	796	65.1	340	64.8	112	22.2	184	58.3	134	55.1	112	80.0
3 to 6 times/week	149	5.0	72	5.9	17	3.2	8	1.6	24	7.5	15	6.2	13	9.3
1 – 2 times/week	223	7.6	105	8.6	43	8.2	30	6.0	28	8.7	11	4.5	6	4.3
2 - 3 times/month	196	6.6	98	8.0	30	5.7	20	4.0	23	7.2	22	9.1	3	2.1
≤Once/month	152	5.1	53	4.3	36	6.9	31	6.2	16	5.0	15	6.2	1	0.7
One time	557	18.9	98	8.0	59	11.2	303	60.1	46	14.3	46	18.9	5	3.6
Coital frequency (some categories collapsed)														
≥Once a day	1678	56.8	796	65.1	340	64.8	112	22.2	184	58.3	134	55.1	112	80.0
<Once a day	720	24.3	328	26.8	126	24.0	89	17.7	91	28.6	63	25.9	23	16.4
One time	557	18.9	98	8.0	59	11.2	303	60.1	46	14.3	46	18.9	5	3.6

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner

characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Sex with AGYW only once 13; Coital frequency 13.

APPENDIX 13: CONDOM USE WITH PARTNER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Always use condoms with AGYW (presented in Aim 1 Table 4.2)														
Yes	642	21.8	161	13.2	34	6.5	342	67.6	57	17.8	44	18.1	4	2.9
No	2309	78.2	1058	86.8	488	93.5	164	32.4	264	82.2	199	81.9	136	97.1
Condom use average														
Never	851	28.8	340	27.9	161	30.8	53	10.5	137	42.7	75	30.9	85	60.7
Rarely	616	20.9	288	23.69	151	28.9	41	8.1	61	19.0	50	20.6	25	17.9
Sometimes	362	12.3	192	15.8	66	12.6	29	5.7	21	6.5	35	14.4	19	13.6
Frequently	480	16.3	238	19.5	110	21.1	41	8.1	45	14.0	39	16.0	7	5.0
Always	642	21.8	161	13.2	34	6.5	342	67.6	54	17.8	44	18.1	4	2.9
Condom use average (some categories collapsed)														
Never to rarely	1467	49.7	628	51.5	312	59.8	94	18.6	198	61.7	125	51.4	110	78.6
Sometimes to frequently	842	28.5	430	35.3	176	33.7	70	13.8	66	20.6	74	30.5	26	18.6
Always	642	21.8	161	13.22	34	6.5	342	67.6	54	17.8	44	18.1	4	2.9
Condom use last sex														
No	960	36.0	415	37.8	217	44.9	101	20.6	125	45.4	83	37.7	19	19.0
Yes	1707	64.0	684	62.2	266	55.1	389	79.4	150	54.6	137	62.3	81	81.0

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the

same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Always use condoms with AGYW 17; Condom use average 17; Condom use at last sex 301.

APPENDIX 14: PARTNERSHIP LENGTH BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partnership length														
One night	522	18.4	162	13.7	74	14. 5	162	33.2	46	15.2	49	22.0	29	22.5
1-30 days	111	3.9	45	3.8	23	4.5	14	2.9	12	4.0	8	3.6	9	7.0
31-180 days	664	23.4	259	21.8	140	27.3	137	28.1	49	16.2	56	25.1	23	17.8
181-360 days	466	16.4	196	16.5	85	16.6	68	13.9	68	22.4	33	14.8	16	12.4
>360 days	1078	37.9	524	44.2	190	37.1	107	21.9	128	42.2	77	34.5	52	40.3
Partnership length (some categories collapsed)														
0-30 days	633	22.3	207	17.5	97	19.0	176	36.1	58	19.1	57	25.6	38	29.5
31-180 days	664	23.4	259	21.8	140	27.3	137	28.1	49	16.2	56	25.1	23	17.8
>180 days	1544	54.3	720	60.7	275	53.7	175	35.8	196	64.7	110	49.3	68	52.7

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.
b Missing: Partnership length 127.

APPENDIX 15: KNOWLEDGE OF PARTNER HIV STATUS BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partner HIV status (presented in Aim 1 Table 4.2)														
Positive	188	6.4	14	1.1	81	15.4	25	4.9	36	11.2	8	3.3	24	17.1
Negative	2204	74.4	1167	95.5	214	40.8	406	79.9	213	66.6	97	39.4	107	76.4
Don't know	569	19.2	41	3.4	230	43.8	77	15.2	71	22.2	141	57.3	9	6.4
Among partners thought to be HIV positive, how does AGYW know														
Partner told	99	52.2	10	71.4	47	58.8	10	41.7	11	30.6	4	50.0	17	70.8
Tested together	86	46.2	5	35.7	25	31.3	17	70.8	24	66.7	5	62.5	10	41.7
Partner showed result of test	29	15.6	2	14.3	9	11.3	3	12.5	6	16.7	3	37.5	6	25.0
Told by someone	3	1.6	0	0	2	2.5	0	0	0	0	0	0	1	4.2
Saw HIV meds	6	3.2	0	0	1	1.3	0	0	0	0	3	8.3	2	8.3
Partner looks sick	2	1.1	0	0	1	1.3	0	0	0	0	0	0	1	4.2
Partner has tuberculosis	3	1.6	0	0	0	0	0	0	0	0	1	12.5	2	8.3

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Among partners thought to be HIV negative, how does AGYW know														
Partner told	1080	49.7	548	47.6	110	52.4	180	45.2	109	52.2	58	59.8	75	70.1
Tested together	1125	51.8	641	55.7	111	52.9	200	50.3	95	45.5	39	40.2	39	36.5
Partner showed result of test	271	12.5	150	13.0	27	12.9	49	12.3	28	13.4	9	9.3	8	13.4
Told by someone	41	1.9	20	1.7	2	1.0	7	1.8	5	2.4	3	3.1	4	3.7
Partner looks healthy	188	8.7	96	8.3	18	8.6	44	11.1	14	6.7	7	7.2	9	8.4
Partner only had sex with AGYW	80	3.7	43	3.7	4	1.9	20	5.0	9	4.3	1	1.0	3	2.8

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Partner HIV status 10; Among partners thought to be HIV positive, how does AGYW know 2; Among partners through to be HIV negative, how does AGYW know 32.

APPENDIX 16: AGYW AND PARTNER CONCURRENCY BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Partner has other concurrent sexual partners (presented in Aim 1 Table 4.2)														
Yes	640	21.6	231	18.9	156	29.7	89	17.5	89	27.7	31	12.7	44	31.4
No	1551	52.4	882	72.1	150	28.6	257	50.6	142	44.2	32	13.0	88	62.9
Don't know	772	26.0	111	9.1	219	41.7	162	31.9	90	28.1	182	74.3	8	5.7
AGYW has other concurrent partners while with partner														
Yes	749	25.4	267	21.9	150	28.9	79	15.6	99	31.1	56	22.9	98	70.0
No	2204	74.6	955	78.1	370	71.1	429	84.4	219	68.9	189	77.1	42	30.0

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Partner has other concurrent partners 9; AGYW has other concurrent partners while with partner 15.

