Partner Violence as a Risk Factor for Incident HIV Infection in Women in Rakai, Uganda

by

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A thesis submitted in conformity with the requirements
for the degree of Doctor of Philosophy in Epidemiology

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Abstract

Background: Intimate partner violence (IPV) is a significant public health problem, which has been associated with HIV infection. Previous studies that assessed IPV and HIV have been limited.

Objectives: The primary objective of this study was to quantify the association between IPV and incident HIV infection in women in Rakai, Uganda. Secondary objectives were to explore whether condom use and number of partners in the past year mediate this association, and to identify risk factors for IPV.

Methods: Data were collected over seven rounds of the Rakai Community Cohort Study between 2000 and 2009. Sexually active women aged 15 to 49 were included in analyses. Longitudinal data analysis was used to quantify the association between IPV and incident HIV infection, modelling participants as random effects. The adjusted population attributable risk fraction was calculated using an adjusted relative risk from a Poisson model. Putative mediators were assessed using Baron and Kenny's criteria and the Sobel-Goodman test. Longitudinal and non-longitudinal analyses were used to assess predictors of IPV.

Results: Women who experienced IPV ever had an odds ratio of incident HIV infection of 1.54 (95% CI 1.14, 2.09, p value 0.01), compared with women who had never experienced IPV. The adjusted population attributable risk fraction of incident HIV during the study period attributable to IPV ever was 14.3% (95% CI 2.8, 23.6). There was no evidence that condom use or partner violence in the past year mediated the relationship between IPV and HIV. Risk factors for IPV included sexual abuse, younger age at first sex, lower levels of education, forced first sex, younger age, being married, relationship of shorter duration, alcohol use by women and by their partners, and thinking that violence is acceptable.

Discussion: This study demonstrates that IPV is associated with incident HIV infection in a population-based cohort in Uganda, although the population attributable risk fraction was modest. The prevention of IPV both in early sexual experiences and in adulthood should be a public health priority, and could contribute to HIV prevention. Further research is needed to understand the pathway from IPV to HIV infection.

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1 Chapter One: Overview

1.1 Thesis overview

This thesis is a secondary data analysis of data collected as part of the Rakai Community Cohort Study between 2000 and 2009. In this work, I focus on the association between intimate partner violence (IPV) and incident HIV infection in women in Rakai, Uganda.

1.2 Roles and Responsibilities

My contributions to this research include the following:

1. Development of the research questions for the thesis;
2. Development of the research protocol for the thesis;
3. Obtaining consent from the investigators in the Rakai Community Cohort Study to conduct this research, including accessing the data (which had already been collected as part of the Rakai Community Cohort Study);
4. Obtaining Research Ethics Board approval at the University of Toronto;
5. Defining and requesting the variables for inclusion in the analyses (which had already been collected as part of the Rakai Community Cohort Study);
6. Conducting the literature review;
7. Conducting the analyses;
8. Writing the thesis; and
9. Preparing manuscripts for submission to peer-reviewed journals.

1.3 Structure of the thesis

This thesis is organized into seven chapters. Chapter 1 is a brief overview of the thesis to orient the reader to the general content and structure of the thesis. Chapter 2 provides a general introduction, including information on the burden of IPV, the HIV epidemic in Uganda, the hypothesized associations between IPV and HIV, the evidence of associations between IPV and HIV, and the justification and objectives for the thesis. Chapter 3 provides an overview of issues relevant to the overall study, including information about the Rakai Community Cohort Study and relevant ethical issues. Chapters 4, 5, and 6 provide the justification, methodology, results, and discussion for each of objectives 1, 2, and 3, respectively. Chapter 7 is a general discussion of the whole thesis, which summarizes the findings, limitations, and significance of this research work, and provides suggestions for future research.

Several appendices are also included, which present approvals from the University of Toronto Research Ethics Board, a list and definition of variables included in analyses, and the results of analyses which are supplemental to the main analyses and discussion.

2 Chapter Two: Introduction

2.1 The burden of intimate partner violence (IPV)

Violence against women is a serious and common human rights and public health problem, which causes significant morbidity and mortality worldwide.[1] Intimate partner violence (IPV) is one form of violence against women, which is defined as "behaviour within an intimate relationship that causes physical, sexual, or psychological harm, including acts of physical aggression, sexual coercion, psychological abuse and controlling behaviours."[2] The WHO Multi-Country Study on Women's Health and Domestic Violence, which was conducted between 2000 and 2003 in 15 sites in 10 countries, identified a lifetime prevalence of physical and/or sexual partner violence ranging from 15% to 71% and a past year prevalence between 4% and 54%.[3] In Uganda, which is where the data for this thesis were collected, the Global Burden of Disease project estimates that in 2004, intentional violence was responsible for 1,300 deaths and 52,000 disability-adjusted life years in females,[4] though specific estimates are not available for IPV in particular. National data from the 2006 Uganda Demographic Health Survey further indicate high levels of violence against women; 60% of women aged 15 to 49 reported ever experiencing violence and 34% reported violence in the past year, the majority of which was perpetrated by an intimate partner, 24% of women aged 15 to 49 reported that their first intercourse was forced against their will, and 35.4% of women have ever experienced sexual violence.[5]

IPV is a public health concern both as a health outcome and as a risk factor for other adverse health outcomes,[2] including reproductive health consequences such as unintended pregnancy, lack of use of contraception, poor outcomes of pregnancy and birth, gynecological morbidity, and sexually transmitted infections including HIV.

2.2 The HIV epidemic in Uganda

In Uganda between 2000 and 2009, which is when the data included in this thesis were collected, the prevalence of HIV in people ages 15 to 49 was stable, with a prevalence in 2009 of 6.5% (95% CI 5.9, 6.9).[*6] The annual HIV incidence rate has also been stable in people ages 15 to 49 over this time period, and has remained below 1% since the 1990s.[6]

Given the high levels of IPV[7, 8] and HIV[6] in Uganda, the relationship between IPV and HIV deserves attention in this context as a potential area for HIV prevention.

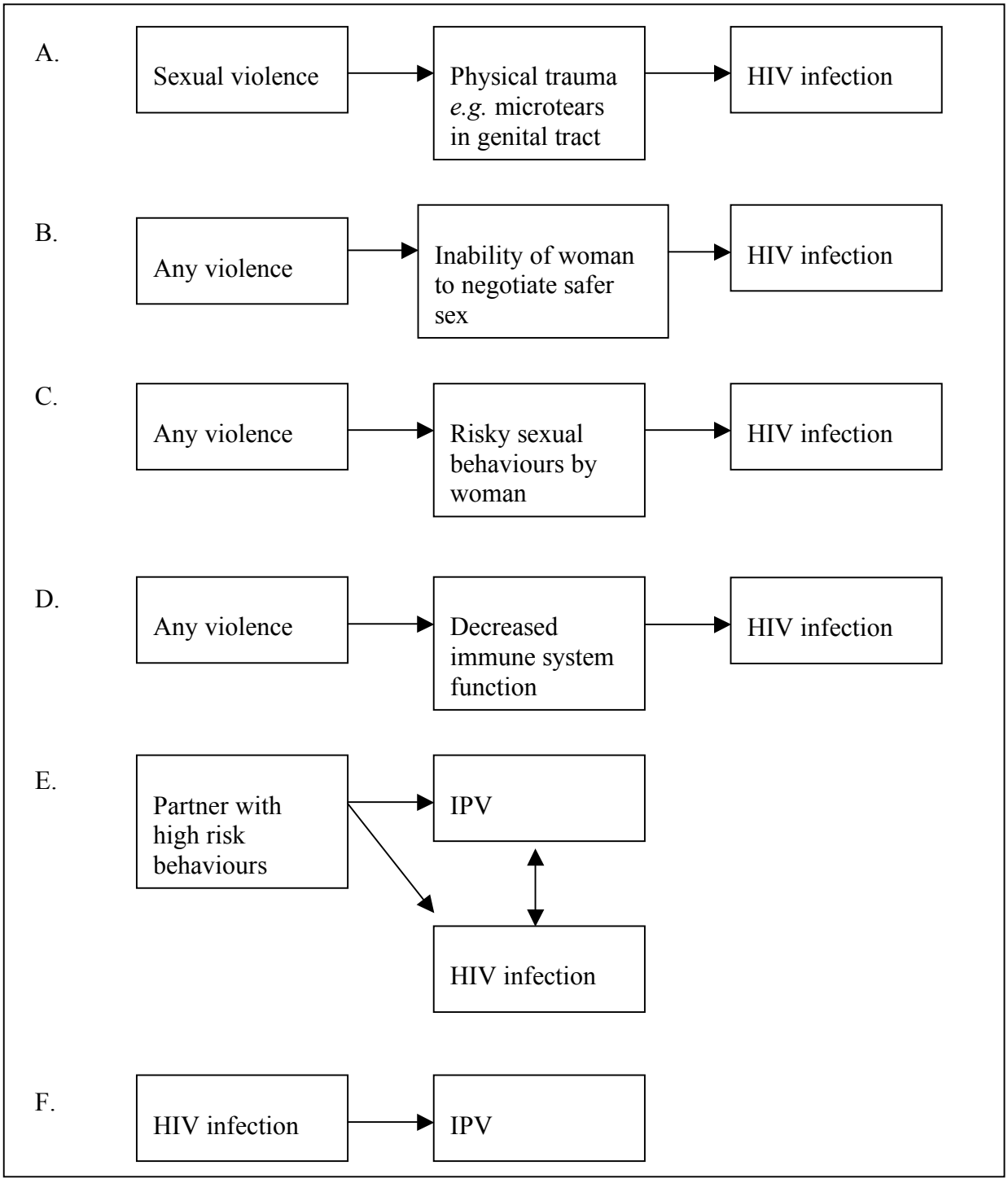
2.3 Theoretical basis for associating IPV and HIV

IPV has been hypothesized to directly affect risk for HIV by several mechanisms, as illustrated in Figure 1.[9] Women who experience forced or coercive sex with an infected partner may be more likely to be infected due to the associated physical trauma,[9] which could increase the susceptibility to HIV upon exposure. Women who experience any type of violence may be limited in their ability to negotiate safer sex practices,[9-11] which may lead to low rates of condom use or to engaging in intercourse which is not desired. Women who experience violence in childhood or in adulthood may be more likely to engage in sexual behaviours in adulthood which increase risk for HIV, such as early sexual initiation, anal sex, commercial sex work, sex with multiple or unfamiliar partners, and low rates of condom use,[9, 12, 13] which may be due to the psychological consequences of violence leading to a failure to develop healthy behaviours or to behave in less risky ways.[12] These two mechanisms may be difficult to distinguish, given that many indicators would be the same; they differ in that women would be able to make decisions regarding risky behaviours in the second mechanism. Also of note, any of these three pathways could be mediated by transmission of other sexually transmitted infections, including genital ulcer diseases such as herpes simplex virus, which are associated with an increased risk of HIV

[*] Unless indicated otherwise, throughout this thesis the presentation of two numbers in brackets after a quantitative estimate represents the 95% confidence interval.

infection.[14] Another potential mechanism is that the psychological stress of violence may affect susceptibility to HIV through immune system suppression.[15] Violence may also be an indirect marker of risk for HIV, since men who perpetrate violence may have higher rates of sexual risk behaviours and therefore a higher rate of HIV, which would, in turn, increase the risk of exposure to their female partners.[16] For each of these mechanisms, violence would lead to HIV infection only if a woman has one or more partners who are infected with HIV. Finally, IPV could be a consequence of infection with HIV if, for example, a woman's disclosure of HIV infection to her partner precipitated violence.[17]

Figure 1. Hypothesized mechanisms for the relationship between IPV and HIV*



2.4 Empirical evidence of associations between IPV and HIV

2.4.1 Evidence of overall association between IPV and HIV

In consideration of the prevalence and burden of HIV and IPV, the empirical evidence is relatively limited for an association between HIV and violence and for the theoretical mechanisms postulated. There is quantitative evidence from studies in sub-Saharan Africa and South Asia to support an overall association between IPV and HIV. A study conducted in Kigali, Rwanda in 1990 found that HIV-positive women with one steady partner in the past year were more likely to report sexual coercion than were HIV-negative women, at 43% vs. 29%.[11] A study of women attending an STI clinic in Kenya from 1996 to 1997 revealed that women with prevalent HIV were almost twice as likely to have experienced physical partner violence in their lifetime in unadjusted analysis, with an odds ratio of 1.8 (1.1, 2.8).[18] A cross-sectional study in 1999 of 240 women accessing voluntary counselling and testing (VCT) in Dar es Salaam, Tanzania showed that the odds of ever having experienced violence was more than two times higher in women who were HIV-positive than in women who were HIV-negative, which was true for both physical and sexual violence.[19] A study of 1366 women seeking antenatal care in Soweto, South Africa from 2001 to 2002 found an adjusted odds of HIV seropositivity of 1.48 (1.15, 1.89) for women who experienced "broad" IPV (defined as both physical and sexual abuse, or either physical or sexual abuse at mid to high frequency) compared with women who reported no IPV or either physical or sexual abuse at low frequency.[20] A study conducted from 2002 to 2003 in Eastern Cape province in South Africa determined that IPV was significantly associated with prevalent HIV infection in bivariate analyses with an odds ratio of 1.56 (1.08, 2).[21] A 2005 study of 245 women at an HIV VCT clinic in Bangalore, India found that women who reported experiencing domestic violence from a current or previous partner were more likely to be infected with HIV ($p<0.001$), but no estimate of the strength of the association was provided.[17] An analysis of data from the 2005 Rwanda Demographic and Health Survey (DHS) indicated that women who experienced sexual abuse and women who experienced emotional abuse, but not those who experienced physical abuse, were significantly more likely to test positive for HIV in bivariate analyses.[22] Those who experienced emotional abuse were significantly more likely to test positive for HIV after adjusting for individual, partner, and household characteristics, with an odds ratio of 3.46 (1.34, 8.78) compared with women who

didn't experience emotional abuse.[22] Another study using the same 2005 Rwanda DHS data found that women with higher scores on a scale based on the number of types of physical, sexual, or psychological violence experienced were significantly more likely to be infected with HIV, after adjusting for women's sociodemographic and sexual risk factors.[23] In a study of a national population-based sample of 124,385 married women in India in 2005 and 2006, women who had ever experienced physical and sexual violence from their husbands were at 3.92 times the odds of prevalent HIV infection as those who had never experienced physical or sexual abuse.[16] Another analysis using the same survey data but restricted to 20,425 husband-wife dyads indicated that wives of men with HIV who perpetrate IPV had an adjusted odds greater than seven-fold of prevalent HIV compared to wives of husbands with HIV who did not perpetrate IPV.[24] In 2006, a study of 600 pregnant women attending urban and rural antenatal clinics in Rwanda found that HIV-positive women were more likely to have experienced physical IPV than HIV-negative women, with an odds ratio of 2.38 (1.59, 3.57).[25]

Only two studies have been conducted using prospective data to look at the association between IPV and HIV. Analysis of data from a prospective study conducted in 2002 to 2006 of 1099 women in Eastern Cape province of South Africa revealed that women who reported more than one episode of physical and/or sexual IPV at baseline were 1.51 (1.04, 2.21) times as likely as those who reported one or no episodes to acquire HIV within a two-year follow up period.[26] A study of serodiscordant couples in seven East and Southern African countries between 2004 and 2007 revealed a significant positive association between verbal or physical IPV and prevalent HIV infection in both males and females, and also a positive association between verbal or physical IPV and incident HIV in participants who were initially HIV-uninfected, though this was not significant statistically, with adjusted odds ratios of 1.62 (p=0.35) for women and 1.69 (p=0.31) for men.[27]

There are also several studies from low- and middle- income countries which have not found a consistent positive or a statistically significant association between IPV and HIV. A study conducted in 2436 women attending an HIV VCT site in Moshi, Tanzania, from 2005 to 2008 did not find an association between physical or sexual IPV and HIV infection, except in single

women (p=0.04).[28] A recently published systematic review of studies on IPV in pregnancy published from 2000 to 2010 found that of eight studies that assessed the association between IPV and HIV during pregnancy, five identified a significant association after controlling for known confounders, with a range in increased odds of HIV infection of 1.48 to 3.1, whereas three studies did not find a significant association.[29] An analysis of data from 10 Demographic and Health Surveys conducted in low- and middle-income countries (including seven countries in sub-Saharan Africa), which included women who were or had previously been married or cohabitating with partners, identified country-specific odds ratios for HIV infection ranging from 0.45 to 1.35 for forms of IPV compared with no IPV, all of which were not statistically significant in analyses adjusted for demographic, social, and behavioural risk factors.[30] In unadjusted analyses, however, small and statistically significant associations were identified between HIV infection and sexual or physical violence compared with no violence and for physical and sexual violence compared with no sexual violence.[30] A 2008 study of South African men aged 18 to 49 found that having perpetrated physical violence toward a female partner was associated with an increased risk of HIV infection in young men aged 18 to 25, but not for men between the ages of 26 and 49, and also that rape perpetration was not associated with HIV infection.[31]

Most of these studies have important limitations. Most studies have used cross-sectional data,[11, 18-25, 28-31] which makes it impossible to determine whether at least some of the association observed is IPV that occurs subsequent to HIV diagnosis. Many studies measure only physical or sexual violence and do not incorporate verbal violence and control into their measure of IPV, [11, 18, 20, 21, 24, 28-31] which could lead to an underestimate of the association between IPV and HIV, especially in the event that a causal mechanism exists between IPV and HIV and that mechanisms B, C, or D, as shown in Figure 1, are important pathways in this relationship (*i.e.* that women who experience IPV are less likely to be able to negotiate safer sex, more likely to have risky sexual behaviours, and/or have decreased immune system function). Several studies were conducted in specific sites,[11, 18-20, 25, 27-29] such as prenatal clinics or VCT testing sites, and the association between IPV and violence may differ in these settings compared to the general population, for example if people who accessed health care services (and who experienced IPV) were at lower risk of being infected with HIV because of exposure to health education and health

promotion efforts. While both unadjusted and adjusted estimates provide valuable information on the association between IPV and HIV, the diverse ways in which adjustment is done, if at all, makes it difficult to compare the consistency of results. A particular issue in adjustment is that several studies adjusted for risk behaviours such as having multiple partners and condom use,[16, 20, 21 23, 24, 26] which are hypothesized to mediate this association (as per mechanisms B and C in Figure 1, *i.e.* that women who experience IPV are less likely to negotiate safer sex behaviours and/or have more risky sexual behaviours), and treating a true mediator as a confounder could dilute any association between IPV and HIV.