APPENDIX 17: TRANSACTIONAL SEX WITH PARTNER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Transactional sex with partner[c] (presented in Aim 1 Table 4.2)														
Yes	766	25.8	328	26.8	124	23.5	40	7.9	114	35.5	46	18.7	114	81.4
No	2202	74.2	898	73.2	403	76.5	468	92.1	207	64.5	200	81.3	26	18.6
Partner gave money														
Yes	2292	77.3	1035	84.5	369	70.1	348	68.5	262	81.6	151	61.66	127	90.7
No	673	22.7	190	15.5	157	29.9	160	31.5	59	18.4	94	38.4	13	9.3
Partner gave money in exchange for sex														
No money given	675	22.74	191	15.58	157	28.79	160	31.50	59	18.38	95	38.62	13	9.3
No exchange	1590	53.57	727	59.30	251	47.63	310	61.02	163	50.78	111	45.12	28	20.0
Money for sex	698	23.52	308	25.12	115	21.82	38	7.48	99	30.84	39	15.85	99	70.7
How often partner gave money														
No money given	675	22.74	191	15.58	167	29.79	160	31.50	59	18.83	95	38.62	13	9.29
Once	372	12.53	128	10.44	79	14.99	48	9.45	38	11.84	32	13.01	47	33.57
A few times/month	1349	45.45	650	53.02	199	37.76	183	36.02	172	53.58	77	31.30	68	48.57
Once/month	335	11.29	149	12.15	56	10.63	62	12.20	35	10.90	28	11.38	5	3.57
Once/week	97	3.27	36	2.94	21	3.98	26	5.12	7	2.18	7	2.85	0	0
>Once/week	135	4.55	72	5.87	14	2.66	25	4.92	10	3.12	7	2.85	7	5.00

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Last time partner gave money														
No money given	675	22.74	191	15.58	167	29.79	160	31.50	59	18.83	95	38.62	13	9.29
This month	1715	58.8	791	64.5	249	47.3	261	51.4	207	64.5	102	41.5	105	75.0
Past 6 months	332	11.2	150	12.2	70	13.3	46	9.1	26	8.1	26	10.6	14	10.0
6 months-1 year	104	3.5	35	2.9	22	4.2	17	3.4	18	5.6	7	2.9	5	3.6
>1 year	138	4.7	57	4.7	28	5.3	23	4.5	11	3.4	16	6.5	3	2.1
If given money, how much given (Rand)														
Mean (SD)	186	(1399)	174	(210)	296	(3455)	102	(138)	230	(230)	158	(196)	180	(238)
Median (IQR)	100	(50, 200)	100	(50, 200)	50	(50, 250)	50	(38, 100)	200	(50, 300)	100	(50, 200)	100	(20, 200)
Partner gave gifts														
Yes	1449	49.0	677	55.3	188	36.0	287	56.7	164	51.1	85	34.8	116	82.9
No	1509	51.0	547	44.7	335	64.1	219	43.3	157	48.9	159	65.2	24	17.1
Partner gave gifts in exchange for sex														
No gift given	1509	51.0	547	44.7	335	64.1	219	43.3	157	48.9	159	65.2	24	17.1
No exchange	1227	41.3	614	50.1	166	31.5	211	41.5	132	41.1	72	29.3	32	22.9
Gifts for sex	220	7.4	61	5.0	22	4.2	8	1.6	32	10.0	13	5.3	84	60.0

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
How often gifts given														
No gifts given	1509	51.0	547	44.7	335	64.1	219	43.3	157	48.9	159	65.2	24	17.1
Once	218	7.4	73	6.0	37	7.0	23	4.5	18	5.6	16	6.5	51	36.4
A few times	323	10.9	147	12.0	54	10.3	52	10.2	33	10.3	20	8.1	17	12.1
Often	711	24.0	348	28.4	80	15.2	113	22.2	91	28.4	42	17.1	37	26.4
Always	193	6.5	106	8.7	17	3.2	31	6.1	21	6.5	7	3.0	11	8.0
Last time gifts given														
No gifts given	1509	51.0	547	44.7	335	64.1	219	43.3	157	48.9	159	65.2	24	17.1
This month	1066	35.9	520	42.4	125	23.7	148	29.1	119	37.1	62	25.2	92	65.7
Past 6 months	234	7.9	91	7.4	35	6.6	52	10.2	30	9.4	14	5.7	12	8.9
6 months-1 year	71	2.4	28	2.3	13	2.5	10	2.0	6	2.0	5	2.0	9	6.4
>1 year	73	2.5	35	2.9	13	2.5	9	2.0	9	2.8	4	1.6	3	2.1

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Type of gift given														
Airtime or cell phone	1261	87.5	590	87.8	171	91.0	204	3.6	127	77.9	71	83.5	98	84.5
Groceries	273	18.9	150	22.3	29	15.4	8	3.7	38	23.3	14	16.5	34	29.3
Clothes, perfume, or makeup	880	61.03	434	64.6	118	62.8	110	50.5	113	69.3	51	60.0	54	46.6
Cool drinks	622	43.1	298	44.4	84	44.7	102	46.8	63	38.7	41	48.2	34	29.3
Alcohol	39	2.7	20	3.0	6	3.2	2	0.9	5	3.1	2	2.4	4	3.5
CDs, DVDs, videos	151	10.5	80	11.9	21	11.2	17	7.8	13	8.0	9	10.6	11	9.5
Flowers	254	17.6	119	17.7	39	20.1	45	20.6	24	14.7	10	11.8	17	14.7

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Transactional sex with partner 0; Partner gave money 3; Partner gave money in exchange for sex 4; How often partner gave money 5; Last time partner gave money 4; If given money, how much given 5; Partner gave gifts 10; Partner gave gifts in exchange for sex 3; How often gifts given 5; Last time gifts given 6; Type of gift given 7.

c Transactional sex defined as feeling obligated to have sex with a partner after receiving gifts or money.

APPENDIX 18: COMMUNICATION WITH PARTNER BY SEXUAL PARTNER TYPES IDENTIFIED BY LATENT CLASS ANALYSIS[a,b]

	Sexual Partner Type													
	All partner-reports		Monogamous HIV-Negative Peer Partner		Unprotected Peer Partner		Casual Protected Peer Partner		Older Out-of-School Partner		Anonymous Out-of-School Peer Partner		Cohabiting with Children Peer Partner	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Ever talked about condoms														
No	623	21.1	253	20.69	129	24.67	71	14.0	24	17.1	70	28.7	76	23.7
Yes	2335	78.9	970	79.31	394	75.33	436	86.0	116	82.9	174	71.3	245	76.3
Ever talked about preventing HIV														
No	495	16.7	175	14.3	122	23.2	68	13.4	22	15.7	44	18.0	64	19.9
Yes	2468	83.3	1050	85.7	403	76.8	439	86.6	118	84.3	201	82.0	257	80.1
Ever talked about HIV testing														
No	503	17.0	150	12.3	120	22.8	74	14.6	20	14.3	70	28.5	69	21.5
Yes	2460	83.0	1073	87.7	406	77.2	433	85.4	120	85.7	176	71.5	252	78.5

a Sexual partner characteristics are based on self-report by the adolescent girls and young women (AGYW). AGYW could report up to three sexual partners at each study visit and may have multiple observations due to repeated study visits. Sexual partner characteristic frequencies include all sexual partners across all follow-up visits. Partners were not followed longitudinally and the same partner could be reported at multiple study visits; thus frequencies represent partner-reports, not distinct sexual partners. Percentages are column percents by sexual partner type.

b Missing: Ever talked about condoms 10; Ever talked about preventing HIV 5; Ever talked about HIV testing 5.

REFERENCES

1. UNAIDS. Global report: UNAIDS report on the global AIDS epidemic. Geneva: Joint United Nations Programme on HIV/AIDS; 2013.

2. Cowan F, Pettifor A. HIV in adolescents in sub-Saharan Africa. Current opinion in HIV and AIDS. 2009;4(4):288-93. Epub 2009/06/18.

3. Shisana O, Rehle, T, Simbayi LC, Zuma, K, Jooste, S, Zungu N, Labadarios, D, Onoya, D et al. South African National HIV Prevalence, Incidence and Behaviour Survey, 2012. Cape Town: 2014.

4. Abdool Karim Q, Abdool Karim SS, Singh B, Short R, Ngxongo S. Seroprevalence of HIV infection in rural South Africa. AIDS (London, England). 1992;6(12):1535-9. Epub 1992/12/01.

5. Napierala Mavedzenge S, Olson R, Doyle AM, Changalucha J, Ross DA. The epidemiology of HIV among young people in sub-Saharan Africa: know your local epidemic and its implications for prevention. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2011;49(6):559-67. Epub 2011/11/22.

6. Pettifor AE, Rees HV, Kleinschmidt I, Steffenso14n AE, MacPhail C, Hlongwa-Madikizela L, et al. Young people's sexual health in South Africa: HIV prevalence and sexual behaviors from a nationally representative household survey. AIDS (London, England). 2005;19(14):1525-34. Epub 2005/09/02.

7. Mermin J, Musinguzi J, Opio A, Kirungi W, Ekwaru JP, Hladik W, et al. Risk factors for recent HIV infection in Uganda. JAMA. 2008;300(5):540-9. Epub 2008/08/05.

8. DiClemente RJ, Salazar LF, Crosby RA. A review of STD/HIV preventive interventions for adolescents: sustaining effects using an ecological approach. Journal of pediatric psychology. 2007;32(8):888-906. Epub 2007/08/30.

9. Luke N. Age and economic asymmetries in the sexual relationships of adolescent girls in sub-Saharan Africa. Studies in family planning. 2003;34(2):67-86. Epub 2003/08/02.

10. Gorbach PM, Holmes KK. Transmission of STIs/HIV at the partnership level: beyond individual-level analyses. Journal of urban health : bulletin of the New York Academy of Medicine. 2003;80(4 Suppl 3):iii15-25. Epub 2004/01/10.

11. Pettifor AE, Levandowski BA, Macphail C, Miller WC, Tabor J, Ford C, et al. A tale of two countries: rethinking sexual risk for HIV among young people in South Africa and the United States. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2011;49(3):237-43 e1. Epub 2011/08/23.

12. Swartzendruber A, Zenilman JM, Niccolai LM, Kershaw TS, Brown JL, Diclemente RJ, et al. It takes 2: partner attributes associated with sexually transmitted infections among adolescents. Sex Transm Dis. 2013;40(5):372-8. Epub 2013/04/17.

13. Hargreaves JR, Morison LA, Kim JC, Busza J, Phetla G, Porter JD, et al. Characteristics of sexual partnerships, not just of individuals, are associated with condom use and recent HIV infection in rural South Africa. AIDS care. 2009;21(8):1058-70. Epub 2009/12/22.

14. Jewkes RK, Dunkle K, Nduna M, Shai N. Intimate partner violence, relationship power inequity, and incidence of HIV infection in young women in South Africa: a cohort study. Lancet. 2010;376(9734):41-8. Epub 2010/06/19.

15. Dunkle KL, Jewkes RK, Brown HC, Gray GE, McIntryre JA, Harlow SD. Gender-based violence, relationship power, and risk of HIV infection in women attending antenatal clinics in South Africa. Lancet. 2004;363(9419):1415-21. Epub 2004/05/04.

16. van der Straten A, King R, Grinstead O, Vittinghoff E, Serufilira A, Allen S. Sexual Coercion, Physical Violence, and HIV Infection Among Women in Steady Relationships in Kigali, Rwanda. AIDS and behavior. 1998;2(1):61-73.

17. Maman S, Mbwambo JK, Hogan NM, Kilonzo GP, Campbell JC, Weiss E, et al. HIV-positive women report more lifetime partner violence: findings from a voluntary counseling and testing clinic in Dar es Salaam, Tanzania. American journal of public health. 2002;92(8):1331-7. Epub 2002/07/30.

18. Decker MR, Seage GR, Hemenway D, Raj A, Saggurti N, Balaiah D, et al. Intimate partner violence functions as both a risk marker and risk factor for women's HIV infection: findings from Indian husband-wife dyads. Journal of acquired immune deficiency syndromes (1999). 2009;51(5):593-600. Epub 2009/05/08.

19. Dunkle KL, Jewkes RK, Nduna M, Levin J, Jama N, Khuzwayo N, et al. Perpetration of partner violence and HIV risk behaviour among young men in the rural Eastern Cape, South Africa. AIDS (London, England). 2006;20(16):2107-14. Epub 2006/10/21.

20. Abrahams N, Jewkes R, Hoffman M, Laubsher R. Sexual violence against intimate partners in Cape Town: prevalence and risk factors reported by men. Bulletin of the World Health Organization. 2004;82(5):330-7. Epub 2004/08/10.

21. Malamuth NM, Sockloskie RJ, Koss MP, Tanaka JS. Characteristics of aggressors against women: testing a model using a national sample of college students. J Consult Clin Psychol. 1991;59(5):670-81. Epub 1991/10/01.

22. Malamuth NM, Linz D, Heavey CL, Barnes G, Acker M. Using the confluence model of sexual aggression to predict men's conflict with women: a 10-year follow-up study. Journal of personality and social psychology. 1995;69(2):353-69. Epub 1995/08/01.

23. DeMaris A. Elevated Sexual Activity in Violent Marriages: Hypersexuality or Sexual Extortion? The Journal of Sex Research. 1997;34(4):361-73.

24. Gielen A, McDonnell K, O'Campo P. Intimate Partner Violence, HIV Status, and Sexual Risk Reduction. AIDS and behavior. 2002;6(2):107-16.