2.4.2 Evidence of specific mechanisms for the association between IPV and incident HIV

There is limited evidence for mechanism A, shown in Figure 1, *i.e.* that sexual violence leads to physical trauma which makes a person more susceptible to HIV. A study from 1985 to 1993 examining patterns of genital injury in 311 women reporting sexual assault as compared with genital injury in 75 women after consensual sex found that women reporting non-consensual sex were significantly more likely to have genital injury.[32]

There are a few studies from North America, South Asia, and sub-Saharan Africa which have looked at the association between IPV and the ability to negotiate safer sex, *i.e.* the first part of mechanism B in Figure 1. A study of 165 sexually active African-American women aged 18 to 29 in San Francisco in 1993 revealed that women in a physically abusive relationship, defined as a primary partner who physically abused the respondent in the past 3 months, *i.e.* slapped or hit the victim, were more likely to fear physical and verbal abuse as a result of negotiating condom use.[10] Participants reported that requesting that their partners use condoms had often resulted in abuse in the past 3 months: verbal abuse for 32.1%, threat of physical abuse for 21.4%, and threat of abandonment for 14.3% of women with physically abusive partners.[10] A study of 208 female sex partners of injection drug or crack users in Florida, Arizona and Oregon from 1993 to 1995 found that women who reported a history of verbal abuse or physical assault by a sex partner were more likely to engage in unprotected anal sex, and those who had been raped and

those who had been threatened with assault reported consistent condom use at similar levels to those who had not, respectively.[33] A qualitative study conducted in Chennai, India between 2000 and 2001 found that many women "acquiesced to sex" to avoid violence and that violence inhibited them from negotiating condom use.[34] In the aforementioned study in women in antenatal clinics in South Africa from 2001 to 2002,[20] having ever used condoms was not significantly associated with IPV (categorized as having experienced IPV more than once compared with one time ever or never), with an odds ratio of 1.09 (0.86, 1.37). In another South African study between 2002 and 2003,[21] IPV was not associated with correct condom use during most recent intercourse, with 37.0% (32.0-42.0) of those who experienced IPV more than once having correctly used condoms compared with 38.7% (35.1-42.4) of those who experienced IPV once or not at all. A study of 168 incarcerated women in the USA just prior to their release back into the community found that a history of IPV was significantly associated with lower condom use self-efficacy, *i.e.* with less confidence in their ability to negotiate condom use with a partner, after adjusting for demographic and risk behaviour variables.[35] In contrast with these findings, an aforementioned study of data from the 2005 Rwanda DHS revealed that current condom use was not correlated with any form of IPV, though specific measures of association and confidence intervals were not provided.[22] In the study of husband-wife dyads in India from 2005 to 2006,[24] IPV in women was significantly associated with having never used condoms, at 38.3% compared with 33.1%, with a p value less than 0.001.

Several studies have examined whether experiencing IPV is associated with behaviours which increase risk for HIV, *i.e.* mechanism C in Figure 1. The previously mentioned study of 208 female sex partners of injection drug or crack users in Florida, Arizona and Oregon from 1993 to 1995 indicated that women who had ever experienced rape were more likely to have multiple sex partners and to engage in anal sex.[33] A study of 327 heterosexual women in Rhode Island and Massachusetts between 1987 and 1992 revealed that adult rape experiences were associated with HIV risk factors such as earlier age of first sex, more sexual partners, and unprotected sex involving drugs, which was true for HIV-positive and HIV-negative women.[13] In the study of women in antenatal clinics in South Africa from 2001 to 2002,[20] IPV was associated with having five or more male partners, with an odds ratio of 1.77 (1.42-2.22) for women who experienced IPV more than once compared to women who experienced IPV once or not at all. In another

South African study from 2002 and 2003,[21] IPV was associated with having three or more partners in the past year, with 19.2% (15.2-23.3) of women who experienced IPV more than once having three or more partners compared with 7.1% (5.5-8.7) of women who experienced IPV once or not at all. A study integrating data from national household surveys conducted with men and women in eight southern African countries in 2002 identified a strong association between having multiple partners in the past 12 months and experiencing IPV, with an odds ratio of 1.87 (1.46, 2.41) for female respondents and of 2.00 (1.47, 2.66) for male respondents, compared with those with one or no partners in the past 12 months.[36] A study of 717 women attending an STI clinic in upstate New York, USA, found that women who reported experiencing IPV had more episodes of unprotected sex, both overall and with a steady partner.[37] In the aforementioned study of husband-wife dyads in India in 2005 and 2006,[24] IPV in women was significantly associated with having multiple sex partners.

As noted, condom use and other safer sex behaviours could reflect either the inability to negotiate safer sex or that women who experience IPV develop risky sexual behaviours, *i.e.* mechanisms B or C in Figure 1. The distinction between these two mechanisms is whether women have control over risky behaviours, *e.g.* for mechanism B, a woman might not be willing or able to negotiate safer sex because she is not in control of sexual decision-making or because of fear of consequences of violence, whereas for mechanism C, a woman might not take actions to mitigate her risk of HIV even if she had the autonomy to do so.[38] It would be difficult to differentiate between these two mechanisms using the data on risk behaviours which are typically collected in studies of sexual behaviour, including most studies on the association between IPV and HIV (though being able to do so would nonetheless be valuable in terms of informing public health action).

There is also evidence to support the hypothesized mechanism that males who perpetrate violence are more likely to have risky sexual behaviours and to be infected with HIV, *i.e.* mechanism E in Figure 1. A study of 6632 men from 1995-1996 in Uttar Pradesh, India found that men who abused their wives were more likely to have extramarital sex and to have symptoms of sexually transmitted infections (STIs).[39] Research conducted on 1396 men in

Eastern Cape province in South Africa between 2002 and 2003 found an association between the perpetration of partner violence and transactional sex with female partners; males who self-reported perpetrating partner violence were significantly more likely to report transactional sex with both casual partners and main partners.[40] A household survey of 457 women in Eastern Uganda in 2003 revealed that husbands having another partner was associated with a higher risk of IPV, with an odds ratio of 2.4 (1.02, 5.7).[41] The aforementioned 2006 study of pregnant women in Rwanda indicated that experiencing IPV was significantly associated with having a male partner with other partners, with an odds ratio of 1.53 (1.15, 2.20).[25] A study of 283 men with steady partners who presented to a clinic in Boston, USA, in 2004 and 2005 found that participants who had perpetrated IPV in the past year were more likely to report inconsistent or no condom use, forced sexual intercourse without a condom, and sexual intercourse with other partners.[42] Analysis of data from a 2004 nationally representative sample of married men in Bangladesh found that men who perpetrated physical and/or sexual violence against their wives were more likely to report premarital and extramarital partners, and men who reported physical violence were more likely to report symptoms of or the diagnosis of an STI in the past year.[43] A separate analysis of the same data identified that men who reported violence against their wives were more likely to marry more than once and to have extramarital partners.[44] The study of husband-wife dyads in India conducted from 2005-2006 revealed that husbands who perpetrated IPV against their wives (as reported by their wives) had an odds ratio of 1.91 (1.11, 3.27) of acquiring HIV infection outside of the marriage, after controlling for husbands' sexual risk factors and potential demographic confounders.[24] A study of heterosexual men in New York City, USA between 2005 and 2007 found that men who perpetrated physical IPV against their main female sexual partner were half as likely as men who didn't perpetrate physical IPV to report consistent condom use, after controlling for sociodemographic, condom-use related, and other factors, with an odds ratio of 0.49 (0.27, 0.86).[45]

There are several limitations to this literature, which preclude determination of the specific mechanism or mechanisms which may be responsible for the association between IPV and HIV. As noted above for studies of the overall association between violence and HIV, most of these studies were cross-sectional,[10, 22, 33, 36, 37, 39, 40, 42, 43, 45] which prevents a clear understanding of the temporality of associations, and were not population-based.[10, 33, 37, 42, 45] Studies examining IPV

in general often did not include all forms of violence,[10, 33, 39, 40, 42, 43, 45] *i.e.* physical, sexual, verbal, and control, which could lead to an underestimate of associations. Also, these analyses generally look at the association between IPV and potential mediators of the relationship between IPV and HIV, but do not conduct a complete mediation analysis by considering the association between the putative mediator and the outcome of HIV in the same dataset.

Also of note, it is plausible that more than one of the specified mechanisms may be operating in conjunction to account for the associations between IPV and HIV, so analyses would ideally consider multiple mechanisms in analyses, which is rarely done. One exception is the study of sex partners of drug users which considered variables which represent both mechanisms B and C in Figure 1, *i.e.* that women who experience IPV are less likely to negotiate safer sex and have riskier sexual behaviours.[33] Another exception is the study of husband-wife dyads in India which found both higher odds of infection in women experiencing IPV compared to women not experiencing IPV (accounting for men's HIV status) and a higher odds of HIV infection in men who perpetrate violence, *i.e.* authors considered both HIV risk in women experiencing IPV (while not identifying a specific mechanism) and HIV risk in men perpetrating IPV (*i.e.* mechanism E in Figure 1).[24] Authors labeled the exposure to higher rates of HIV from men who perpetrate IPV and the increased risk of acquiring HIV when exposed in the context of IPV as "double jeopardy."[16,24]

2.5 Justification of the thesis research project

Given the current state of knowledge, prospective longitudinal data are required to be able to elucidate temporality and the mechanisms which may mediate this relationship.[16, 46-48] Research studies must be adequately powered to address the specific research question. Studies should be population-based if the goal of the study is to generalize the results to the general population. Given the uncertainty about the type of exposure to IPV which may be most relevant to the association between IPV and HIV, data on IPV should include all forms of IPV, *i.e.* physical IPV, sexual IPV, verbal IPV, and controlling behaviours, as well as indicators of frequency, severity, and timing of various forms of IPV. Studies should include data on relevant

confounders, mediators, and effect modifiers, and should treat each of these groups of variables appropriately in analyses. Finally, given the burden of both IPV and HIV in sub-Saharan Africa and the possibility of effect modification of the IPV-HIV association by geography, studies are required which reflect the social and health context of sub-Saharan Africa.

The Rakai Community Cohort Study (RCCS) provides the opportunity to address each of these issues. Based in the Rakai District in Uganda, the RCCS has included questions about IPV in each survey round since 2000, as well as questions about many relevant confounders, mediators, and effect modifiers. Throughout this time, the study has also been collecting biological samples for HIV testing with each survey round. The incidence of HIV and the prevalence of violence are both high in Rakai. This cohort therefore provides longitudinal data required to further examine the relationship between IPV and incident HIV in women, which will be the focus of this thesis.

Some relevant research on IPV has been done already using RCCS data, specifically to identify risk factors for physical and sexual IPV,[7, 8] to explore experiences of sexual coercion in adolescent women,[49] and to begin to look at how IPV and HIV may be related.[50] A study using data from 1998 to 1999 on 4279 women of reproductive age found that coercive sex with the current male partner was common and associated with younger age at first intercourse, alcohol consumption before sex by the male partner, and a woman's perception of her male partner's HIV risk.[8] A study using data from 2000 to 2001 on 5109 women of reproductive age found unadjusted associations between domestic violence and younger age, fewer children, lower level of education, shorter length of relationship, use of alcohol by self or by partner, perception of likelihood that male partner may have HIV, and younger age at first intercourse, respectively.[7] A qualitative study with adolescent women identified a continuum of sexual coercion in intimate relationships, and that sexual coercion was perceived to be a normal part of intimate relationships.[49] In 15 to 24 year old women from 2001 to 2003, alcohol use before sex by at least one partner in the past year was independently associated with each of physical and sexual violence, respectively, in the past year, and sexual coercion in the past year was found to be associated with prevalent HIV.[50] A separate analysis indicated that sexual coercion and alcohol use might also be independently associated with incident HIV infection, however, this analysis

was inadequately powered, likely due to the fact that only two years of data were included in the analysis.[50] Given the research to date, there is still clearly the opportunity to further define the relationship between IPV and HIV, in particular incident HIV infection which has not been well studied, as well as to further explore risk factors for IPV using data from the RCCS.

2.6 Thesis objectives

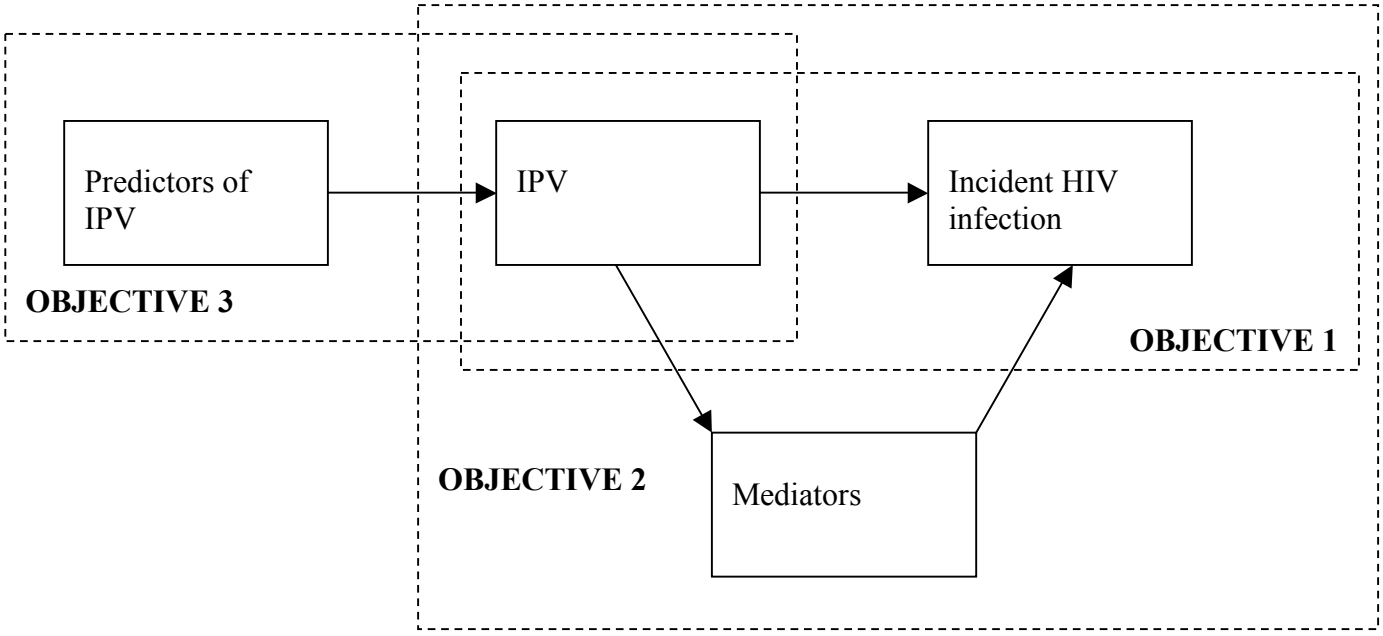
Objective 1. To estimate the risk of incident HIV infection for women experiencing violence in intimate partnerships compared to women who have not experienced violence in intimate partnerships in Rakai, Uganda. (primary objective)

Objective 2. To examine potential mediators of the relationship between IPV and HIV infection in Rakai, Uganda.

Objective 3. To quantify risk factors for intimate partner violence in women in Rakai, Uganda.

The three objectives are modelled in Figure 2.