25. Jewkes R, Dunkle K, Nduna M, Levin J, Jama N, Khuzwayo N, et al. Factors associated with HIV sero-positivity in young, rural South African men. Int J Epidemiol. 2006;35(6):1455-60.

26. Pettifor AE, Measham DM, Rees HV, Padian NS. Sexual power and HIV risk, South Africa. Emerging infectious diseases. 2004;10(11):1996-2004. Epub 2004/11/20.

27. Jewkes R, Levin J, Penn-Kekana L. Gender inequalities, intimate partner violence and HIV preventive practices: findings of a South African cross-sectional study. Social Sciences and Medicine. 2003;56(1):125-34.

28. Jama Shai N, Jewkes R, Levin J, Dunkle K, Nduna M. Factors associated with consistent condom use among rural young women in South Africa. AIDS care. 2010;22(11):1379-85. Epub 2010/08/24.

29. Pronyk PM, Hargreaves JR, Kim JC, Morison LA, Phetla G, Watts C, et al. Effect of a structural intervention for the prevention of intimate-partner violence and HIV in rural South Africa: a cluster randomised trial. Lancet. 2006;368(9551):1973-83. Epub 2006/12/05.

30. Kim JC, Watts CH, Hargreaves JR, Ndhlovu LX, Phetla G, Morison LA, et al. Understanding the impact of a microfinance-based intervention on women's empowerment and the reduction of intimate partner violence in South Africa. American journal of public health. 2007;97(10):1794-802. Epub 2007/09/01.

31. Bankole A, Biddlecom A, Guiella G, Singh S, Zulu E. Sexual behavior, knowledge and information sources of very young adolescents in four sub-Saharan African countries. African journal of reproductive health. 2007;11(3):28-43. Epub 2008/05/07.

32. Luke N. Confronting the 'sugar daddy' stereotype: age and economic asymmetries and risky sexual behavior in urban Kenya. International family planning perspectives. 2005;31(1):6-14. Epub 2005/05/13.

33. Blanc A, Wolff B. Gender and decision-making over condom use in two districts in Uganda. African journal of reproductive health. 2001;5(3):15-28.

34. Maughan-Brown B, Kenyon C, Lurie MN. Partner age differences and concurrency in South Africa: Implications for HIV-infection risk among young women. AIDS and behavior. 2014;18(12):2469-76. Epub 2014/07/23.

35. Luke N. Cross-generational and transactional sexual relatioinships in Sub-Saharan Africa. 2002.

36. Leclerc-Madlala S. Age-disparate and intergenerational sex in southern Africa: the dynamics of hypervulnerability. AIDS (London, England). 2008;22 Suppl 4:S17-25. Epub 2008/12/17.

37. Wyrod R, Fritz K, Woelk G, Jain S, Kellogg T, Chirowodza A, et al. Beyond sugar daddies: intergenerational sex and AIDS in urban Zimbabwe. AIDS and behavior. 2011;15(6):1275-82. Epub 2010/09/03.

38. Ott MQ, Barnighausen T, Tanser F, Lurie MN, Newell ML. Age-gaps in sexual partnerships: seeing beyond 'sugar daddies'. AIDS (London, England). 2011;25(6):861-3. Epub 2011/03/02.

39. Hope R. Addressing Cross-Generational Sex: A Desk Review of Research and Programs. Washington DC: Population Reference Bureau; 2007.

40. Gregson S, Nyamukapa CA, Garnett GP, Mason PR, Zhuwau T, Carael M, et al. Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. Lancet. 2002;359(9321):1896-903. Epub 2002/06/12.

41. Kelly RJ, Gray RH, Sewankambo NK, Serwadda D, Wabwire-Mangen F, Lutalo T, et al. Age differences in sexual partners and risk of HIV-1 infection in rural Uganda. Journal of acquired immune deficiency syndromes (1999). 2003;32(4):446-51. Epub 2003/03/18.

42. Harling G, Newell ML, Tanser F, Kawachi I, Subramanian SV, Barnighausen T. Do age-disparate relationships drive HIV incidence in young women? Evidence from a population cohort in rural KwaZulu-Natal, South Africa. Journal of acquired immune deficiency syndromes (1999). 2014;66(4):443-51. Epub 2014/05/13.

43. Balkus JE, Nair G, Montgomery ET, Mishra A, Palanee-Phillips T, Ramjee G, et al. Age-disparate partnerships and risk of HIV-1 acquisition among South African women participating in the VOICE trial. Journal of acquired immune deficiency syndromes (1999). 2015;70(2):212-7. Epub 2015/06/08.

44. de Oliveira T, Kharsany AB, Graf T, Cawood C, Khanyile D, Grobler A, 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. Epub 2016/12/05.

45. Muula AS, Ngulube TJ, Siziya S, Makupe CM, Umar E, Prozesky HW, et al. Gender distribution of adult patients on highly active antiretroviral therapy (HAART) in Southern Africa: a systematic review. BMC public health. 2007;7:63. Epub 2007/04/27.

46. Tromp N, Michels C, Mikkelsen E, Hontelez J, Baltussen R. Equity in utilization of antiretroviral therapy for HIV-infected people in South Africa: a systematic review. International journal for equity in health. 2014;13(1):60. Epub 2014/08/01.

47. Schaefer R, Gregson S, Eaton JW, Mugurungi O, Rhead R, Takaruza A, et al. Age-disparate relationships and HIV incidence in adolescent girls and young women: evidence from Zimbabwe. AIDS (London, England). 2017;31(10):1461-70. Epub 2017/04/21.

48. Evan M, Risher K, Zungu N, Shisana O, Moyo S, Celentano DD, et al. Age-disparate sex and HIV risk for young women from 2002 to 2012 in South Africa. Journal of the International AIDS Society. 2016;19(1):1-16. Epub 2017/04/02.

49. Evans M, Maughan-Brown B, Zungu N, George G. HIV Prevalence and ART Use Among Men in Partnerships with 15-29 Year Old Women in South Africa: HIV Risk Implications for Young Women in Age-Disparate Partnerships. AIDS and behavior. 2017. Epub 2017/03/09.

50. Leclerc-Madlala S. Transactional sex and the pursuit of modernity. Social Dynamics. 2003;29(2):213-33.

51. MacPhail C, Campbell C. 'I think condoms are good but, aai, I hate those things': condom use among adolescents and young people in a Southern African township. Social science & medicine (1982). 2001;52(11):1613-27. Epub 2001/05/01.

52. Kaufman C, Stavrou S. 'Bus Fare Please': The Economics of Sex and Gifts among Young People in Urban South Africa. Culture, health & sexuality. 2004;6(5):377-91.

53. Hunter M. The Materiality of Everyday Sex: Thinking beyond 'prostitution'. African Studies. 2002;61(1):99-120.

54. Ranganathan M, Heise L, Pettifor A, Silverwood RJ, Selin A, MacPhail C, et al. Transactional sex among young women in rural South Africa: prevalence, mediators and association with HIV infection. Journal of the International AIDS Society. 2016;19(1):20749. Epub 2016/07/30.

55. Masvawure T. 'I just need to be flashy on campus': female students and transactional sex at a university in Zimbabwe. Culture, health & sexuality. 2010;12(8):857-70. Epub 2010/01/14.

56. Wojcicki J. Commercial Sex Work or Ukuphanda? Sex-for-Money Exchange in Soweto and Hammanskraal Area, South Africa. Cult Med Psychiatry. 2002;26(3):339-70.

57. 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. Social science & medicine (1982). 2016;168:186-97. Epub 2016/09/26.

58. Nkosana J, Rosenthal D. The dynamics of intergenerational sexual relationships: the experience of schoolgirls in Botswana. Sexual health. 2007;4(3):181-7. Epub 2007/10/13.

59. Nyanzi S, Pool R, Kinsman J. The negotiation of sexual relationships among school pupils in south-western Uganda. AIDS care. 2001;13(1):83-98. Epub 2001/02/15.

60. Dunkle KL, Jewkes R, Nduna M, Jama N, Levin J, Sikweyiya Y, et al. Transactional sex with casual and main partners among young South African men in the rural Eastern Cape: prevalence, predictors, and associations with gender-based violence. Social science & medicine (1982). 2007;65(6):1235-48. Epub 2007/06/15.

61. Dunkle KL, Jewkes RK, Brown HC, Gray GE, McIntryre JA, Harlow SD. Transactional sex among women in Soweto, South Africa: prevalence, risk factors and association with HIV infection. Social science & medicine (1982). 2004;59(8):1581-92. Epub 2004/07/29.

62. Jewkes R, Dunkle K, Koss MP, Levin JB, Nduna M, Jama N, et al. Rape perpetration by young, rural South African men: Prevalence, patterns and risk factors. Social Science & Medicine. 2006;63(11):2949-61.

63. Jewkes R, Dunkle K, Nduna M, Shai NJ. Transactional Sex and HIV Incidence in a Cohort of Young Women in the Stepping Stones Trial. Journal of AIDS & Clinic Research. 2012;3:158.

64. Pettifor AE, Kleinschmidt I, Levin J, Rees HV, MacPhail C, Madikizela-Hlongwa L, et al. A community-based study to examine the effect of a youth HIV prevention intervention on young people aged 15-24 in South Africa: results of the baseline survey. Tropical medicine & international health : TM & IH. 2005;10(10):971-80. Epub 2005/09/28.

65. Staras SA, Livingston MD, Maldonado-Molina MM, Komro KA. The influence of sexual partner on condom use among urban adolescents. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2013;53(6):742-8. Epub 2013/08/13.

66. Cassell JA, Mercer CH, Imrie J, Copas AJ, Johnson AM. Who uses condoms with whom? Evidence from national probability sample surveys. Sex Transm Infect. 2006;82(6):467-73. Epub 2006/12/08.

67. Van Rossem R, Meekers D, Akinyemi Z. Consistent condom use with different types of partners: evidence from two Nigerian surveys. AIDS education and prevention : official publication of the International Society for AIDS Education. 2001;13(3):252-67. Epub 2001/07/19.

68. Norman LR. Predictors of consistent condom use: a hierarchical analysis of adults from Kenya, Tanzania and Trinidad. International journal of STD & AIDS. 2003;14(9):584-90. Epub 2003/09/27.

69. Fleming PJ, Mulawa M, Burke H, Shattuck D, Mndeme E, Attafuah J, et al. The role of relationship types on condom use among urban men with concurrent partners in Ghana and Tanzania. AIDS care. 2015;27(4):466-72. Epub 2014/10/23.

70. Chopra M, Townsend L, Johnston L, Mathews C, Tomlinson M, O'Bra H, et al. Estimating HIV prevalence and risk behaviors among high-risk heterosexual men with multiple sex partners: use of respondent-driven sampling. Journal of acquired immune deficiency syndromes (1999). 2009;51(1):72-7. Epub 2009/03/14.

71. Delva W, Meng F, Beauclair R, Deprez N, Temmerman M, Welte A, et al. Coital frequency and condom use in monogamous and concurrent sexual relationships in Cape Town, South Africa. Journal of the International AIDS Society. 2013;16:18034. Epub 2013/04/27.

72. Harrison A, Cleland J, Frohlich J. Young people's sexual partnerships in KwaZulu-Natal, South Africa: patterns, contextual influences, and HIV risk. Studies in family planning. 2008;39(4):295-308. Epub 2009/03/03.

73. Harrison A, O'Sullivan LF. In the absence of marriage: long-term concurrent partnerships, pregnancy, and HIV risk dynamics among South African young adults. AIDS and behavior. 2010;14(5):991-1000. Epub 2010/04/01.

74. Nguyen NL, Powers KA, Hughes JP, MacPhail CL, Piwowar-Manning E, Patel EU, et al. Sexual partnership patterns among South African adolescent girls enrolled in HIV Preventions Trial Network 068: measurement challenges and implications for HIV/STI transmission. Sex Transm Dis. 2015;42(11):612-8. Epub 2015/10/16.

75. Sayles JN, Pettifor A, Wong MD, MacPhail C, Lee SJ, Hendriksen E, et al. Factors associated with self-efficacy for condom use and sexual negotiation among South african youth. Journal of acquired immune deficiency syndromes (1999). 2006;43(2):226-33. Epub 2006/09/05.

76. Hoffman S, O'Sullivan LF, Harrison A, Dolezal C, Monroe-Wise A. HIV risk behaviors and the context of sexual coercion in young adults' sexual interactions: results from a diary study in rural South Africa. Sex Transm Dis. 2006;33(1):52-8. Epub 2005/12/31.

77. Parker L, Pettifor A, Maman S, Sibeko J, MacPhail C. Concerns about partner infidelity are a barrier to adoption of HIV-prevention strategies among young South African couples. Culture, health & sexuality. 2014;16(7):792-805. Epub 2014/05/13.

78. Meyer-Weitz A, Reddy P, Weijts W, van den Borne B, Kok G. The socio-cultural contexts of sexually transmitted diseases in South Africa: implications for health education programmes. AIDS care. 1998;10 Suppl 1:S39-55. Epub 1998/06/17.

79. Civic D. The association between characteristics of dating relationships and condom use among heterosexual young adults. AIDS education and prevention : official publication of the International Society for AIDS Education. 1999;11(4):343-52. Epub 1999/09/24.

80. Hocking JE, Turk D, Ellinger A. The effects of partner insistence of condom usage on perceptions of the partner, the relationship, and the experience. Journal of adolescence. 1999;22(3):355-67. Epub 1999/08/27.

81. Decker MR, Chung SE, Ellen JM, Sherman SG. Do young women engage in greater sexual risk behaviour with biological fathers of their children? Sex Transm Infect. 2015. Epub 2015/09/24.