Figure 2. Model of objectives 1-3



3 Chapter Three: The Rakai Community Cohort Study

3.1 Setting

Rakai District is a rural region in southwestern Uganda, which borders on Tanzania and Lake Victoria. In 2002, the population was found by census to be 404,300, with an annual growth rate of 1.8%, leading to an estimated population in 2010 of 466,300.[51]

3.2 Cohort development and characteristics

The Rakai Community Cohort Study (RCCS) was established in 1994 in the Rakai District, Uganda. Some of the first cases of HIV/AIDS were detected in Uganda, and until 1990, Rakai District was "one of the poorest and neglected districts in the country."[52] In the early 1990s, the Rakai District had limited health services, with only two rural health centres with limited inpatient services and 28 small health posts which lacked basic supplies, as well as a small number of private health care providers and drug stores offering limited outpatient care in the larger towns.[53] Beginning in 1988, the Rakai Project team initially conducted a series of HIV and STI epidemiological and behavioural studies.[54] Data from these studies revealed a high HIV prevalence and incidence and high rates of other STIs, and indicated limited success of behavioural interventions.[54] These factors suggested that Rakai would be an appropriate site for a randomized trial of STI control for the prevention of HIV, which was conducted from 1994 to 1998, and which was the initial prospective study which evolved into the RCCS.[54] Since then, the RCCS has focused on STIs including HIV in this region, and studies have included randomized trials, operations research, molecular epidemiology research, and observational studies.[52]

For the RCCS, a population of communities of interest on secondary roads in the Rakai District was defined and 56 such communities were selected for inclusion based on the criteria of a

known or estimated seroprevalence of 10 to 25%, a stable population, and year round road access.[54] The RCCS is an open cohort study, which enrols new in-migrants and age-eligible residents, and is ongoing. The number of participants is maintained at about 12,000. Since 1994, the RCCS has conducted repeat censuses and surveys at 10 to 14 month intervals in these communities. The census is conducted about a week prior to the survey, and is used to enumerate all residents in the households under study, including births, deaths, changes in marital status, and in- and out- migration since the previous survey. A list of people who are eligible for survey participation is generated, based on age and having resided in the community for at least 6 months. Interviews are administered to all consenting adults ages 15 to 49 years residing in 56 communities in the Rakai District. During the survey, all eligible residents are invited to participate in the study. Written informed consent is obtained at enrolment and follow-up, and all participants are asked to sign or place their fingerprint on a consent form. Consenting participants are interviewed confidentially by trained interviewers of the same gender in the local language, Luganda. Interviews typically last 90 to 120 minutes.

The survey consists of questions on sociodemographic characteristics, sexual risk behaviours, sexual partners, and reproductive health. Biological specimens including blood and genital swabs are collected for HIV and STI detection, and during the period under study, HIV test results were typically available to participants within a period of one to three weeks after samples were drawn. Since 2000, questions on violence in intimate relationships have been included in the survey, so data from all subsequent survey rounds (including 2000) will be included in this study. Refusal rates to participate in the survey are low, ranging from 6-7% for individual survey rounds. Initially no financial incentives were provided, although a bar of soap is provided to each participant as a gesture of appreciation for study participation. More recently, participants have been compensated 3000 Uganda shillings (~$1.50) for work time lost.

3.3 Ethics

Given the sensitive nature of data collected, several procedures have been developed in the RCCS to protect the confidentiality of information provided by respondents and to minimize

potential risks to respondents from study participation.[7] These include obtaining informed consent to participate at study enrolment and at each follow up; having highly trained interviewers of the same sex conduct the interviews in complete privacy without disclosure of any survey information to family or other community members; maintaining completed questionnaires in secure facilities; and coding interview schedules with participants' study identification numbers and keeping personal identifiers separate from interview schedules. There has also been an increase in the identification and availability of referral services over the course of the period under study.

The procedures of the RCCS are consistent with the World Health Organization's guidelines for research on violence against women, Putting Women First: Ethical and Safety Recommendations for Research on Domestic Violence Against Women.[55] Over the period under study, the RCCS was approved by institutional review boards (IRBs) in Uganda, the Scientific and Ethics Committee of the Uganda Virus Research Institute and the Uganda National Council of Science and Technology, and IRBs in the USA, initially Columbia University IRB and the Johns Hopkins University Committee of Human Research, and subsequently the Johns Hopkins Bloomberg School of Public Health IRB and the Western IRB.

Research Ethics Board approval for the analyses conducted for this thesis was obtained from the HIV Research Ethics Board at the University of Toronto in July 2010 and renewed in July 2011 (see letters of approval in Appendices 1 and 2). In terms of confidentiality, no personally identifiable information was available in the dataset used for these analyses. Data were stored on a password-protected computer and backed up frequently. Data will be stored for a minimum of five years subsequent to the completion of the study.

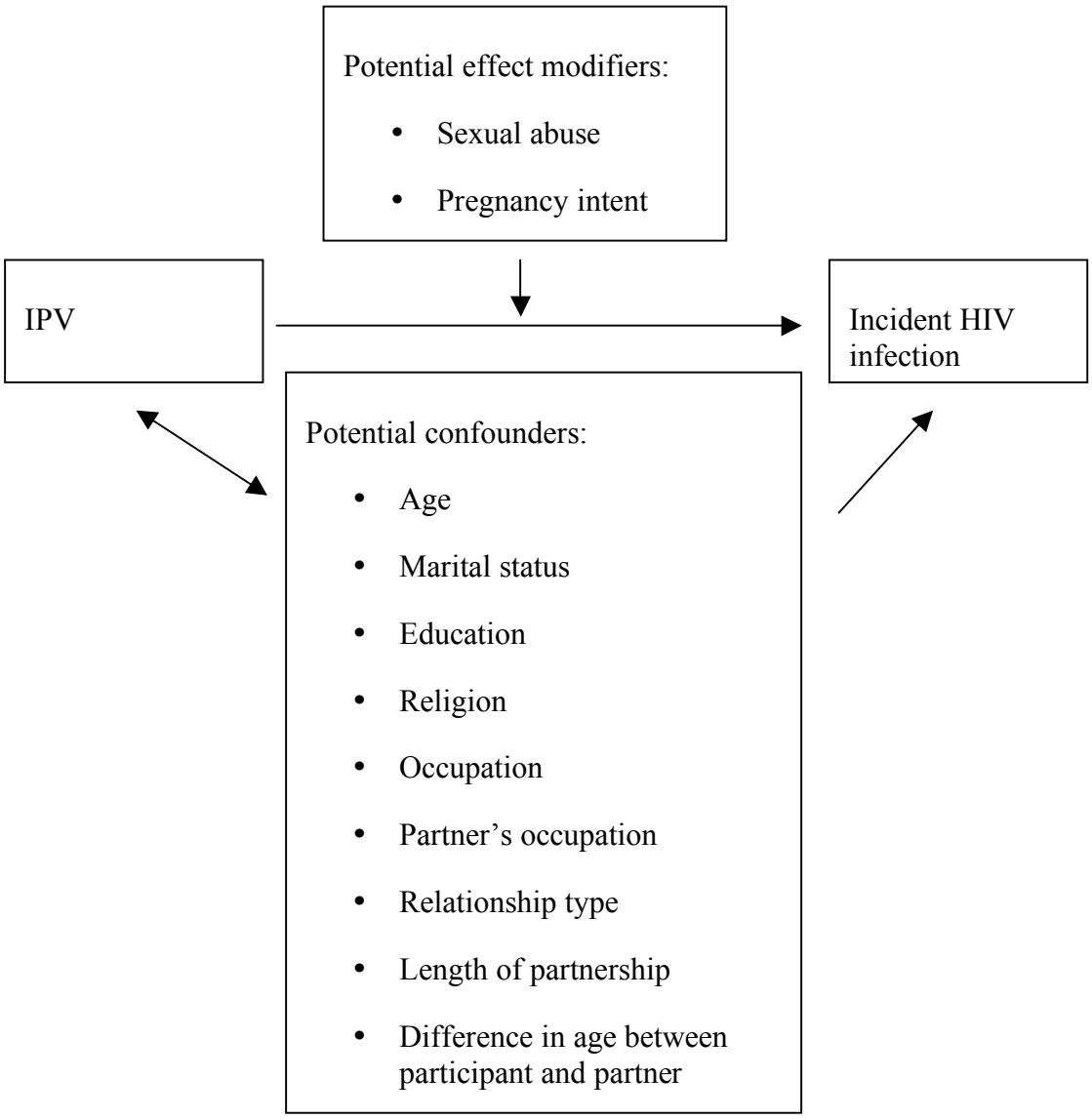
4 Chapter Four: Quantifying the Association between Intimate Partner Violence and HIV Infection

4.1 Objective 1

To estimate the risk of incident HIV infection among women experiencing violence in intimate partnerships compared to women who have not experienced violence in intimate partnerships in Rakai, Uganda.

4.2 Model of Objective 1

Figure 3. Model of hypothesized associations for Objective 1



4.3 Hypothesis

Women who have experienced IPV will be at greater risk of incident infection with HIV than women who have not experienced IPV.

4.4 Justification

As noted in Chapter 2, findings regarding an association between IPV and HIV infection have been inconsistent, which is likely due to methodological limitations of studies and the lack of external generalizability of results from certain settings. Longitudinal data from the RCCS can be used to address several of these issues, such as considering various forms of IPV, the temporal sequence of the associations, appropriately treating potentially confounding, effect modifying, and mediating variables, and having adequate statistical power. In this way, these data can be used to quantify the associations between forms of IPV and HIV.

4.5 Methods

4.5.1 Sample

Women who participated in the study between 2000 and 2009 (*i.e.* in RCCS rounds 7 to 13) were included in analyses if they were seronegative in 2000 (or at baseline if they entered the cohort subsequent to 2000), participated in at least two rounds during the period under study, and were in a sexual relationship for all or part of the period under study. Once a person became HIV-positive, further rounds of study participation were excluded from the analysis.

4.5.2 Variables

Definitions of variables included in data analyses and information on the rounds in which data on these variables were collected are provided in Appendix 3.

4.5.2.1 Outcome

HIV infection was defined as a positive result of two enzyme immunoassays (Vironostika HIV, Organon Teknika, Charlotte, North Carolina, USA, and Cambridge Biotech, Worcester, Massachusetts, USA), confirmed by Western blot (bioMérieux VITEK, St. Louis, Missouri,

USA) or RT-PCR (Roche, Molecular Systems, Branchburg, New Jersey, USA). All of the testing algorithms are associated with very high sensitivity and specificity. If HIV status was missing or the test result was indeterminate in a round in which the subject participated and negative in a subsequent round, HIV status was assumed to be negative. Otherwise, observations for participants with missing HIV status were excluded from the analyses.

4.5.2.2 Primary exposure

Intimate partner violence (IPV) was defined as any physical, sexual, or verbal violence by a partner in an intimate relationship, and was modelled in various ways: by type of IPV, *i.e.* physical, sexual, or verbal; severity of IPV; frequency of IPV; and period of exposure to IPV.

Questions on IPV which were used in the survey were modified from the Revised Conflict Tactics Scales (CTS2).[56, 57] For some analyses, types of violence were classified as minor or severe, consistent with the CTS2. The question on minor physical violence was whether a husband or partner had "pushed you, pulled you, slapped you or held you down," and severe physical violence questions were whether a husband or partner had "punched you with a fist or with something that could hurt you," "kicked you or dragged you," "tried to strangle you or burn you," or "attacked you with a knife, gun or other weapon." The question on minor verbal violence was whether a husband or partner had "verbally abused or shouted at you" and the question on severe verbal violence was whether a husband or partner had "threatened you with a knife, gun, or other weapon." Sexual violence was defined as a sexual partner having "used verbal threats to force you to have sex when you did not want to," "physically forced you to have sex when you did not want to," or "forced you to perform other sexual acts you did not want to do," all of which were considered severe. Questions were asked in all rounds about having experienced each type of violence in the past year, and in only a few rounds about having experienced each type of violence ever, *i.e.* for verbal and physical violence in Rounds 7 and 8 and for sexual violence in Rounds 8 and 9.

Questions about frequency of violence over the past year were also asked only in certain rounds, *i.e.* for verbal and physical violence in Rounds 7, 8, and 9, for sexual violence in Rounds 8 and 9, and for any of sexual, verbal, or physical violence in Round 13, with responses categorized as having experienced violent acts zero, one, two, three to five, six to 10, 11 to 20, or greater than 20 times.

For period of exposure to IPV, five time periods were examined: current year, past year, during the study up to the year before the current year, violence during the study to the year before the current year or prior to the study (including either or both of these periods, depending on available data), and ever. Data on having ever experienced all three types of IPV, *i.e.* physical, sexual, and verbal violence, were collected only in round 8.

4.5.2.3 Potential confounders

Potential confounders were defined *a priori* on the basis of theoretical considerations, *i.e.* on the basis of which variables were collected in the study and which variables have either been found to confound the association between violence and HIV in other studies or could putatively confound the association. Sociodemographic factors included age,[16-28, 31] marital status,[18, 19 22, 25, 27, 28, 31, 41] education,[16-19, 21, 23-28, 31, 41] religion,[16, 24] occupation,[31] and partner's occupation, and relationship factors with the primary sexual partner included type of relationship,[20, 27] length of partnership,[19] and difference in age.[17, 19, 21, 22, 26, 27] For participants who reported multiple partners in the past year, data about the partner with whom the participant reported having had sex most recently was used to determine the type of relationship with partner, alcohol use by partner, length of sexual partnership, and difference in age with partner; it was not possible to determine which specific partner (if any) had perpetrated IPV.

For sociodemographic factors, age was modelled as a continuous variable. Marital status was classified as never married, previously married, currently married in a polygamous relationship, and currently married in a monogamous relationship. Education was categorized as less than five

years of school, five to seven years of school, and secondary school or higher. Religion was categorized as Catholic, Protestant, Muslim, or other. Based on the number of people in each category, occupation was categorized for participants as agriculture, shopkeeper/trading/vending, housework, professional, student, home brewing/bar worker/bar owner, and other, and for partners as agriculture, shopkeeper/trading/vending, professional, student, home brewing/bar worker/bar owner, trucker, and other.

For relationship factors, the type of relationship with the primary sexual partner was classified as husband, current consensual partner, boyfriend, or other. Length of sexual partnership was categorized as less than four years, four to six years, or more than six years. A categorical variable was created for the difference in age between the participant and her partner, which was categorized as the partner being 10 or more years older, five years older to less than 10 years older, less than five years older, the same age, less than five years younger, or five or more years younger.

4.5.2.4 Potential effect modifiers

As with potential confounders, potential effect modifiers were identified *a priori* based on theoretical considerations and on which data had been collected in the RCCS. Two potential effect modifiers were examined: pregnancy intent and childhood or adolescent sexual abuse. Pregnancy intent was hypothesized to modify the association between IPV and HIV since women who were trying to conceive would putatively be less likely to use condoms, which might mediate the association between IPV and HIV, or since dynamics relevant to the IPV- HIV association might differ in relationships in which women intend to conceive. Childhood or adolescent sexual abuse was hypothesized to modify the association between IPV and HIV since women who experience abuse in childhood or early in their reproductive lives might differ from those who have not experienced such abuse in terms of their sexual risk behaviours, as per mechanism C in Figure 1 (and described in Chapter 2), or in terms of other aspects of relating to partners that may be relevant to the association between IPV and HIV infection.

Pregnancy intent was defined in follow up rounds as responding yes to "Are you trying to become pregnant?" for women who were not currently pregnant and yes to "Did you intend to have this pregnancy at this time?" for women who were pregnant at the time of the interview, and in baseline rounds as answering yes to "Have you currently been trying to become pregnant for more than 12 months without success?" for women who were not currently pregnant. Data on sexual abuse in childhood or adolescence were collected only in round 10 for those who had already participated in a prior round, and sexual abuse in childhood or adolescence was defined as a response of yes to the question "Thinking back to the time you were growing up till 18 years/ the time of first sex, were you ever sexually abused by a male?"

4.5.3 Statistical analysis

Descriptive analyses were done to examine participant characteristics, including comparison of the sample included in these analyses compared with the full study population, comparison of the frequency of sociodemographic and behavioural characteristics at baseline (*i.e.* the first round in which each participant participated of included rounds) for people who did and did not develop HIV during the study, description of the frequency of and overlap between various forms of IPV, and description of the rates of incident HIV infection for people experiencing specific forms of IPV. Wald tests were used to calculate confidence intervals for HIV infection rates.

To test the hypothesis that IPV predicts HIV infection, longitudinal data analyses (for repeated measures) were conducted, using a mixed model where the individual was treated as a random effect with an exchangeable correlation matrix. A model with random effects was selected over other ways to manage clustered data (*e.g.* generalized estimating equations) given the hypothesis that regression coefficients for IPV and HIV vary across individuals; there are likely unobserved factors that are common to all responses for a given person but which vary across people[58] which affect the likelihood of infection with HIV. Further, a random effect model is likely preferable in the context of unbalanced data, *i.e.* when the number of observations vary substantially between

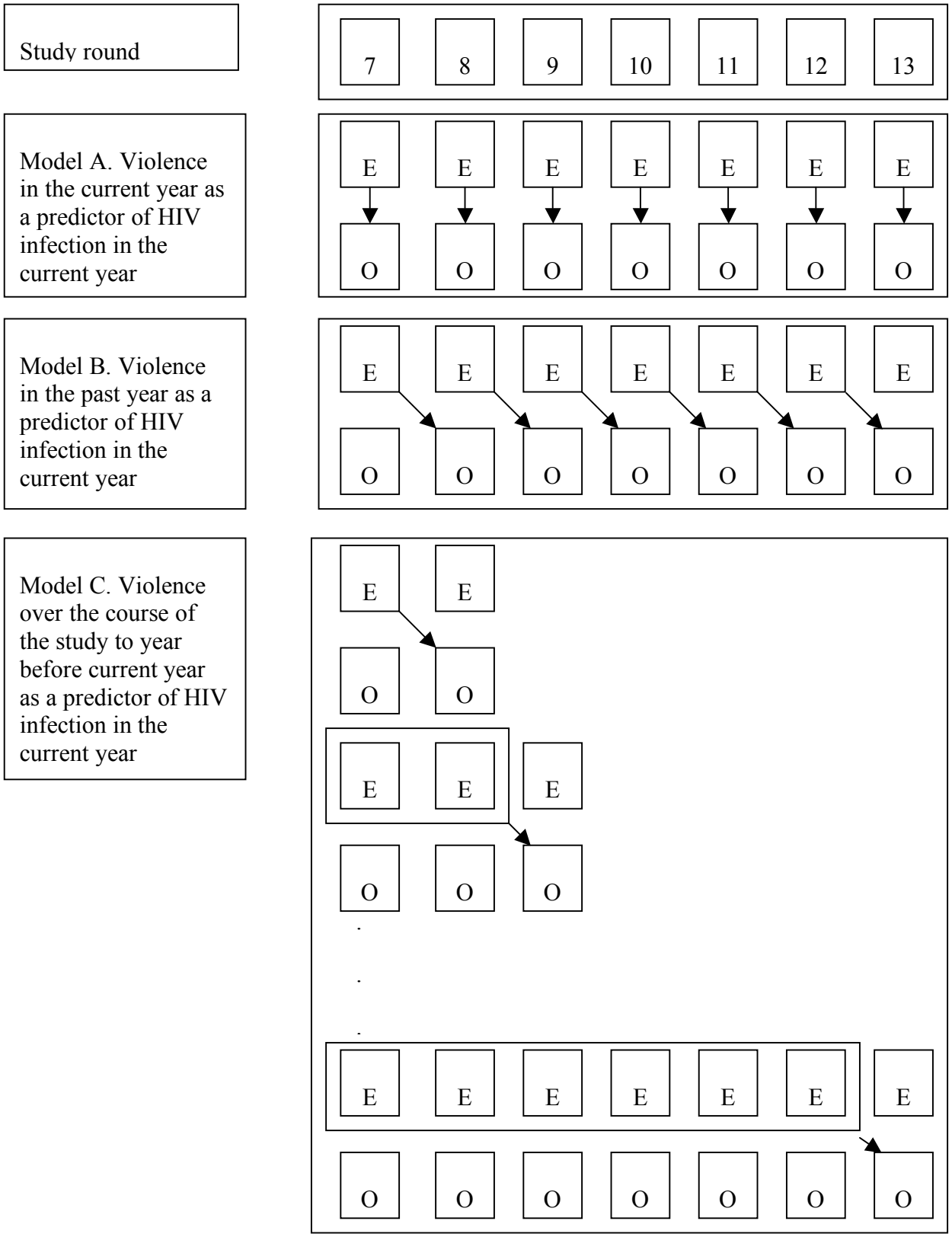
clusters.[59] Logistic regression was used across models to look at the odds of violence in women who acquired HIV compared to the odds of violence in women who did not acquire HIV. Data from all available rounds of participation were used for each participant, regardless of whether specific rounds were missed between rounds of participation. Since the outcome of interest was incident HIV infection, rounds of participation were excluded from the analysis after a person developed HIV. In bivariate analyses, potential confounders were assessed for association with the main exposure and the outcome. All covariates which were associated with both the exposure and outcome were included in a multivariable model, and covariates were considered for removal based on whether their removal individually or collectively changed the coefficient for the violence-HIV association by more than 10% to 15%,[60] first considering variables with the highest p values in the multivariable model.

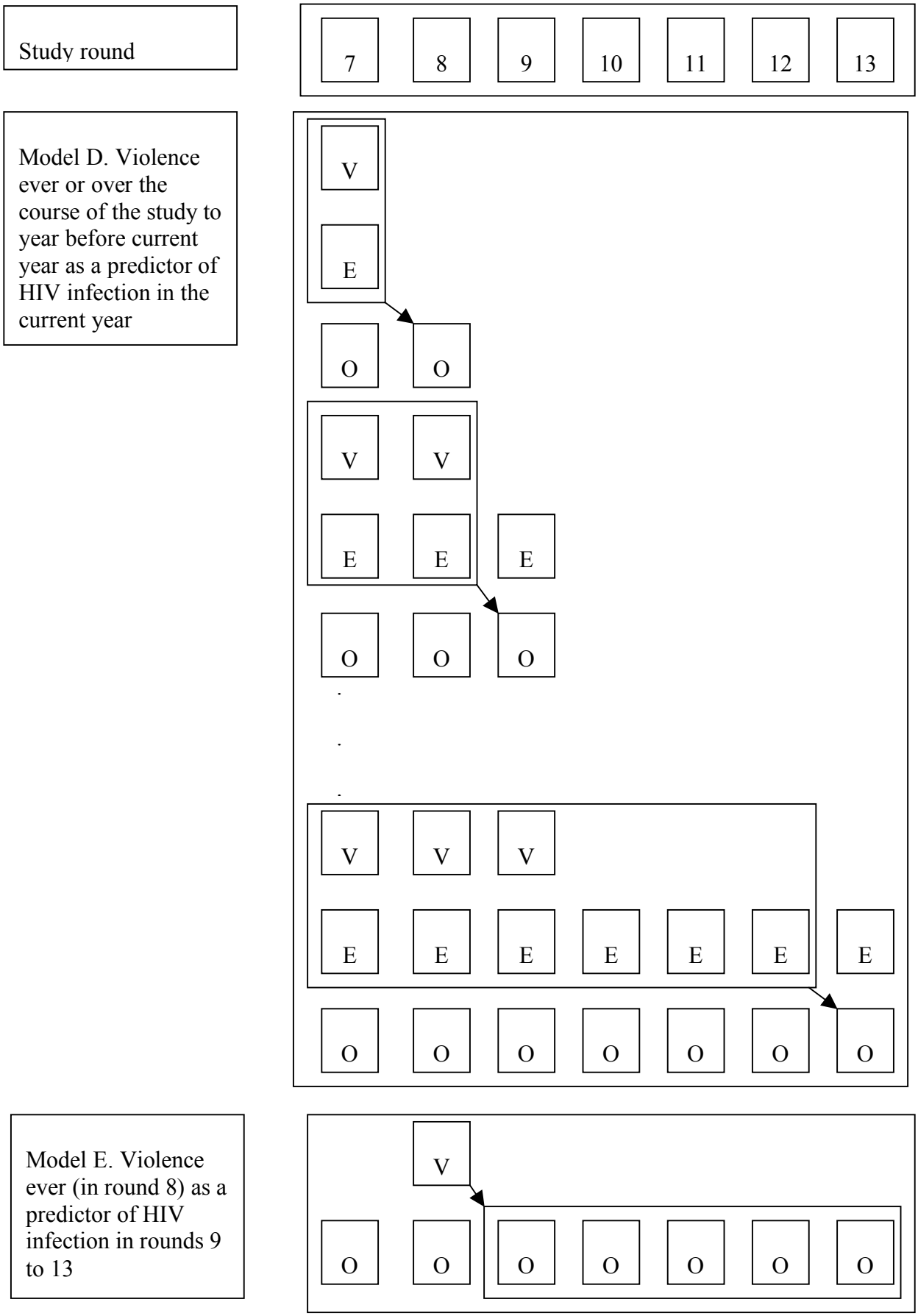
To assess whether putative confounders were functioning as effect modifiers in these data, all potential confounders were tested for interaction with IPV, by stratifying the model of IPV and HIV by category of each potential variable to look for qualitatively different relationships, and, in some cases, by looking at the statistical significance of an interaction term in the full multivariable model. Sexual abuse in childhood or adolescence and pregnancy intent were assessed as potential effect modifiers in stratified analyses for each of these variables, specifically assessing for multiplicative interaction, *i.e.*, when the relative difference (*i.e.* risk or odds ratio) in the exposure and outcome association differs based on whether the potential effect modifier is present, and for additive interaction, *i.e.*, when the absolute difference in risk of the outcome between those exposed and not exposed is heterogeneous based on the presence of the effect modifier.[61]

To examine the nature of violence (with respect to risk of HIV infection), IPV was modelled in several ways in regression analyses: by timing of exposure, by type, by severity, and by frequency. For timing of exposure, five ways of modelling violence were examined, as shown in Figure 4. Longitudinal data analysis was used to look at four types of exposure: violence in the current year as a predictor of HIV infection in the current year, violence in the past year as a predictor of HIV infection in the current year, violence during the study up to the year before the

current year as a predictor of HIV infection in the current year, violence during the study to the year before the current year or prior to the study (including either or both of these periods, depending on available data). Non-longitudinal analysis was used to look at violence ever as a predictor of HIV over subsequent rounds of the study, using data from round 8 only, which as noted already was the only round which included questions about ever having experienced all three forms of violence. Multiple approaches were used to model type of IPV: any IPV compared to no IPV; sexual IPV compared to no IPV; verbal IPV compared to no IPV; physical IPV compared to no IPV; any minor IPV and any severe IPV, compared to no IPV; any minor physical IPV and any severe physical IPV, compared to no IPV; and any minor verbal IPV and any severe verbal IPV, compared to no IPV.

Figure 4. Models of timing of exposure to IPV, where E=exposure in past year, V=exposure ever, and O=outcome




Study round
7
8
9
10
11
12
13
Model D. Violence ever or over the course of the study to year before current year as a predictor of HIV infection in the current year
V
E
O
O
V
V
E
E
E
O
O
O
V
V
V
E
E
E
E
E
E
E
O
O
O
O
O
O
O
Model E. Violence ever (in round 8) as a predictor of HIV infection in rounds 9 to 13
V
O
O
O
O
O
O
O

To assess whether a history of IPV or IPV during the study independently affect the risk of infection with HIV, logistic regression analysis was done to test the association for women who reported IPV ever (in round 8) and no current IPV, no IPV ever and current IPV, or IPV ever and current IPV, each compared with women who reported no IPV ever and no current IPV.

To assess whether using the date of first positive test resulted in different estimates than other measures of the time of infection, sensitivity analyses were done. The midpoint date between the last HIV negative test result and the first HIV positive test result was calculated for people who acquired HIV over the course of the study, and the round of infection was then modelled as the round which was taking place on that date.

Tests for linear trend of odds across coefficients of a categorical variable, *i.e.* for the frequency of violence as a predictor of HIV infection, were conducted by testing nested models of the variable as categorical or continuous with a likelihood ratio test, and in consideration of the coefficient for treating the ordinal variable as a continuous variable.[60]

To estimate the proportion of cases of HIV which was associated with IPV exposure, the population attributable risk fraction was calculated, as the difference between the unadjusted incidence rate of HIV in the whole sample included in the study, *i.e.* the risk in the population, and the unadjusted incidence rate of HIV in women in the study who did not experience violence ever, *i.e.* the risk in the unexposed, divided by the unadjusted incidence rate of HIV in the whole sample included in the study, *i.e.* the risk in the population. Confidence intervals were obtained using the Walter method.[62, 63] To estimate the proportion of cases of HIV which were causally associated with IPV exposure, the adjusted population attributable risk fraction was calculated as the exposure prevalence among cases, p_c, times the adjusted relative risk of HIV infection for women exposed to IPV ever compared to women not exposed to IPV ever minus one, RR-1, divided by the adjusted relative risk of HIV infection for women exposed to IPV ever compared to women not exposed to IPV ever, RR.[64] The adjusted relative risk was obtained from a Poisson repeated measures model with individual treated as a random effect and controlling for

confounding variables. For the adjusted population attributable risk fraction, 95% confidence intervals were calculated by using the upper and lower 95% confidence intervals for the relative risk in the same formula.

Several analyses were undertaken to examine the extent of missing data and the influence of missing data on the associations of interest. First, rates of follow up were calculated by experience of IPV for each round after the initial round of participation, for all rounds after the initial round of participation, and in the final round, as a means of identifying whether data were missing completely at random. Second, a sensitivity analysis was performed using plausible values of the incidence rates of HIV in participants who were lost to follow up, to see how estimates of the relative association between IPV and HIV would change. Values were selected to represent a range of likely incidence rates, based on the incidence rates of HIV in people who were not lost to follow up (by history of exposure to IPV), and the estimated incidence rates in the overall population in Uganda over this period.[6] Third, participants were stratified by number of rounds of participation, and frequency of IPV and incidence of HIV were calculated in their final year of participation. Adjusted odds of HIV infection for participants experiencing IPV compared to participants not experiencing IPV were calculated using repeated measures analyses, as described above for the whole sample, using four periods of exposure to violence: the current year, the past year, during the study to date, and ever or during the study to date. Finally, multiple imputation was performed for the exposure, any IPV, with 10 iterations and using the multivariate normal distribution method, which is based on a Markov chain Monte Carlo method, which "simulat[es] from a Bayesian (approximate) posterior predictive distribution of missing data," given the observed data.[65-67] Variables used to impute data were the exposure (IPV), outcome (HIV test result), and covariates to be included in the analytic model, *i.e.* marital status, and difference in age between the participant and her partner. Repeated measures analysis was then conducted of the multiply imputed data.

All analyses were conducted using Stata 11.

4.5.4 Power

Sample size estimation was done prior to the start of the study, using the following formula for each exposure group, which is appropriate for longitudinal studies with binary outcome variables:[68]

$$m=\frac{[z_{\alpha}\{2[(p_A+p_B)/2][1-(p_A+p_B)/2][1+(n-1)\rho]\}^{1/2}+z_{\beta}^{1/2}]^2}{nd^2}$$

where m=the number of subjects needed per group, d= the smallest meaningful difference to be detected, n=the number of repeated observations per person, ρ= correlation, p_A= the HIV incidence in the exposed group, and p_B= the HIV incidence in the unexposed group.

In the sample included in these analyses (as described subsequently in this chapter), the HIV incidence in the group exposed to IPV during the study, p_A, was 0.056 (*i.e.* 5.6%), and the HIV incidence in the group that did not experience any IPV during the study, p_B, was 0.0461, so the difference between these groups, d, is 0.01. Seven study rounds were included, which means n is seven. With a correlation, ρ, of 0.3, 2996 subjects are needed in each of the exposed and unexposed groups, and with a correlation of 0.5, 4292 subjects are needed in each of the exposed and unexposed groups, for two-sided type I error of 0.05 and beta of 0.2. Given that there are almost five thousand participants who experienced IPV and five thousand participants who did not experience IPV, the study is adequately powered to address the primary objective.

4.6 Results

4.6.1 Descriptive analysis

Of 20,584 women included in the study from 2000 to 2009, 10,256 (49.8%) met criteria for inclusion in these analyses, as shown in Appendix 4. Compared with the original population (excluding those younger than 15 and older than 49), this sample of women included

proportionately fewer people younger than 24 (54.5% compared with 57.5%, $p<0.001$), and more people who had ever been married (79% vs. 70.3%, $p=0.0000$). There was no statistically significant difference in the proportion of women with less than five years of education (24% vs. 25.3%, $p=0.22$). Each woman participated in an average of 3.9 rounds during the period under study with a total of 39612 rounds of participation for all subjects. Characteristics of participants in the first round of participation during the period under study are described in Table 1.