82. Hensel DJ, Fortenberry JD. Adolescent mothers' sexual, contraceptive, and emotional relationship content with the fathers of their children following a first diagnosis of sexually transmitted infection. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2011;49(3):327-9. Epub 2011/08/23.

83. Johnston-Briggs BD, Liu J, Carter-Pokras O, Barnet B. Effect of partner relationship on motivation to use condoms among adolescent mothers. Journal of the National Medical Association. 2008;100(8):929-35. Epub 2008/08/23.

84. Nelson LE, Morrison-Beedy D, Kearney MH, Dozier A. Always, never, or sometimes: examining variation in condom-use decision making among Black adolescent mothers. Research in nursing & health. 2011;34(4):270-81. Epub 2011/06/03.

85. Nelson LE, Morrison-Beedy D, Kearney MH, Dozier A. Black adolescent mothers' perspectives on sex and parenting in nonmarital relationships with the biological fathers of their children. Journal of obstetric, gynecologic, and neonatal nursing : JOGNN / NAACOG. 2012;41(1):82-91. Epub 2012/07/28.

86. Paxton KC, Williams JK, Bolden S, Guzman Y, Harawa NT. HIV risk behaviors among African American women with at-risk male partners. Journal of AIDS & clinical research. 2013;4(7):221. Epub 2014/01/24.

87. Kaufman CE, Clark S, Manzini N, May J. Communities, opportunities, and adolescents' sexual behavior in KwaZulu-Natal, South Africa. Studies in family planning. 2004;35(4):261-74. Epub 2005/01/05.

88. Fortenberry JD, Tu W, Harezlak J, Katz BP, Orr DP. Condom use as a function of time in new and established adolescent sexual relationships. American journal of public health. 2002;92(2):211-3. Epub 2002/01/31.

89. Allen M, Emmers-Sommer TM, Crowell TL. Couples negotiating safer sex behaviors: A meta-analysis of the impact of conversation and gender. In: Allen M, Preiss RW, Gayle BM, Burrell NA, editors. Interpersonal communication research: Advances through meta-analysis. Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers; 2002. p. 263-79.

90. Noar SM, Carlyle K, Cole C. Why communication is crucial: meta-analysis of the relationship between safer sexual communication and condom use. Journal of Health Communication. 2006;11(4):365-90.

91. Sheeran P, Abraham C, Orbell S. Psychosocial correlates of heterosexual condom use: a meta-analysis. Psychological bulletin. 1999;125(1):90-132. Epub 1999/02/17.

92. James S, Reddy SP, Taylor M, Jinabhai CC. Young people, HIV/AIDS/STIs and sexuality in South Africa: the gap between awareness and behaviour. Acta paediatrica (Oslo, Norway : 1992). 2004;93(2):264-9. Epub 2004/03/30.

93. Campbell C, MacPhail C. Peer education, gender and the development of critical consciousness: participatory HIV prevention by South African youth. Social science & medicine (1982). 2002;55(2):331-45. Epub 2002/07/30.

94. Varga CA. How gender roles influence sexual and reproductive health among South African adolescents. Studies in family planning. 2003;34(3):160-72. Epub 2003/10/16.

95. Lanza ST, Rhoades BL, Greenberg MT, Cox M. Modeling multiple risks during infancy to predict quality of the caregiving environment: contributions of a person-centered approach. Infant behavior & development. 2011;34(3):390-406. Epub 2011/04/12.

96. Mathur S, Wei Y, Zhong X, Song X, Nalugoda F, Lutalo T, et al. Partner characteristics associated with HIV acquisition among youth in Rakai, Uganda. Journal of acquired immune deficiency syndromes (1999). 2015;69(1):75-84. Epub 2015/01/27.

97. Manning WD, Giordano PC, Longmore MA. Hooking up: the relationship contexts of “nonrelationship” sex. Journal of Adolescent Research. 2006;21(5):459-83.

98. Maughan-Brown B. Variation in concurrent sexual partnerships and sexually transmitted diseases among African men in Cape Town, South Africa. Sex Transm Dis. 2012;39(7):537-42. Epub 2012/06/19.

99. Grieb SM, Davey-Rothwell M, Latkin CA. Concurrent sexual partnerships among urban African American high-risk women with main sex partners. AIDS and behavior. 2012;16(2):323-33. Epub 2011/05/04.

100. Gamarel KE, Reisner SL, Darbes LA, Hoff CC, Chakravarty D, Nemoto T, et al. Dyadic dynamics of HIV risk among transgender women and their primary male sexual partners: the role of sexual agreement types and motivations. AIDS care. 2015:1-8. Epub 2015/08/15.

101. Crosby R, Shrier LA. A partner-related risk behavior index to identify people at elevated risk for sexually transmitted infections. The journal of primary prevention. 2013;34(1-2):81-7. Epub 2013/01/29.

102. Catallozzi M, Bell DL, Short MB, Marcell AV, Ebel SC, Rosenthal SL. Does perception of relationship type impact sexual health risk? Sex Transm Dis. 2013;40(6):473-5. Epub 2013/05/18.

103. Short MB, Catallozzi M, Breitkopf CR, Auslander BA, Rosenthal SL. Adolescent intimate heterosexual relationships: measurement issues. Journal of pediatric and adolescent gynecology. 2013;26(1):3-6. Epub 2011/11/18.

104. Gorbach PM, Stoner BP, Aral SO, WL HW, Holmes KK. "It takes a village": understanding concurrent sexual partnerships in Seattle, Washington. Sex Transm Dis. 2002;29(8):453-62.

105. Nobelius AM, Kalina B, Pool R, Whitworth J, Chesters J, Power R. Sexual partner types and related sexual health risk among out-of-school adolescents in rural south-west Uganda. AIDS care. 2011;23(2):252-9. Epub 2011/01/25.

106. Kahle EM, Hughes JP, Lingappa JR, John-Stewart G, Celum C, Nakku-Joloba E, et al. An empiric risk scoring tool for identifying high-risk heterosexual HIV-1-serodiscordant couples for targeted HIV-1 prevention. Journal of acquired immune deficiency syndromes (1999). 2013;62(3):339-47. Epub 2012/11/29.

107. Davies SL, Cheong J, Lewis TH, Simpson CA, Chandler SD, Tucker JA. Sexual risk typologies and their relationship with early parenthood and STI outcomes among urban African-American emerging adults: a cross-sectional latent profile analysis. Sex Transm Infect. 2014;90(6):475-7. Epub 2014/05/27.

108. Haydon AA, Herring AH, Prinstein MJ, Halpern CT. Beyond age at first sex: patterns of emerging sexual behavior in adolescence and young adulthood. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2012;50(5):456-63. Epub 2012/04/25.

109. Vasilenko SA, Kugler KC, Butera NM, Lanza ST. Patterns of adolescent sexual behavior predicting young adult sexually transmitted infections: a latent class analysis approach. Archives of sexual behavior. 2015;44(3):705-15. Epub 2014/01/23.