Table 1. Characteristics of participants at baseline (N=10,256), stratified by HIV status by the end of the study

		Total		HIV-		HIV+		p value*
		n	%	n	%	N	%	
		9980	100	9463	94.8	517	5.2	-
Demographic characteristics								
Age	15-19	2661	26.0	2481	26.2	122	23.6	0.000
	20-24	2921	28.5	2671	28.2	168	32.5	
	25-34	3046	29.7	2792	29.5	174	33.7	
	35+	1628	15.9	1519	16.1	53	10.3	
Education	<5 years	2624	25.7	2414	25.6	136	26.4	0.33
	5-7 years	4403	43.2	4060	43.1	234	45.4	
	>7 years	3175	31.1	2943	31.3	145	28.2	
Marital status	Never married	2161	21.1	1963	20.7	136	26.3	0.000
	Previously married	1048	10.2	924	9.8	89	17.2	
	Currently married- polygamous	1609	15.7	1483	15.7	88	17.0	
	Currently married- monogamous	5438	53.0	5093	53.8	204	39.5	
Religion	Catholic	6033	59.1	5550	58.9	330	64.1	0.04
	Protestant	2139	21.0	1973	21	105	20.4	
	Muslim	1632	16.0	1513	16.1	68	13.2	
	Other	400	3.9	383	4.1	12	2.30	

-continued-

Table 1 continued

		Total		HIV-		HIV+		p value*
		n	%	n	%	n	%	
Occupation	Agriculture	6256	61.0	5801	61.3	300	58.0	0.000
	Shopkeeper/ trading/ vending	803	7.8	730	7.7	47	9.1	
	Housework	603	5.9	546	5.8	38	7.4	
	Professional	697	6.8	642	6.8	29	5.6	
	Student	847	8.3	800	8.5	24	4.6	
	Home brewing/bar worker/owner	161	1.6	130	1.4	26	5.0	
	Other	888	8.7	813	8.6	53	10.3	
Partner's occupation	Agriculture	2908	30.0	2692	30.2	134	27.0	0.14
	Shopkeeper/ trading/ vending	2560	26.4	2366	26.5	137	27.6	
	Professional	1155	11.9	1063	11.9	57	11.5	
	Student	266	2.8	240	2.7	9	1.8	
	Home brewing/bar worker/owner	100	1.0	91	1.0	6	1.2	
	Trucker	371	3.8	325	3.6	29	5.8	
	Other	2325	24.0	2146	24.1	125	25.2	
Relationship characteristics								
Type of relationship	Husband	5154	52.9	4823	53.7	181	36.0	0.000
	Current consensual partner	2085	21.4	1923	21.4	123	24.5	
	Boyfriend	2333	23.9	2074	23.1	186	37.0	
	Other	179	1.8	159	1.8	13	2.6	
Length of time in relationship	<3 years	3099	37.4	2837	37.1	193	47.5	0.000
	4-6 years	1728	20.8	1594	20.8	81	20.0	
	>6 years	3465	41.8	3222	42.1	132	32.5	

-continued-

Table 1 continued

		Total		HIV-		HIV+		p value*
		n	%	n	%	n	%	
Partner age difference	Same age	540	7.0	492	6.9	30	7.4	0.93
	≥10 years older	1173	15.3	1076	15.2	62	15.4	
	5-9 years older	2220	28.9	2057	29.0	117	29.0	
	<5 years older	3490	45.4	3216	45.4	178	44.1	
	<5 years younger	220	2.9	203	2.9	15	3.7	
	≥5 years younger	48	0.6	46	0.7	2	0.5	
HIV risk factors								
Woman's use of alcohol before sex	No	7041	72.7	6518	73.0	329	66.1	0.001
	Yes	2649	27.3	2406	27.0	169	33.9	
Partner's use of alcohol before sex	No	4446	49.4	4116	49.7	205	43.2	0.01
	Yes	4564	50.7	4167	50.3	270	56.8	
Condom use in past year	None	6900	76.3	6407	76.8	318	70.2	0.01
	Sometimes	1402	15.5	1287	15.4	88	19.4	
	Always	736	8.1	654	7.8	47	10.4	
Number of partners in past year	One	8661	93.6	8002	93.7	419	89.5	0.000
	More than one	595	6.4	540	6.3	49	10.5	

*p value is from Pearson chi square tests

In fewer than 5% of years on which data are available (N=36428 years), women reported having had more than one partner. For the 1627 years of observation in which women reported having more than one partner, the partner with whom the woman reported having had intercourse most recently was the husband in 343 of 826 years (41.5%) of observations for married women.

The prevalence of self-reported IPV is described in Table 2. Of the 10,200 women for whom data were available on IPV ever (*i.e.* 99.5% of the 10256 women included in study), 58.9% reported having experienced IPV. More than half of women (53.0%) experienced verbal IPV, while more than a third reported each of physical IPV and sexual IPV (44.7% and 35.1%, respectively). Of the 10,177 women for whom data were available on all types of violence over the study period, 5628 (55.3%) experienced any IPV over the course of their participation in the study, and the proportion of women who experienced sexual, verbal, and physical abuse during the study were similar to the proportion of women who experienced IPV ever. Regarding IPV in the past year, 2906 (28.5%) reported any violence, and 1631 (16.0%) reported sexual violence, 2287 reported verbal violence (22.5%), and 1714 reported physical violence (16.8%).

Table 2. Reported experiences of IPV by study participants, n/N (%)

Type of violence	Past year*	Over study period	Ever
Any sexual, verbal, or physical	2906/10200 (28.5)	5628/10177 (55.3)	6008/10200 (58.9)
Any sexual	1631/10195 (16.0)	3573/10195 (35.1)	3573/10195 (35.1)
Any verbal	2287/10175 (22.5)	4679/10175 (46.0)	5397/10185 (53.0)
Any physical	1714/10176 (16.8)	3518/10176 (34.6)	4555/10185 (44.7)

*Data from last round on which violence data are available for each individual.

Most women experienced more than one form of IPV in the same period. In the last year of participation for the 2906 women who experienced IPV, 764 (26.3%) experienced only verbal violence, 58 (2.0%) only physical violence, and 270 (9.3%) only sexual violence, while 460 (15.8%) experienced both verbal and physical violence, 298 (10.2%) physical and sexual violence, and 165 (5.7%) verbal and sexual violence. Eight hundred ninety-eight women (30.9%) experienced all three forms of violence.

Data on the frequency of violence were available only for a limited number of rounds; of the 10658 rounds in which women reported experiencing any violence, data on frequency were

available for only 4475 rounds (46.6%). Looking at all rounds when violence was experienced, violence occurred only once in the past 12 months in 19.8% of rounds (884), twice in 19.3% (864), three to five times in 30.7% (1375), six to 10 times in 14.0% (627), 11 to 20 times in 5.3% (237), and more than 20 times in 10.9% of rounds (488). Looking at people who experienced violence over the course of the study with data available on frequency in at least some rounds, 17.5% (534) experienced violence at most once over the course of a year, 17.6% (538) at most twice, 29.8% (912) at most three to five times, 15.5% (475) at most six to 10 times, 6.1% (185) at most 11 to 20 times, and 13.5% (413) at most more than 20 times over the course of a year.

HIV test results were available for 34,615 of 39,612 rounds of observation (87.4%) included in these analyses, or 9,980 of 10,256 women (97.3%). HIV status was imputed for 3,593 rounds (9.0%) for which HIV status was missing when women had a subsequent negative test, yielding a total of 38,208 test results. Five hundred seventeen participants, *i.e.* 5.2% of those with known HIV status and 5.0% overall, acquired HIV over the course of the study. As shown in Table 3, for all three forms of violence and for any violence, incident HIV infections tended to occur more often when women had experienced violence in the past year compared with years when women didn't experience violence, though the difference was only significant for verbal violence and physical violence. However, the rate of infection was not consistently higher in women who experienced any violence over the study period compared with women who didn't experience any violence over the study period, and the difference was not statistically significant for any form of violence.

Table 3. HIV incidence by type of IPV experienced, by exposure to IPV in the past year or during the study

Type of violence		IPV in past year*					IPV over study				
		HIV cases	Person years (PYs)	Incidence per 100 PYs	95% CI‡	p value	HIV cases	Person years (PYs)†	Incidence per 100 PYs	95% CI‡	p value
Any sexual, verbal, or physical	No	342	24160	1.42	1.27, 1.57		223	20267	1.10	0.96, 1.24	
	Yes	172	10658	1.61	1.38, 1.87	0.16	308	28194	1.09	0.97, 1.22	0.93
Any sexual	No	406	24853	1.63	1.48, 1.80		310	27810	1.11	0.99, 1.24	
	Yes	97	5354	1.81	1.47, 2.21	0.36	198	18487	1.07	0.93, 1.23	0.66
Any verbal	No	359	25348	1.42	1.27, 1.56		241	22464	1.07	0.94, 1.22	
	Yes	140	7220	1.94	1.62, 2.26	0.00	263	23804	1.10	0.98, 1.25	0.74
Any physical	No	383	28176	1.36	1.22, 1.49		304	28181	1.08	0.96, 1.20	
	Yes	116	5075	2.29	1.87, 2.70	0.00	202	18082	1.12	0.96, 1.27	0.70

*Individuals contributed time to both yes and no categories if they experienced violence only in certain years of their participation in the study. Cases of HIV were considered to be associated with violence if violence took place in the year in which HIV infection occurred. †For this table, person years at risk of HIV infection were calculated as the difference between participation in the first and last rounds, not excluding time when the person missed rounds. ‡95% confidence intervals calculated using Wald method.

4.6.2 Regression models

Of the covariates assessed, age and education level were not associated with HIV status, so they were excluded from multivariable models. Marital status and difference in age between the participant and her partner were found to consistently confound the association between IPV and HIV in multivariable models, so they were controlled for in all adjusted analyses.

4.6.2.1 Violence in the current year as a predictor of HIV infection in the current year

In bivariate analyses, women experiencing any IPV had an odds 1.09 times (0.87, 1.39) greater of acquiring HIV than women who experienced no violence, as shown in Table 4. After adjusting for confounders, the association between any violence and HIV increased to 1.32 (1.05, 1.67). Looking at the experience of each of the three forms of violence compared to no violence, adjusted for confounding, sexual violence was associated with an OR of 1.24 (0.90, 1.70), physical violence with an OR of 1.74 (1.30, 2.34), and verbal violence with an OR of 1.45 (1.13, 1.86), though only the associations for physical and verbal violence were statistically significant.

Looking at categories of severity of violence, there were statistically significant associations for any severe violence with HIV infection, with an OR of 1.41 (1.09, 1.83), and for severe physical violence with an OR of 2.41 (1.62, 3.57). Minor verbal violence was also significantly associated with HIV infection with an OR of 1.45 (1.12, 1.86). The associations for severe violence with HIV infection were stronger than the associations for minor violence for each of any violence, physical violence, and verbal violence, however, confidence intervals overlapped between minor and severe violence in these three models.

Table 4. Longitudinal data analysis of IPV in the current year as a predictor of incident HIV infection in the current year (with shading in gray for p<0.05)

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model†	Adjusted OR‡ (95% CI) p value	N in model †
1	None	325	23483	34141	1	26163, 9507	1	22021, 8832
	Any sexual, verbal or physical	168	10658	34141	1.09 (0.87, 1.39) 0.45		1.32 (1.05, 1.67) 0.02	
2	None	325	23483	28837	1		1	19102, 8283
	Any sexual	94	5354	28837	0.97 (0.70, 1.35) 0.88	22669, 8955	1.24 (0.90, 1.70) 0.19	
3	None	325	23483	29142	1		1	18994, 8238
	Any physical	112	5659	29142	1.47 (1.09, 1.98) 0.01	22475, 8899	1.74 (1.30, 2.34) 0.000	
4	None	325	23483	31959	1		1	20568, 8497
	Any verbal	137	8476	31959	1.19 (0.92, 1.54) 0.20	24374, 9148	1.45 (1.13, 1.86) 0.004	
5	None	325	23483	34141	1	26163, 9507	1	22021, 8832
	Any minor	51	3942	34141	0.98 (0.69, 1.40) 0.93		1.16 (0.81, 1.66) 0.43	
	Any severe	117	6716	34141	1.16 (0.89, 1.51) 0.28		1.41 (1.09, 1.83) 0.01	

-continued-

Table 4 continued

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model†	Adjusted OR‡ (95% CI) p value	N in model†
6	None	325	23483	29142	1	22475, 8899	1	18994, 8238
	Any minor physical	55	3463	29142	1.11 (0.76, 1.62) 0.60		1.36 (0.94, 1.97) 0.11	
	Any severe physical	57	2196	29142	2.13 (1.43, 3.17) 0.000		2.41 (1.62, 3.57) 0.000	
7	None	325	23483	31959	1	24374, 9148	1	20568, 8497
	Any minor verbal	131	7755	31959	1.18 (0.91, 1.52) 0.22		1.45 (1.12, 1.86) 0.004	
	Any severe verbal	6	721	31959	1.76 (0.61, 5.04) 0.30		1.53 (0.49, 4.80) 0.47	

*n is number of years of observation for this category and N is the number of years of observation available for this variable. †N in model is number of observations, number of groups (*i.e.* women). ‡Adjusted for: marital status and difference in age between participant and her partner.

There was no clear trend in the odds of HIV infection with an increase in the frequency of any, verbal, physical, or sexual violence, respectively, in the current year. For any violence, the odds ratios were 1.64 (0.79, 3.41) for violence once in the past year compared with no violence, 0.55 (0.20, 1.49) for violence twice, 1.32 (0.70, 2.46) for violence three to five times, 0.61 (0.18, 2.03) for violence six to 10 times, and 0.40 (0.08, 2.12) for violence more than 20 times, with a non-significant test for linear trend (p=0.27). There were no cases of HIV in people who experienced violence 10 to 20 times.

Using the round in the middle of the last negative HIV test and the first positive HIV test instead of the first round in which HIV was detected, the association between violence and HIV

infection was similar for any violence, sexual violence, physical violence and verbal violence. For any violence compared to no violence, the odds ratio was 1.44 (1.15, 1.80).

4.6.2.2 Violence in the past year as a predictor of HIV infection in the current year

The odds ratio of HIV infection for women experiencing any IPV in the past year was 1.35 (1.04, 1.76) compared with women who didn't experience any violence, after controlling for confounders. Women experiencing any sexual violence and women experiencing physical violence odds of infection of 1.10 (0.77, 1.59) and 1.30 (0.93, 1.82), respectively, compared to women who didn't experience any violence. Verbal violence was associated with an adjusted odds ratio of 1.45 (1.08, 1.93).

Looking at the severity of violence, the odds of infection were similar for women experiencing any severe violence compared to any minor violence. Women experiencing any minor physical violence didn't have an odds of infection higher than those who didn't experience violence, with an OR of 1.09 (0.72, 1.64), whereas women experiencing any severe physical violence were at increased odds of infection, with an OR of 1.71 (1.10, 2.66). For verbal violence, severe violence was associated with a greater odds of infection than minor violence, compared to no violence, however, the difference between severe verbal violence and minor verbal violence was not statistically significant.

Table 5. Longitudinal data analysis of IPV in the past year as a predictor of incident HIV infection in the current year (with shading in gray for p<0.05)

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model†	Adjusted OR‡ (95% CI) p value	N in model†
1	None	215	15669	23029	1	21047, 7815	1	17711, 7258
	Any sexual, verbal or physical	121	7360	23029	1.17 (0.89, 1.54) 0.25		1.35 (1.04, 1.76) 0.03	
2	None	215	15669	19193	1	17454, 7096	1	14640, 6526
	Any sexual	51	3524	19193	1.03 (0.71, 1.50) 0.86		1.10 (0.77, 1.59) 0.60	
3	None	215	15669	19418	1	17749, 7301	1	14940, 6723
	Any physical	66	3749	19418	1.24 (0.88, 1.74) 0.22		1.30 (0.93, 1.82) 0.12	
4	None	215	15669	21555	1	19742, 7667	1	16644, 7100
	Any verbal	101	5886	21555	1.23 (0.91, 1.65) 0.18		1.45 (1.08, 1.93) 0.01	
5	None	215	15669	23029	1	21047, 7815	1	17711, 7258
	Any minor	47	2817	23029	1.20 (0.82, 1.75) 0.34		1.46 (1.02, 2.10) 0.04	
	Any severe	74	4543	23029	1.15 (0.83, 1.59) 0.39		1.28 (0.93, 1.75) 0.13	

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Table 5 continued

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model†	Adjusted OR‡ (95% CI) p value	N in model†
6	None	215	15669	19418	1	17749, 7301	1	14940, 6723
	Any minor physical	35	2330	19418	1.03 (0.66, 1.59) 0.91		1.09 (0.72, 1.64) 0.70	
	Any severe physical	31	1419	19418	1.61 (1.00, 2.59) 0.05		1.71 (1.10, 2.66) 0.02	
7	None	215	15669	21555	1	19742, 7667	1	16644, 7100
	Any minor verbal	85	5283	21555	1.18 (0.87, 1.60) 0.29		1.38 (1.03, 1.86) 0.03	
	Any severe verbal	16	603	21555	1.69 (0.87, 3.26) 0.12		2.08 (1.07, 4.03) 0.03	

*n is number of years of observation for this category and N is the number of years of observation available for this variable. †N in model is number of observations, number of groups (*i.e.* women). ‡Adjusted for marital status and difference in age between participant and her partner.

There was no clear trend in the odds of HIV infection with increasing frequency of violence in the past year for any, sexual, verbal, or physical violence. The odds ratios were 1.46 (0.71, 3.01) for any violence once compared with no violence, 1.56 (0.75, 3.25) for violence twice, 0.93 (0.45, 1.90) for violence three to five times, 1.19 (0.46, 3.11) for violence six to 10 times, and 2.16 (0.93, 5.04) for violence more than 20 times, with a non-significant test for linear trend (p=0.33). There were no cases of HIV in women who experienced violence 11 to 20 times.

Using the round in the middle of the last negative HIV test and the first positive HIV test instead of the first round in which HIV was detected, the results were similar for any violence in the past year compared to no violence, with an odds ratio of 1.40 (1.07, 1.82).

4.6.2.3 Violence during the study prior to the current year as a predictor of HIV infection in current year

There was an independent association between experiencing any violence over the course of the study before the current year and HIV infection in the current year, with an adjusted OR of 1.58 (1.18, 2.12). Women experiencing each form of violence also had a higher odds of HIV infection than women who experienced no violence, with odds ratios of 1.54 or higher for each type of violence, as shown in Table 6.

After controlling for confounders, women experiencing any severe violence had an odds ratio of 1.79 (1.29, 2.49) for HIV infection compared with women experiencing no violence, and women experiencing any minor violence had an odds ratio of 1.18 (0.78, 1.79) compared with women experiencing no violence. Severe physical violence and severe verbal violence were each independently associated with HIV infection compared to no violence with similar odds ratios greater than 2.4. For any violence, physical violence, and verbal violence, respectively, the association between severe violence and HIV infection was greater than the association between minor violence and HIV infection, though the difference in odds of HIV infection between minor violence and severe violence was not statistically significant.

Table 6. Longitudinal data analysis of IPV during the study prior to the current year as a predictor of incident HIV infection (with shading in gray for p<0.05)

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model‡	Adjusted OR† (95% CI) p value	N in model‡
1	None	172	12053	24875	1	22451, 8188	1	18891, 7608
	Any sexual, verbal or physical	237	12822	24875	1.80 (1.33, 2.43) 0.000		1.58 (1.18, 2.12) 0.002	
2	No violence	172	12053	19417	1	17371, 6945	1	14580, 6384
	Any sexual	139	7364	19417	1.81 (1.29, 2.55) 0.001		1.54 (1.11, 2.12) 0.009	
3	No violence	172	12053	19061	1	17261, 7166	1	14526, 6555
	Any physical	135	7008	19061	1.94 (1.36, 2.77) 0.000		1.75 (1.23, 2.50) 0.002	
4	No violence	172	12053	22435	1	20358, 7848	1	17142, 7252
	Any verbal	198	10382	22435	1.85 (1.35, 2.54) 0.000		1.71 (1.25, 2.35) 0.001	
5	None	172	12053	24875	1	22451, 8188	1	18891, 7608
	Any minor	55	3722	24875	1.22 (0.80, 1.88) 0.35		1.18 (0.78, 1.79) 0.4	
	Any severe	182	9100	24875	2.13 (1.53, 2.96) 0.000		1.79 (1.29, 2.49) 0.000	

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Table 6 continued

Model	Type of violence	Cases of HIV	n*	N*	Unadjusted OR (95% CI) p value	N in model‡	Adjusted OR† (95% CI) p value	N in model‡
6	No violence	172	12053	19061	1	17261, 7166	1	14526, 6555
	Any minor physical	65	4081	19061	1.59 (1.02, 2.48) 0.04		1.37 (0.91, 2.07) 0.13	
	Any severe physical	70	2927	19061	3.13 (1.93, 5.06) 0.000		2.41 (1.52, 3.82) 0.000	
7	No violence	172	12053	22435	1	20358, 7848	1	17142, 7252
	Any minor verbal	148	8320	22435	1.70 (1.22, 2.38) 0.002		1.54 (1.11, 2.14) 0.01	
	Any severe verbal	50	2062	22435	2.77 (1.62, 4.75) 0.000		2.64 (1.58, 4.40) 0.000	

*n is number of years of observation for this category and N is the number of years of observation available for this variable. †Adjusted for marital status and difference in age between participant and her partner. ‡N in model is number of observations, number of groups (*i.e.* women).

The odds of HIV infection increased with having experienced more frequent violence in at least one year over the course of the study, which was true for any violence, sexual violence, verbal violence, and physical violence. Odds ratios were 0.82 (0.44, 1.54) for having experienced any violence at most once in at least one year, 1.28 (0.72, 2.26) for violence twice, 1.50 (0.97, 2.31) for violence between three and five times, 1.90 (1.08, 3.32) for violence between six and 10 times, 1.16 (0.46, 2.96) for violence between 11 and 20 times, and 3.19 (1.86, 5.47) for violence more than 20 times in at least one year, with a significant test for linear trend (p=0.000).

Using the round in the middle of the last negative HIV test and the first positive HIV test instead of the first round in which HIV was detected, the results for any violence compared to no violence over the course of the study were slightly lower than the results for analyses using HIV

test in the round when first positive, with an odds ratio of 1.45 (1.08, 1.96) compared with 1.58 (1.18, 2.12), though the difference was not statistically significant.

4.6.2.4 Violence ever or during study prior to the current year as a predictor of HIV infection in the current year

Women who had experienced any violence ever or during the study had an odds ratio of HIV infection of 1.54 (1.14, 2.09) compared with women who hadn't experienced violence. There were significant independent associations between any sexual violence, any physical violence, and any verbal violence, respectively, and HIV infection, with odds ratios all above 1.5. Women who experienced any minor violence or any minor physical violence did not have a higher odds of HIV infection compared to those who experienced no violence, with odds ratios close to one. In contrast, any severe violence, any severe physical violence, any minor verbal violence, and any severe verbal violence were each independently associated with HIV infection.

Table 7. Longitudinal data analysis of reported IPV ever* or during the study prior to the current year as a predictor of incident HIV infection (with shading in gray for p<0.05)

Model	Type of violence	Cases of HIV	n†	N†	Unadjusted OR (95% CI) p value	N in model‡	Adjusted OR§ (95% CI) p value	N in model‡
1	None	152	10435	24837	1	22428, 8180	1	18771, 7599
	Any sexual, verbal or physical	256	14402	24837	1.69 (1.24, 2.29) 0.001		1.54 (1.14, 2.09) 0.01	
2	No violence	152	10435	17799	1	15993, 6619	1	13497, 6063
	Any sexual	139	7364	17799	1.73 (1.22, 2.45) 0.002		1.53 (1.08, 2.16) 0.02	
3	No violence	152	10435	21024	1	18956, 7373	1	15964, 6791
	Any physical	195	10589	21024	1.78 (1.28, 2.47) 0.001		1.62 (1.15, 2.28) 0.01	
4	No violence	152	10435	23394	1	21164, 7938	1	17797, 7357
	Any verbal	233	12959	23394	1.69 (1.24, 2.31) 0.001		1.55 (1.14, 2.11) 0.01	
5	None	152	10435	24837	1	22428, 8180	1	18871, 7599
	Any minor	55	4181	24837	1.10 (0.71, 1.70) 0.67		1.11 (0.73, 1.68) 0.64	
	Any severe	201	10221	24837	2.06 (1.48, 2.88) 0.000		1.78 (1.27, 2.49) 0.001	

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Table 7 continued

Model	Type of violence	Cases of HIV	n†	N†	Unadjusted OR (95% CI) p value	N in model‡	Adjusted OR§ (95% CI) p value	N in model‡
6	No violence	152	10435	21024	1	18956, 7373	1	15964, 6791
	Any minor physical	82	5318	21024	1.38 (0.93, 2.05) 0.11		1.23 (0.82, 1.84) 0.31	
	Any severe physical	113	5271	21024	2.33 (1.57, 3.47) 0.000		2.16 (1.41, 3.31) 0.000	
7	No violence	152	10435	23394	1	21164, 7938	1	17797, 7357
	Any minor verbal	167	9763	23394	1.60 (1.15, 2.22) 0.005		1.44 (1.04, 1.99) 0.03	
	Any severe verbal	66	3196	23394	2.02 (1.27, 3.22) 0.003		1.96 (1.25, 3.07) 0.003	

*Questions about having ever experienced violence were asked only in rounds 8 and 9 for sexual violence, and in rounds 7 and 8 for physical and verbal violence, and only to participants who had participated in a previous round. †n is number of years of observation for this category and N is the number of years of observation available for this variable. ‡N in model is number of observations, number of groups (*i.e.* women). §Adjusted for marital status and difference in age between participant and her partner.

Using the round in the middle of the last negative HIV test and the first positive HIV test instead of the first round in which HIV was detected, the association between any violence ever or over the course of the study and HIV infection was somewhat lower than the association calculated using the time of infection as the year of diagnosis, with an odds ratio of 1.47 (1.08, 2.00) compared to 1.54 (1.14, 2.09), though the difference was not statistically significant.

4.6.2.5 Violence ever prior to the current year as a predictor of HIV infection over the rest of the study

Reporting a history of IPV was associated with 1.48 times (1.05, 2.07) the odds of HIV infection as not reporting any IPV, after controlling for confounders, which was statistically significant. Sexual, physical, and verbal violence were each independently associated with HIV infection with odd ratios above 1.5. Any minor violence and any minor physical violence were not associated with HIV infection, with odds ratios close to one. Severe physical violence, minor verbal violence, and severe verbal violence were each associated with HIV infection compared with experiencing no violence, though the association was not statistically significant for severe verbal violence.

Table 8. Logistic regression of IPV ever* as a predictor of incident HIV infection (with shading in gray for p<0.05)

Model	Type of violence	Cases of HIV	n†	N†	Unadjusted OR (95% CI) p value	N in model	Adjusted OR‡ (95% CI) p value	N in model
1	None	82	2245	5061	1	3700	1	2977
	Any sexual, verbal, or physical	151	2816	5061	1.60 (1.18, 2.17) 0.003		1.48 (1.05, 2.07) 0.02	
2	None	82	2245	3987	1	2915	1	2350
	Any sexual	97	1742	3987	1.63 (1.16, 2.28) 0.004		1.50 (1.03, 2.18) 0.04	
3	None	82	2245	4551	1	3322	1	2680
	Any physical	132	2306	4551	1.67 (1.22, 2.82) 0.001		1.53 (1.08, 2.17) 0.02	
4	None	82	2245	4572	1	3350	1	2698
	Any verbal	130	2327	4572	1.69 (1.23, 2.31) 0.001		1.61 (1.14, 2.28) 0.01	
5	None	82	2245	5061	1	3698	1	2977
	Any minor	27	670	5061	1.22 (0.76, 1.97) 0.41		1.11 (0.65, 1.90) 0.7	
	Any severe	124	2146	5061	1.72 (1.25, 2.36) 0.001		1.60 (1.12, 2.28) 0.01	

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Table 8 continued

Model	Type of violence	Cases of HIV	n†	N†	Unadjusted OR (95% CI) p value	N in model	Adjusted OR‡ (95% CI) p value	N in model
6	None	82	2245	4551	1	3322	1	2680
	Any minor physical	55	1140	4551	1.26 (0.85, 1.88) 0.25		1.15 (0.74, 1.79) 0.53	
	Any severe physical	77	1166	4551	2.08 (1.46, 2.96) 0.000		1.94 (1.30, 2.88) 0.001	
7	None	82	2245	4572	1	3350	1	2698
	Any minor verbal	123	2200	4572	1.68 (1.22, 2.31) 0.001		1.60 (1.13, 2.28) 0.01	
	Any severe verbal	7	127	4572	1.79 (0.75, 4.25) 0.19		1.70 (0.65, 4.48) 0.28	

*Questions about ever having experienced all three types of violence were included only in round 8, so data on violence are only taken from round 8 for these analyses. †n is number of years of observation for this category and N is the number of years of observation available for this variable. ‡Adjusted for marital status and difference in age between participant and her partner.

4.6.2.6 Summary of regression analyses for IPV and incident HIV

Table 9 summarizes the findings of regression analyses for IPV and incident HIV across the five periods of exposure modelled and for specific types of IPV. For most types of IPV, the odds ratios for HIV infection were higher for longer periods of exposure, *i.e.* for IPV over the study, IPV ever or over the study, and IPV ever, compared with shorter periods of exposure, *i.e.* for IPV in the current year or in the past year. For most periods of exposure, the odds of infection were similar for any IPV, sexual IPV, physical IPV, and verbal IPV. For any IPV, physical IPV, and verbal IPV, severe IPV tended to be associated with a higher odds of HIV infection than minor IPV. Of note, the differences in ORs for longer periods of exposure compared with shorter

periods of exposure and for severe forms of IPV and minor forms of IPV were not statistically significant.

Table 9. Summary of adjusted odds ratios* for the association between IPV and incident HIV infection (with shading in gray for $p<0.05$)

Model	Type of violence	Current year	Past year	Over study	Ever/ over study	Ever
1	None	1	1	1	1	1
	Any sexual, verbal or physical	1.32	1.35	1.58	1.54	1.48
2	None	1	1	1	1	1
	Any sexual	1.24	1.10	1.54	1.53	1.50
3	None	1	1	1	1	1
	Any physical	1.74	1.30	1.75	1.62	1.53
4	None	1	1	1	1	1
	Any verbal	1.45	1.45	1.71	1.55	1.61
5	None	1	1	1	1	1
	Any minor	1.16	1.46	1.18	1.11	1.11
	Any severe	1.41	1.28	1.79	1.78	1.60
6	None	1	1	1	1	1
	Any minor physical	1.36	1.09	1.37	1.23	1.15
	Any severe physical	2.41	1.71	2.41	2.16	1.94
7	None	1	1	1	1	1
	Any minor verbal	1.45	1.38	1.54	1.44	1.60
	Any severe verbal	1.53	2.08	2.64	1.96	1.7

*Adjusted for marital status and age difference between participant and her partner.

4.6.3 Subgroup and stratified analyses

Looking at women who reported no history of violence in round 8, 5.0% of those who subsequently experienced violence during the study were infected with HIV, whereas 4.7% of those who did not experience violence during the study were infected with HIV. Considering the independent contributions of any violence ever and violence during the study, a logistic regression model adjusted for confounders revealed odds ratios of 1.37 (0.82, 2.31) for women who reported any violence ever in round 8 and no violence in subsequent rounds (N=738), 1.51 (0.87, 2.60) for women who had experienced no violence ever by round 8 and experienced violence in subsequent rounds (N=612), and 1.98 (1.28, 3.05) for women who had experienced violence ever by round 8 and experienced violence in subsequent rounds (N=1392), each compared with women who had not experienced violence by round 8 and did not experience violence in subsequent rounds (N=1122).

Looking only at women who reported one partner in the past year, for whom the data on confounders and violence necessarily refer to the same partner, the estimates of the association between IPV and HIV were similar to those for all women. The adjusted odds ratios for women with only one partner were 1.19 (0.91, 1.56) for any abuse in the current year, 1.23 (0.92, 1.65) for any abuse in the past year, 1.54 (1.13, 2.10) for any abuse over the study prior to the current year, 1.49 (1.08, 2.04) for violence ever or during the study prior to the current year, and 1.59 (1.11, 2.27) for violence ever.

Considering potential effect modifiers, as shown in Appendices 5 and 6, women who reported having experienced sexual abuse in childhood or adolescence were at higher odds of HIV infection when looking at longer periods of exposure to violence, *i.e.* over the course of the study prior to the current year; ever or over the course of the study prior to the current year; or ever. This suggests the presence of a multiplicative interaction, though it was not statistically significant, *i.e.* this indicates that the relative difference in outcome between those exposed and not exposed varied, based on the presence of sexual abuse in childhood or adolescence. There is also evidence of additive interaction between having experienced sexual abuse and violence over

the course of the study as predictors of HIV infection over the course of the study, *i.e.* there is evidence that the absolute difference in risk of HIV between those exposed and not exposed varies based on whether sexual abuse in childhood or adolescence was experienced. However, the increase in absolute attributable risk is small and the difference is not statistically significant, with an attributable risk of 1.45 (-3.45, 5.51) in women who experienced sexual abuse in childhood or adolescence compared with 1.00 (-1.99, 3.87) in women who didn't experience sexual abuse.

For pregnancy intent, the odds ratios do not indicate multiplicative interaction with violence for most periods of exposure to violence. There is a suggestion of an additive interaction between pregnancy intent at baseline and violence over the course of the study as predictors of HIV infection, with an absolute attributable risk of 0.67 (-0.28, 1.60) for women who at baseline didn't intend to become pregnant and 4.02 (-0.08, 7.80) for women who did intend to become pregnant, though this is not statistically significant.

4.6.4 Population attributable risk fraction

Of the 9926 women for whom data on IPV ever and HIV status were available, 508 (5.12%) were infected with HIV during the study. Of the 4069 women who did not report any violence ever, 184 (4.52%) were infected with HIV. The population attributable risk fraction, *i.e.* the proportion of incident cases of HIV infection associated with IPV in the RCCS population, was therefore 11.6% (1.7, 21.6). The adjusted relative risk of HIV infection for women exposed to IPV ever compared with women not exposed to IPV ever was 1.32 (1.05, 1.67). The adjusted population attributable risk fraction, *i.e.* the proportion of incident cases of HIV infection putatively causally associated with IPV in the RCCS population, was therefore 14.3% (2.8, 23.6).

4.6.5 Missing data

As shown in Table 10, in each round, the follow up rates were lower for people who reported violence in their first round of participation, with the exception of the participants in round 7. Differences in follow up rates were quite small, however, ranging between 0.2% and 4.1%.