110. Sandfort T, Yi H, Knox J, Reddy V. Sexual partnership types as determinant of HIV risk in South African MSM: an event-level cluster analysis. AIDS and behavior. 2013;17 Suppl 1:S23-32. Epub 2012/09/08.

111. Magidson J, Vermunt JK. Latent class models for clustering: A comparison with K-means. Canadian Journal of Marketing Research. 2002;20:37-44.

112. Baird SJ, Garfein RS, McIntosh CT, Ozler B. Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. Lancet. 2012;379(9823):1320-9. Epub 2012/02/22.

113. Hargreaves JR, Morison LA, Kim JC, Bonell CP, Porter JD, Watts C, et al. The association between school attendance, HIV infection and sexual behaviour among young people in rural South Africa. J Epidemiol Community Health. 2008;62(2):113-9. Epub 2008/01/15.

114. Pettifor AE, Levandowski BA, MacPhail C, Padian NS, Cohen MS, Rees HV. Keep them in school: the importance of education as a protective factor against HIV infection among young South African women. Int J Epidemiol. 2008;37(6):1266-73. Epub 2008/07/11.

115. Cluver L, Orkin M, Boyes M, Gardner F, Meinck F. Transactional sex amongst AIDS-orphaned and AIDS-affected adolescents predicted by abuse and extreme poverty. Journal of acquired immune deficiency syndromes (1999). 2011;58(3):336-43. Epub 2011/08/23.

116. Operario D, Underhill K, Chuong C, Cluver L. HIV infection and sexual risk behaviour among youth who have experienced orphanhood: systematic review and meta-analysis. Journal of the International AIDS Society. 2011;14:25. Epub 2011/05/20.

117. Cluver L, Boyes M, Orkin M, Pantelic M, Molwena T, Sherr L. Child-focused state cash transfers and adolescent risk of HIV infection in South Africa: a propensity-score-matched case-control study. The Lancet Global health. 2013;1(6):e362-70. Epub 2014/08/12.

118. Rosenberg M, Pettifor A, Nguyen N, Westreich D, Bor J, Barnighausen T, et al. Relationship between receipt of a social protection grant for a child and second pregnancy rates among South African women: a cohort study. PloS one. 2015;10(9):e0137352. Epub 2015/09/24.

119. Rosenberg M, Pettifor A, Van Rie A, Thirumurthy H, Emch M, Miller WC, et al. The relationship between alcohol outlets, HIV risk behavior, and HSV-2 infection among South African young women: a cross-sectional study. PloS one. 2015;10(5):e0125510. Epub 2015/05/09.

120. Vasilenko SA, Lanza ST. Predictors of multiple sexual partners from adolescence through young adulthood. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2014;55(4):491-7. Epub 2014/02/25.

121. Feldstein Ewing SW, Ryman S, Gillman A, Weiland B, Thayer R, Bryan A. Developmental Cognitive Neuroscience of Adolescent Sexual Risk and Alcohol Use. AIDS and behavior. 2015. Epub 2015/08/21.

122. Hatcher AM, Colvin CJ, Ndlovu N, Dworkin SL. Intimate partner violence among rural South African men: alcohol use, sexual decision-making, and partner communication. Culture, health & sexuality. 2014;16(9):1023-39. Epub 2014/06/19.

123. Kalichman SC, Pitpitan E, Eaton L, Cain D, Carey KB, Carey MP, et al. Bringing it home: community survey of HIV risks to primary sex partners of men and women in alcohol-serving establishments in Cape Town, South Africa. Sex Transm Infect. 2013;89(3):231-6. Epub 2012/12/18.

124. Kiene SM, Subramanian SV. Event-level association between alcohol use and unprotected sex during last sex: evidence from population-based surveys in sub-Saharan Africa. BMC public health. 2013;13:583. Epub 2013/06/19.

125. Watt MH, Aunon FM, Skinner D, Sikkema KJ, Kalichman SC, Pieterse D. "Because he has bought for her, he wants to sleep with her": alcohol as a currency for sexual exchange in South African drinking venues. Social science & medicine (1982). 2012;74(7):1005-12. Epub 2012/02/14.

126. Yamanis TJ, Doherty IA, Weir SS, Bowling JM, Kajula LJ, Mbwambo JK, et al. From coitus to concurrency: sexual partnership characteristics and risk behaviors of 15-19 year old men recruited from urban venues in Tanzania. AIDS and behavior. 2013;17(7):2405-15. Epub 2012/09/20.

127. Kahn K, Collinson MA, Gomez-Olive FX, Mokoena O, Twine R, Mee P, et al. Profile: Agincourt health and socio-demographic surveillance system. Int J Epidemiol. 2012;41(4):988-1001. Epub 2012/08/31.

128. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Applied Psychological Measurement. 1977(1):385-401.

129. Garcia-Moreno C, Jansen HA, Ellsberg M, Heise L, Watts CH. Prevalence of intimate partner violence: findings from the WHO multi-country study on women's health and domestic violence. Lancet. 2006;368(9543):1260-9. Epub 2006/10/10.

130. Pulerwitz J, Gortmaker SL, William D. Measuring Sexual Relationship Power in HIV/STD Research. Sex Roles. 2000;42(7/8):637-60.

131. Lanza ST, Collins LM, Lemmon DR, Schafer JL. PROC LCA: A SAS Procedure for Latent Class Analysis. Structural equation modeling : a multidisciplinary journal. 2007;14(4):671-94. Epub 2007/01/01.

132. Lanza ST, Flaherty BP, Collins LM. Latent class and latent transition analysis. Handbook of psychology. 2003.

133. Collins L, Lanza S. Latent Class and Latent Transition Analysis. New Jersey: John Wiley & Sons, Inc.; 2010.

134. Pettifor A, MacPhail C, Hughes JP, Selin A, Wang J, Gomez-Olive FX, 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. The Lancet Global health. 2016;4(12):e978-e88. Epub 2016/11/07.

135. Clayton D, Hills M. Statistical Models in Epidemiology. Oxford: Oxford University Press; 1993.

136. UNAIDS. Empowering Young Women and Adolescent Girls: Fast-Tracking the End of the AIDS Epidemic in Africa. 2015.

137. Goodreau SM, Cassels S, Kasprzyk D, Montano DE, Greek A, Morris M. Concurrent partnerships, acute infection and HIV epidemic dynamics among young adults in Zimbabwe. AIDS and behavior. 2012;16(2):312-22.

138. Morris M, Epstein H. Role of concurrency in generalised HIV epidemics. Lancet. 2011;378(9806):1843-4; author reply 5-6. Epub 2011/11/29.

139. Balkus JE, Brown E, Palanee T, Nair G, Gafoor Z, Zhang J, et al. An Empiric HIV Risk Scoring Tool to Predict HIV-1 Acquisition in African Women. Journal of acquired immune deficiency syndromes (1999). 2016;72(3):333-43. Epub 2016/02/27.

140. Irungu EM, Heffron R, Mugo N, Ngure K, Katabira E, Bulya N, et al. Use of a risk scoring tool to identify higher-risk HIV-1 serodiscordant couples for an antiretroviral-based HIV-1 prevention intervention. BMC infectious diseases. 2016;16(1):571. Epub 2016/10/19.

141. Alexander J, Rose J, Dierker L, Chan PA, MacCarthy S, Simmons D, et al. It is complicated: sexual partner characteristic profiles and sexually transmitted infection rates within a predominantly African American population in Mississippi. Sex Transm Dis. 2015;42(5):266-71. Epub 2015/04/14.

142. Pettifor A, MacPhail C, Selin A, Gomez-Olive FX, Rosenberg M, Wagner RG, 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 and behavior. 2016;20(9):1863-82. Epub 2016/02/20.

143. The United States President's Emergency Plan for AIDS Relief. DREAMS: Working Together for an AIDS-free Future for Girls and Women. 2017 [May 17, 2017]; Available from: http://www.dreamspartnership.org.

144. Mercer CH, Jones KG, Johnson AM, Lewis R, Mitchell KR, Gravningen K, et al. How can we objectively categorise partnership type? A novel classification of population survey data to inform epidemiological research and clinical practice. Sex Transm Infect. 2017;93(2):129-36. Epub 2016/08/19.

145. 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. Epub 2016/08/16.

146. Ritchwood TD, Hughes JP, Jennings L, MacPhail C, Williamson B, Selin A, et al. Characteristics of Age-Discordant Partnerships Associated With HIV Risk Among Young South African Women (HPTN 068). Journal of acquired immune deficiency syndromes (1999). 2016;72(4):423-9. Epub 2016/03/16.

147. Rosenberg M, Pettifor A, Miller WC, Thirumurthy H, Emch M, Afolabi SA, et al. Relationship between school dropout and teen pregnancy among rural South African young women. Int J Epidemiol. 2015;44(3):928-36. Epub 2015/02/27.

148. Stoner MCD, Edwards JK, Miller WC, Aiello AE, Halpern CT, Julien A, et al. The effect of school attendance and school drop out on incident HIV and HSV-2 among young women in rural South Africa enrolled in HPTN 068. 9th IAS Conference on HIV Science; July 2017; Paris 2017.

149. Shisana O, Risher K, Celentano DD, Zungu N, Rehle T, Ngcaweni B, et al. Does marital status matter in an HIV hyperendemic country? Findings from the 2012 South African National HIV Prevalence, Incidence and Behaviour Survey. AIDS care. 2016;28(2):234-41. Epub 2015/11/10.

150. Kalichman SC, Simbayi LC, Kaufman M, Cain D, Jooste S. Alcohol use and sexual risks for HIV/AIDS in sub-Saharan Africa: systematic review of empirical findings. Prevention science : the official journal of the Society for Prevention Research. 2007;8(2):141-51. Epub 2007/02/01.

151. Mataure P, McFarland W, Fritz K, Kim A, Woelk G, Ray S, et al. Alcohol Use and High-Risk Sexual Behavior Among Adolescents and Young Adults in Harare, Zimbabwe. AIDS and behavior. 2002;6(3):211–9.

152. Pithey A, Parry C. Descriptive systematic review of Sub-Saharan African studies on the association between alcohol use and HIV infection. SAHARA J : journal of Social Aspects of HIV/AIDS Research Alliance. 2009;6(4):155-69. Epub 2010/05/21.

153. Wechsberg WM, Jones HE, Zule WA, Myers BJ, Browne FA, Kaufman MR, et al. Methamphetamine ("tik") use and its association with condom use among out-of-school females in Cape Town, South Africa. The American journal of drug and alcohol abuse. 2010;36(4):208-13. Epub 2010/06/22.

154. Rosenberg M, Pettifor A, Lippman SA, Thirumurthy H, Emch M, Miller WC, et al. Relationship between community-level alcohol outlet accessibility and individual-level herpes simplex virus type 2 infection among young women in South Africa. Sex Transm Dis. 2015;42(5):259-65. Epub 2015/04/14.

155. Handa S, Halpern CT, Pettifor A, Thirumurthy H. The government of Kenya's cash transfer program reduces the risk of sexual debut among young people age 15-25. PloS one. 2014;9(1):e85473. Epub 2014/01/24.

156. Cambou MC, Perez-Brumer AG, Segura ER, Salvatierra HJ, Lama JR, Sanchez J, et al. The risk of stable partnerships: associations between partnership characteristics and unprotected anal intercourse among men who have sex with men and transgender women recently diagnosed with HIV and/or STI in Lima, Peru. PloS one. 2014;9(7):e102894. Epub 2014/07/17.

157. Janulis P, Feinstein BA, Phillips G, 2nd, Newcomb ME, Birkett M, Mustanski B. Sexual Partner Typologies and the Association Between Drug Use and Sexual Risk Behavior Among Young Men Who Have Sex With Men. Archives of sexual behavior. 2017. Epub 2017/02/15.

158. Perez-Brumer AG, Oldenburg CE, Segura ER, Sanchez J, Lama JR, Clark JL. Anonymous partnerships among MSM and transgender women (TW) recently diagnosed with HIV and other STIs in Lima, Peru: an individual-level and dyad-level analysis. Sexually transmitted infections. 2016. Epub 2016/02/26.

159. Rosengard C, Adler NE, Gurvey JE, Ellen JM. Adolescent partner-type experience: psychosocial and behavioral differences. Perspectives on sexual and reproductive health. 2005;37(3):141-7. Epub 2005/09/10.

160. Mensch B, Hewett P, Erulkar A. The reporting of sensitive behavior by adolescents: a methodological experiment in Kenya. Demography. 2003;40(2):247-68.

161. Norris S, Richter L. HIV/AIDS risk research among young people: a methodological study of the reporting of sensitive issues among adolescents in the Birth to Twenty study, South Africa. XVI International AIDS Conference; Toronto 2006.

162. Waruru A, Nduati R, Tylleskar T. Audio computer-assisted self-interviewing (ACASI) may avert socially desirable responses about infant feeding in the context of HIV. BMC Med Inform Decis Mak. 2005;5(24).

163. Celum CL, Delany-Moretlwe S, McConnell M, van Rooyen H, Bekker LG, Kurth A, et al. Rethinking HIV prevention to prepare for oral PrEP implementation for young African women. Journal of the International AIDS Society. 2015;18(4 Suppl 3):20227. Epub 2015/07/23.

164. Bekker LG, Gill K, Wallace M. Pre-exposure prophylaxis for South African adolescents: What evidence? South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde. 2015;105(11):907-11. Epub 2015/12/04.

165. Haydon AA, Herring AH, Halpern CT. Associations between patterns of emerging sexual behavior and young adult reproductive health. Perspectives on sexual and reproductive health. 2012;44(4):218-27. Epub 2012/12/13.

166. Abdool Karim Q, Dellar R. Inclusion of adolescent girls in HIV prevention research - an imperative for an AIDS-free generation. Journal of the International AIDS Society. 2014;17:19075. Epub 2014/03/19.