Table 10. Loss to follow up over subsequent rounds by experience of IPV in initial round of participation

Violence status by round, N			Loss to follow up by round,* % (n/N)					
Round	Violence		8	9	10	11	12	13
7	No	2593	4.5 (117/2593)	30.5 (783/2568)	34.8 (887/2550)	40.3 (1021/2536)	46.5 (1169/2516)	50.2 (1252/2492)
	Yes	1310	4.7 (61/1310)	29.0 (374/1290)	35.6 (455/1277)	40.0 (505/1264)	46.0 (578/1257)	50.6 (628/1241)
8	No	2836		30.6 (860/2806)	37.0 (1031/2784)	43.4 (1202/2771)	49.3 (1356/2752)	53.9 (1473/2731)
	Yes	2225		32.0 (704/2197)	38.1 (829/2177)	43.4 (913/2155)	49.0 (1049/2140)	54.2 (1144/2109)
9	No	3084			18.5 (565/3046)	27.6 (834/3024)	37.4 (1120/2995)	43.6 (1294/2965)
	Yes	1464			19.1 (275/1437)	30.1 (427/1419)	39.1 (548/1403)	45.2 (622/1375)
10	No	2914				19.3 (555/2882)	31.1 (886/2848)	38.4 (1079/2813)
	Yes	1495				23.4 (343/1467)	33.2 (483/1454)	40.6 (580/1427)
11	No	3945					19.7 (765/3892)	33.2 (1272/3834)
	Yes	1498					21.2 (313/1474)	35.8 (517/1446)
12	No	4246						20.4 (848/4160)
	Yes	1508						20.6 (304/1475)

*Percent lost to follow up is calculated as the number of people missing not by design (*i.e.* all missing of those who participated in a specified round minus those who were excluded from subsequent rounds because they became HIV-positive) divided by those who participated in a specified round minus those who were missing by design (*i.e.* who were excluded because they became HIV-positive).

The follow up rates were similar for people who experienced any IPV compared to those who experienced no violence over the study before a certain round, with women who experienced violence participating in 62.2% of rounds and women who didn't experience violence participating in 62.0% of rounds after they joined the cohort, as shown in Table 11. Given that the outcome of interest is HIV incidence over the course of the study, participation in later rounds is of particular importance to being able to detect the outcome; Table 11 also shows that 53.7% of people who experienced violence during the study before round 13 participated in this round (so that data on their HIV status at the end of the period under study are available), while 52.2% of people who didn't experience violence during the study before this round participated in round 13.

Table 11. Loss to follow up by round and experience of IPV over study

IPV study to date		Number of participants missing after joining the cohort and total number of participants who had joined the cohort, by round						Percent missing,* % (n/N)	
		8	9	10	11	12	13	All rounds	Round 13
Yes	Missing	61	831	1137	1490	1922	2347	37.8 (7788/20610)	46.3 (2347/5068)
	Total	1310	2683	3274	3795	4480	5068		
No	Missing	117	829	1116	1392	1786	2186	38.0 (7426/19526)	47.8 (2186/4576)
	Total	2593	2501	2875	3017	3964	4576		

*Percent missing is calculated for all rounds as the sum of the rounds in which persons were missing not by design divided by the sum of the number of observations expected in each round. For round 13, percent missing is the ratio of the number of people missing not by design (*i.e.* all missing of those who had joined the cohort minus those who were excluded from subsequent rounds because they became HIV-positive) divided by all cohort participants minus those who were missing by design (*i.e.* who were excluded because they became HIV-positive).

As a sensitivity analysis, various plausible values were considered for the incident HIV rates in the population lost to follow up, as shown in Table 12, and resulting HIV incidence rates and relative risks for HIV were calculated for those experiencing violence compared to those not experiencing violence. Under most of these assumptions, the calculated relative risk for the full study population is similar to or greater than the relative risk calculated for those who were not

lost to follow up. The exception to this is Scenario 3, where the incidence of HIV is 1.25 times higher than the measured value for women who experienced IPV, and 1.5 times higher than the measured estimate in women who experienced no IPV, *i.e.* there is a proportionately lower increase in incidence for those who experienced violence and were not followed up compared to those who did not experience violence and were not followed up; in this scenario, the relative risk is closer to one for the whole study population than the risk calculated for those who were not lost to follow up. (Looking at odds and odds ratios instead of incidences and relative risks would lead to estimates further from the null).

Table 12. Sensitivity analysis of how plausible HIV incidence rates in participants lost to follow up would affect HIV incidence rates in the whole study population and the relative risk of the association between IPV and HIV

Population and assumptions for incidence rates in women experiencing IPV and women not experiencing IPV			HIV incidence, %		Relative risk
			Any IPV	No IPV	
Participants not lost to follow up*			5.60	4.54	1.23
Assumptions for participants lost to follow up	Scenario 1: incidence rates same as in those not lost to follow up	Participants lost to follow up	5.60	4. 54	1. 23
		Study population	5.60	4. 54	1. 23
	Scenario 2: incidence 1.5 times in those with IPV, 1.25 times in those with no IPV	Participants lost to follow up	8.40	5.68	1.48
		Study population	6.90	5.08	1.36
	Scenario 3: incidence 1.25 times in those with IPV, 1.5 times in those with no IPV	Participants lost to follow up	7.00	6.81	1.03
		Study population	6.25	5.63	1.11
	Scenario 4: incidence 1.5 times in those with IPV and those with no IPV	Participants lost to follow up	8.40	6.81	1.23
		Study population	6.91	5.63	1.23
	Scenario 5: incidence 0.75 times in those with IPV and those with no IPV	Participants lost to follow up	4.20	3.41	1.23
		Study population	4.95	4.00	1.24

*Percentage not lost to follow up is 53.7% for participants who experienced any violence and 52.2% for participants who did not experience any violence.

Analyses of data by the number of rounds of participation for women who were sexually active in the past year shows the following trends, as per Table 13: those who participated in more study rounds were less likely to experience IPV in their final year of participation than those who participated in fewer study rounds, and those who participated in more study rounds were at a lower risk of developing HIV infection in their final year of participation compared with those who participated in fewer study rounds. The incidence of HIV infection in the final year of participation decreased both for those experiencing IPV and for those not experiencing IPV as the number of rounds of participation increased. Looking at the adjusted association between IPV and HIV infection stratified by the number of rounds of participation, there is no apparent trend as the number of rounds of participation increases, which might occur if women who participated in fewer rounds were are considerably higher or lower risk of HIV infection than women who participated in more rounds. There was no trend for any of violence in the current year, violence in the past year, violence during the study prior to the current year, or violence ever or during the study prior to the current year. Data for violence in the current year and violence ever or during the study prior to the current year are shown in Table 13.

Table 13. Stratified analysis of IPV as a predictor of incident HIV infection by number of rounds of participant follow up

I*	N	IPV prevalence n/N (%)†	HIV incidence n/N (%)†	HIV incidence in those with violence n/N (%)†	HIV incidence in those without violence n/N (%)†	Violence-HIV association			
						Violence in current year‡		Violence ever/over study‡	
						OR (95% CI) p value	N§	OR (95% CI) p value	N§
2	3605	1242/3605 (34.5)	192/3235 (5.9)	71/1105 (6.4)	121/2130 (5.7)	1.22 (0.88, 1.71) 0.23	4725, 3121	1.72 (0.78, 3.81) 0.15	1835, 1835
3	1772	538/1771 (30.4)	114/1456 (7.8)	39/407 (8.7)	74/1009 (7.3)	1.09 (0.69, 1.71) 0.72	3160, 1518	2.18 (1.40, 3.41) 0.001	1837, 1296
4	1433	401/1432 (28.0)	71/1027 (6.9)	30/294 (10.2)	41/733 (5.6)	1.96 (1.16, 3.31) 0.01	2642, 1154	3.33 (1.79, 6.19) 0.000	1985, 1050
5	1119	261/1119 (23.3)	40/762 (5.3)	13/178 (7.3)	27/584 (4.6)	1.39 (0.70, 2.77) 0.35	2984, 862	1.84 (0.90, 3.76) 0.10	2318, 837
6	1128	282/1128 (25.0)	43/850 (5.1)	11/217 (5.1)	32/633 (5.1)	0.80 (0.38, 1.66) 0.54	4157, 968	7.60 (2.30, 25.06) 0.001	3406, 957
7	1517	316/1517 (20.8)	18/1429 (1.3)	3/304 (1.0)	15/1125 (1.3)	0.64 (0.18, 2.28) 0.49	8745, 1635	1.58 (0.49, 5.06) 0.44	7490, 1624

*I refers to number of rounds of participation. †Incidence and prevalence are for participants in the final year of follow up, and period of exposure to violence is the current year. ‡Adjusted for marital status and difference in age between participant and her partner. §N in model is number of observations, number of groups (*i.e.* women).

Multiple imputation of violence data resulted in only a small proportion of missing data for violence being imputed, *i.e.* less than 10% of observations missing for participants who had already participated in a round, since there were missing observations for at least one predictor variable in the imputation for most missing observations. HIV test results for most rounds (*i.e.* all rounds except 13) were omitted as predictors of imputed values for violence because they were collinear across rounds, which is likely due to the fact that participants were excluded from

analyses after the first round in which they tested positive. Repeated measures analysis of the multiply imputed data revealed an odds ratio of 1.31 (1.07, 1.61) for violence in the current year, which is similar to the association calculated from the original data: 1.32 (1.05, 1.67).

4.7 Discussion

IPV is common in women in the RCCS, and the majority of women who experienced IPV experienced more than one form of violence and experienced violence more than once within the course of at least one year during the period under study. Across regression analyses, as summarized in Table 9, there was a positive association between violence and incident HIV infection. The association tended to be stronger when looking at IPV exposure over longer periods (*i.e.* over the period of the study, ever or over the period of the study, or ever) compared to shorter periods (*i.e.* in the current year or over the past year), more frequent exposure to IPV (in the case of longer periods of exposure), and more severe forms of IPV, though these associations were typically not statistically significant. The effect of violence on HIV infection was moderate in size, with women who experienced any violence prior to the study or during the study period at an odds of 1.54 (1.14, 2.09), compared with women who did not experience violence. This is similar in magnitude to the estimate of relative risk from the two other prospective studies, which found an adjusted incidence rate ratio of 1.51 (95% CI 1.04, 2.21) in women experiencing physical or sexual IPV[26] (though the reference group in this study was women who experienced IPV one time or no times whereas in the current study the reference group was women who did not experience IPV ever) and an adjusted odds ratios of 1.62 (p=0.35) in women and 1.69 (p=0.31) in men experiencing verbal or physical IPV,[27] respectively.

The study findings translate into an IPV adjusted population attributable risk fraction for HIV infection of 14.3% (2.8, 23.6) over the study period, which represents an important proportion of the cases of HIV infection and which is similar to the adjusted population attributable risk fraction calculated in another prospective study: 11.9% (95% CI 1.4,19.3)[26] (though as noted the reference group in this study was women who did not experience IPV ever, whereas in the other prospective study the reference group was women who experienced IPV one time or no times).[26]

4.7.1 Findings regarding the association between IPV and HIV

As shown in Table 9, there is no single type of violence for which the odds of HIV infection was consistently particularly high relative to the others; estimates were similar for any violence, sexual violence, physical violence, and verbal violence. This may suggest that it is not a specific type of violence which potentially causes HIV infection, but rather that the experience of violence increases the risk of HIV infection. Interpretation of this finding is limited by the fact that there is significant overlap between the forms of IPV experienced by most women, with almost one third of women who reported any IPV experiencing all three forms of IPV. That notwithstanding, given that more than 50% of women who experienced IPV did not experience sexual IPV, it is unlikely that mechanism A shown in Figure 1, *i.e.* that sexual violence leads to physical trauma which increases the susceptibility to HIV upon exposure, is the major or at least the sole mechanism for the increased risk of HIV infection associated with IPV.

For any violence, physical violence, and verbal violence, severe forms of violence tended to be associated with a greater odds of infection with HIV compared with minor forms of violence, though the differences between minor and severe forms of violence were not statistically significant. This may reflect the relatively small sample sizes in several of the categories of minor and severe IPV, which would lead to a lack of precision in estimates of odds ratios. Of note, this finding does not lend support to any specific mechanism in particular; with any of the proposed mechanisms, it is likely that severe IPV could be associated with a greater risk of HIV than minor IPV.

The analyses of frequency of violence and the risk of HIV infection suggested that more frequent violence may be more strongly associated with HIV infection, in particular in models of longer periods of exposure to violence. This association has been found in at least one other study.[20] However, in the current study, data on frequency were available for less than half of women who reported violence and there were few infections with HIV in people who experienced violence most frequently (*e.g.* more than six times over the past year), such that estimates were not precise and differences were not statistically significant.

Given the aforementioned uncertainty regarding the period of exposure to IPV which is relevant to HIV infection, this study also provides important findings regarding specific associations in different periods of exposure to IPV. For some associations, *e.g.* physical violence, the odds of infection tended to be stronger for IPV in the current year than in the past year. This may reflect bidirectionality of this association, *i.e.* that there is both an increased risk of IPV with HIV infection and an increased risk of HIV with IPV. It is also notable that odds ratios tended to be greater overall in models of longer periods of exposure, *i.e.* during the study, ever or during the study, and ever, compared with shorter periods of exposure, *i.e.* in the current year or past year. This may indicate that, at least for some women, there is a lag between the time of exposure and HIV infection, which could reflect that it takes time to develop changes in behaviours which increase the risk of HIV, *i.e.* mechanisms B and C in Figure 1. It may also be that risk increases immediately or shortly after IPV exposure, however, that a lag occurs because the acquisition of HIV is more likely with the repeated exposures which would take place over time. Another potential explanation is that women who experience IPV may not experience IPV consistently across years; classifying women as having been exposed to IPV even if this exposure were inconsistent across study rounds would lead to a more appropriate estimate of the association between IPV and HIV in the event that any history (or any recent history) of IPV is what is relevant to risk of HIV infection, such as might be the case for mechanisms B and C in Figure 1, *i.e.* that IPV leads to the inability or unwillingness of women to negotiate safer sex or to women behaving in ways which are risky for acquiring HIV.

It is not possible to determine the exact year of infection for women who did not participate in certain rounds, however, the fact that infection must take place either in or prior to the year of diagnosis suggests that the true magnitude of association would tend toward the midpoint estimate. The sensitivity analyses conducted using the date between the last negative and first positive HIV test instead of the first round in which HIV was detected yielded lower odds ratios for models of longer exposure periods, *i.e.* for violence during the study prior and for violence ever or during the study, and higher odds ratios for models of shorter exposure periods, *i.e.* for violence in the current year and violence in the past year, though the differences between estimates using the year of the first positive test and the midpoint between the last negative and

first positive tests were not statistically significant. The true value of the association between violence and HIV infection may therefore differ from the magnitude calculated using the year of diagnosis, however, this difference would likely not be substantial.

Regarding potential modifiers of this effect, there is evidence of additive and multiplicative interactions between childhood or adolescent sexual abuse and IPV, and of an additive interaction between pregnancy intent and violence, however, these interactions were not statistically significant. For sexual abuse, the analysis is limited by the relatively few women for whom data are available on history of sexual abuse before the age of 18, since this question was only included in a single round. Further, the effects of sexual abuse may putatively vary for people who are abused in early childhood compared to those who experienced abuse in adolescence, so there may be heterogeneity within this group in terms of the magnitude of the effect modification.

This study also suggests that having ever experienced violence and experiencing violence only during the course of the study may each independently predict risk of HIV infection. Although the associations for women who reported IPV ever in round 8 and no IPV over the rest of the study, and for women who reported no IPV ever in round 8 and IPV over the rest of the study were not statistically significant, they were both positive at 1.37 (0.82, 2.31) and 1.51 (0.87, 2.60), respectively. Notably this analysis included relatively few women since questions about ever having experienced all three forms of violence were only included in round 8, which may have limited the statistical power of this analysis. Though of course the time of participation in round 8 does not necessarily mark any important point in the social or sexual development of these women, this finding does suggest that interventions directed both at the prevention of early experiences of IPV (*e.g.* in adolescence and early adulthood) and at the prevention of IPV in adulthood could impact HIV infection.

4.7.2 Role of community

An important methodological issue is that all communities of interest as defined by the study investigators (see Chapter 3) were included in the RCCS. To explain the design using the terminology of complex survey methodology,[69, 70] the communities do not represent clusters of participants selected at random, but instead they make up all the communities of interest in the target population. Therefore, the communities in the study are equivalent to sampling strata as opposed to primary sampling units or sampling clusters. The analyses presented in this thesis are consistent with this study design and communities are not, therefore, treated as randomly sampled clusters.

Using the alternative terminology of sampling for multi-level models, the individual study participants are clustered in communities at the second or aggregate level. Because the communities are mutually exclusive and add up to a defined target population of interest, it is theoretically appropriate to treat community as a fixed effect, and this is the approach taken throughout this thesis. Community was not modelled as a random effect primarily because the research objectives did not focus on the influence of community or context; the research objective was to estimate the association between exposure to IPV and HIV transmission for the individual, and ecological variables reflecting the community did not play a theoretical role in the associations being studied.

4.7.3 Study strengths

The strengths of the RCCS of particular relevance to this thesis work are its size, high participation rates, prospective nature, long length of follow up, representativeness of a defined community-based population, inclusion of relevant data on potentially confounding, mediating, and effect modifying variables, and the inclusion of questions about three forms of IPV, *i.e.* physical, sexual, and verbal violence. Specifically, having repeated measures of exposure to IPV over time allows for a more detailed understanding of the ways in which IPV during particular periods of time may be associated with HIV infection. Also, since the RCCS includes all

consenting residents of participating communities, the participation rates in the study are high, and the sample of women included in this study is similar in key characteristics to the overall population of women in the study communities, the findings are likely to be generalizable to the population of women in Rakai District, and importantly, to other rural Ugandan populations. In terms of these analyses, strengths include the use of various ways of modelling IPV in terms of type of IPV, period of exposure, and frequency, as well as the use of random effects models which is likely most appropriate for modelling this association across individuals.

4.7.4 Study limitations

There are also several limitations to the study. It is important to appropriately measure and model IPV in order to obtain an accurate estimate of the prevalence of IPV and the association between IPV and HIV. Regarding measurement, the questions on IPV used in the Rakai Community Cohort Study were modified from the Revised Conflict Tactics Scales (CTS2),[56, 57] however, this version of the scale has not been validated in this population. Also, the CTS2 does not include questions about control, which is a component of IPV[2] and which could play an important role in the association between IPV and HIV; this would likely lead to an underestimation of the true association between IPV and HIV. In general, both versions of the Conflict Tactics Scales have been criticized as not providing information about the context in which acts of violence occur,[71] which may be relevant to understanding the experience of violence and its risks. This issue has been addressed to a limited extent in this study by including relevant supplemental questions about context, such as questions about attitudes toward violence. These issues could lead to two consequences: first, there could be misclassification bias which could lead to random error in the estimate of the IPV and HIV association if the misclassification is not associated with HIV status, or to differential bias if the misclassification is associated with HIV status. Second, even in the absence of misclassification bias, the category of people who have experienced violence may represent a heterogeneous group of individuals in terms of risk of HIV infection, which could obscure patterns where certain subgroups of women experiencing violence are at varying levels of risk. It is also possible that social desirability and recall problems may have biased these estimates, which would likely be due to underreporting[72] and likely biased toward the null as long as they were not differential by HIV status.

Regarding modelling of IPV, there is no best way to model violence on the basis of theory, and there are potential advantages and limitations to each of the methods used in these analyses. When looking at violence in the current year, it is possible that HIV infection may have occurred prior to the experience of violence in some cases, and data are not available on the pattern of violence or the specific time of infection in the past year. However, it is notable that study participants were not likely to have been aware of their HIV status before the survey was conducted. Since all other models look at the experience of violence reported in rounds prior to the round in which HIV status was tested, *i.e.* data are used from multiple rounds, they have less power to detect differences. However, this should not affect the magnitude of the odds ratios, which are consistently greater than one.

As for other limitations, power may also be a significant issue in certain subanalyses, *e.g.* in the examination of effect modifiers, especially sexual abuse in childhood or adolescence since data on this variable were collected in only one round. There may have been inadequate control of confounding, because of the lack of data on or inclusion in models of relevant variables or because of measurement error. This may contribute to misestimation of the association between violence and HIV infection. Data were not available to indicate pregnancy intent for women in baseline rounds who were currently pregnant, which would contribute to decreased power.

Another important limitation is the lack of inclusion of data on partner risk behaviours and partner HIV status, which are necessary in order to determine whether IPV is a risk factor or risk marker for HIV. These data were not available for analysis. While partner data would be valuable and important in assessing for a causal association, the findings of this study remain nonetheless relevant for understanding the overall association between IPV and HIV, which is relevant from the perspective of the secondary prevention of HIV.

Finally, the number of participants who were lost to follow up is potentially of concern. The fact that the rate of loss to follow up was associated with the exposure (*i.e.* with violence) in certain analyses suggests that data on violence and HIV status are not missing completely at random.[58] However, the lack of data on outcome status in those who were lost to follow up precludes the determination of whether the loss to follow up is differential or non-differential with respect to HIV risk.[73] Sensitivity analyses were reassuring that in most plausible scenarios of HIV incidence in participants lost to follow up, the relative association between violence and HIV is preserved. To ascertain the accuracy of these scenarios, it would be necessary to undertake validation studies in which the HIV status could be tested for all those who were lost to follow up or a sample of those who were lost to follow up, however, this would be costly and resource intensive and therefore likely not feasible. Stratified analyses showed that the odds ratio for the violence- HIV association did not change significantly as number of rounds of participation increase, *i.e.* the odds ratio for the association between IPV and HIV for those women who participated for a short time is similar to the odds ratio for those women who participated for a long time. This suggests that if the women who were lost to follow up had not been lost to follow up, the estimates of the association between violence and HIV would not have changed appreciably. It should be possible to test this hypothesis with multiple imputation of data missing in rounds after a participant joined the cohort, however, multiple imputation only resulted in imputation of a small proportion of missing observations. This is due to the nature of the data; when a participant is present for a round, typically data are present for all relevant variables, however, if a participant missed a round, there were no data available for any variables in that round. The methods used to impute data are dependent on the presence of observations in the predictor variables, *i.e.* the variables used to predict the values of the variables to be imputed. Further, including the outcome as a predictor is considered important to obtaining accurate estimates of multiply imputed data, [60] however, in this case, the collinearity of the outcome across rounds resulted in most of the outcome data being excluded from the imputation process. Therefore the multiple imputation procedure was of limited value for these data. It would be possible to impute data for IPV and for confounders based on previous rounds, for example using the most recently reported response or the response provided most often, however, this type of imputation would not be appropriate for the outcome, and so would yield a greater number of observations only for analyses of IPV in the past year. While it is therefore not possible to

precisely determine the extent to which loss to follow up may bias the estimate of association, the analyses noted above are reassuring that loss to follow up is likely of minor impact.

4.7.5 Study contributions

This study builds on previous work on the association between IPV and HIV, and adds substantial knowledge to this field. First, the study confirms that IPV is independently associated with HIV infection using population-based data, appropriate temporal modelling for IPV and HIV, and a more comprehensive definition of IPV. As noted, there have only been two prospective studies of the association between IPV and HIV, each of which has issues which may limit the interpretation and use of their findings. In the study by Jewkes *et al.* of women in South Africa,[26] only physical and sexual IPV were measured, which could lead to an underestimate of the IPV-HIV association. Estimates of the odds of HIV infection were calculated for women who experienced IPV more than one time compared with those who experienced IPV one time or not at all, without clear justification for the use of this reference category (as opposed to using women who experienced no IPV as a reference category). Given the lack of understanding about the mechanism of the association between IPV and HIV, and also in light of the suggested findings in this thesis work about an increase in the odds of HIV infection with increasingly frequent exposure to IPV (including from no IPV to having experienced IPV one time) with longer periods of exposure, this categorization may not be appropriate, and may lead to an underestimation of the association between IPV and HIV. The Jewkes *et al.* study also did not capture changes in IPV history over the course of the study, *i.e.* did not capture incident IPV, which could lead to misclassifiation bias, *i.e.* misclassifying those who experienced IPV over the course of the study but not prior to the study as having never experienced IPV, which would also bias the association toward the null. In the study by Were *et al.* of serodiscordant couples in East and Southern African countries,[27] only physical and verbal abuse were measured, which could lead to an underestimate of the magnitude of association between IPV and HIV. There were very few reports of IPV in women who seroconverted, *i.e.* IPV was reported by only 7 of 146 women who acquired HIV, which may explain why the positive association between IPV and HIV infection was not statistically significant, with a p value of 0.35. Another issue in the Were *et al.* study was the relatively short period of follow up,

which was 24 months for 75% of women, which is particularly important since no questions were asked about having ever experienced IPV. If longer periods of IPV exposure are most relevant to risk for HIV infection, as suggested in this thesis work, then it would be important to model IPV ever or at least IPV during longer periods of exposure.

The results from this study are therefore more credible overall than the results from other studies, because this work addresses several of the limitations noted about the other two prospective studies.[26, 27] Also, the limitations of these other studies notwithstanding, the findings of this thesis work are consistent with the other studies with respect to the strength of the association[26, 27] and the adjusted population attributable risk fraction,[26] which increases confidence about the validity of these findings (in light of their reproducibility) and suggests that the findings of this study regarding a positive association between IPV and HIV are likely generalizable to other settings in sub-Saharan Africa and potentially elsewhere.

Second, this study elucidates important characteristics of the association between IPV and HIV which were heretofore unknown and which are of particular note in the context of a study which is longitudinal and population-based, *i.e.* that odds of HIV infection tended to be greater for severe compared with minor forms of IPV, for more frequent IPV exposure, and when modelling longer periods of exposure to IPV compared to shorter periods; that the associations between IPV and HIV tended to be consistent across forms of IPV; and that the effect of IPV on HIV may be modified by a history of abuse in childhood or adolescence and by pregnancy intent. Knowledge about these characteristics is valuable for understanding mechanisms of risk and for informing potential interventions.

4.7.6 Overall conclusions

Overall, this study confirms that IPV is independently associated with incident HIV infection, and indicates that women who experience IPV currently or in the past are typically at a risk of HIV infection approximately one and a half times the risk of women who do not experience

violence. Given the consistency of this magnitude of association with other prospective studies, this finding is likely generalizable to women in sub-Saharan Africa, and potentially elsewhere. It remains unclear how this increased risk may be mediated, and further research is clearly needed to elucidate the mechanisms of risk. Even in the absence of an understanding of mechanism, however, recognizing the increased risk of HIV infection associated with IPV would be of benefit in secondary prevention programs such as HIV VCT, and certainly the imperative to decrease violence in early life and in intimate partnerships in adolescence and adulthood remains strong.

5 Chapter Five: Potential Mediators of the Association between Intimate Partner Violence and HIV Infection

5.1 Objective 2

To examine potential mediators of the relationship between IPV and HIV infection in Rakai, Uganda.

5.2 Hypothesis

The association between IPV and HIV is mediated by the inability to negotiate safer sex in women who have experienced IPV, as indicated by their condom use in the past year. The association between IPV and HIV is also mediated by high risk sexual behaviours by women who have experienced IPV, as indicated by their number of partners in the past year.

5.3 Justification

Understanding how IPV causes an increase in the risk of infection with HIV is important both to demonstrate that a causal relationship exists and to identify ways to intervene in the pathway between IPV and HIV infection. Based on the data available in the Rakai Community Cohort Study, there are two potential mediators which can be assessed: condom use in the past year and number of partners in the past year. Condom use is postulated to function as a mediator based on mechanisms B and C of Figure 1, *i.e.*. that women who experienced IPV may be limited in their ability to negotiate safer sex or that women with a history of IPV may behave in ways that would increase their risk of HIV infection. Specifically, the hypothesized association is that women who experience IPV may not be willing or able to have their partners use condoms, which could increase their risk of HIV infection. Number of partners is also postulated to function as a

mediator based on mechanism C of Figure 1, *i.e.* that women who have a history of IPV may behave in ways that would increase their risk of HIV infection. Specifically, women with a history of IPV might be more likely to have multiple sexual partners, whether concurrently or sequentially, which could increase the risk of exposure to and infection with HIV. The evidence for the association between IPV and these potential mediators is summarized in Chapter 2.

For all of the direct mechanisms for IPV increasing the risk of HIV infection, *i.e.* mechanisms A to D in Figure 1, there are other potential mediators which could be assessed, however, data on other mediators were not collected by the RCCS. Condom use in the past year is only one of several potential indicators of mechanisms B and C, and number of partners in the past year is only one of several potential indicators of mechanism C.

5.4 Methods

5.4.1 Sample

The same sample was used as for objective 1, as described in Chapter 4.

5.4.1.1 Variables

Definitions of variables included in data analyses and information on the rounds in which data on these variables were collected are provided in Appendix 3.

5.4.1.1.1 Primary Exposure

The primary exposure for this analysis is any form of IPV: sexual, verbal or physical. As with objective 1 (described in Chapter 4), temporal exposure to IPV was modelled in several ways: violence in the year prior to the current year, violence during the study to the year before to the

current year, violence ever or during the study to the year before the current year, and violence ever.

5.4.1.1.2 Outcome

As for objective 1 (described in Chapter 4), the outcome is incident HIV infection.

5.4.1.1.3 Potential mediators

Condom use in the past year and number of partners in the past year were examined as potential mediators. In rounds 7 and 8, questions were asked about condom use in the past six months whereas in rounds 9 to 13, questions were asked about condom use in the past year, and in all rounds these questions were asked only to those who reported having been sexually active in that time period. Specifically, participants were asked if they used condoms (yes or no), and if so, how often they used condoms (sometimes or always). For this analysis, condom use was categorized as always, sometimes, or never. In the dataset, within each round, data were collected on number of partners either as a specific number of partners, *e.g.* one or two, or as a categorical variable, *e.g.* a few (*i.e.* one or two) or a lot (*i.e.* three or more). For this reason and also given the distribution of women across these categories, the number of partners in the past 12 months was categorized as one partner or more than one partner.

5.4.1.1.4 Confounders

Based on covariates that were found to confound the association between IPV and HIV in objective 1 (described in Chapter 4), covariates included in adjusted analyses were marital status and age difference between a woman and her partner, and these variables were categorized in the same way as in the analyses for objective 1 (described in Chapter 4).

5.4.1.1.5 Potential effect modifiers

Associations between condom use and HIV infection may putatively vary based on the nature of the relationship, *e.g.* whether a woman is in a casual relationship or married. For this reason, it is plausible that condom use may mediate the association between violence and HIV only in certain subgroups, specifically, for women who are not married, and women who are in a relationship type other than a marriage or consensual union.

5.4.2 Statistical analysis

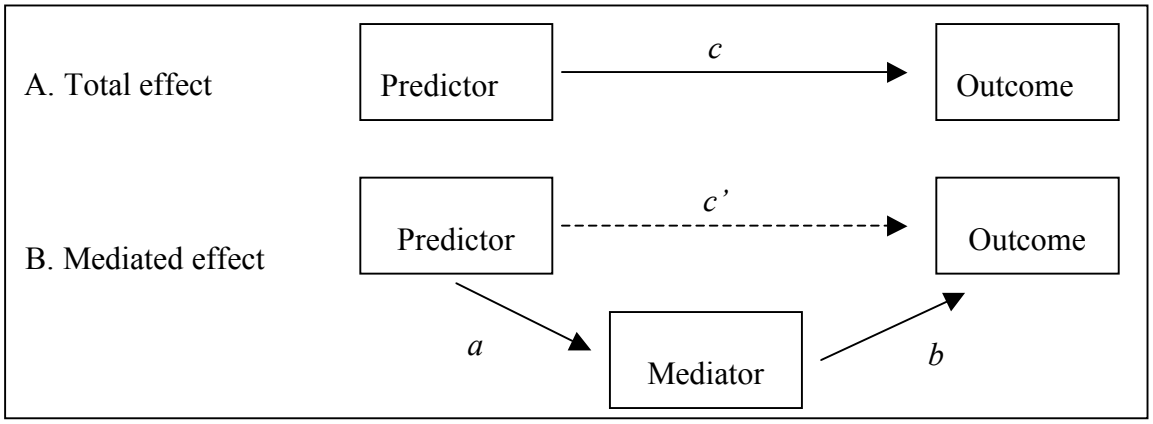
The frequency of condom use and the number of sexual partners were compared for women who experienced IPV and women who did not experience IPV, and for women who developed HIV and women who didn't develop HIV, using chi-square tests.

To test for mediation, four associations were assessed, as described by Baron and Kenny:[74] the predictor and outcome association (*c*), the predictor and mediator association (*a*), the mediator and outcome association while controlling for the predictor (*b*), and the predictor and outcome association while controlling for the mediator (*c'*), as shown in Figure 5. These associations were assessed in three ways. First, repeated measures analyses with logistic regression were used for three periods of exposure to IPV: IPV in the current year, IPV during the study, and IPV prior to the study or during the study, with mediator data taken from the round subsequent to the exposure data and outcome data taken from the round subsequent to the mediator data. As a sensitivity analysis, analyses were also run using exposure data from one round and both mediator and outcome data from the subsequent round. Second, associations were assessed using logistic regression of the most recently available three sequential rounds for IPV in the current year, IPV during the study, and IPV prior to the study or during the study. Third, logistic regression was used to assess IPV ever as measured in round 8, data on the mediator from round 9 and data on incident HIV infection in rounds 10 to 13.

Given that the difference between the total effect and the direct effect would likely not be a reliable estimate of the indirect effect with logistic regression or multilevel models,[75] Sobel-Goodman mediation tests were performed to calculate the indirect effect (as the product of the predictor-mediator association and the mediator outcome association controlling for the predictor) and the standard error of the indirect effect,[76] using data from the most recently available three rounds or from round 8, round 9, and rounds 10 to 13 for data on having experienced IPV ever. Since there may be significant skew in the distribution of indirect effects,[77] which could cause Type II error,[76] bootstrapping with 500 repetitions was performed of estimates from the most recently available three rounds or from round 8, round 9, and rounds 10 to 13 for data on having experienced IPV ever. The resulting 95% confidence intervals from these distributions are presented; percentile confidence intervals are shown for bootstrapped estimates instead of bias-corrected confidence intervals, given potential Type I error with bias correction.[78] Separate analyses were also done to calculate the difference in odds ratios between models including and excluding each mediator variable.

Data on confounders were taken from the round in which data on the mediator were taken, *i.e.* either the second round of three rounds in models where data on the outcome were taken from the round subsequent to the round on which data on the mediator were taken, or the second of two rounds in models where data on the mediator and outcome were taken from the same round. Confounders used in these analyses were those identified for the association between IPV and HIV in analyses in Chapter 2, *i.e.* marital status and difference in age between partners.

Figure 5. Path models showing total and mediated effects[77]



To ensure the temporal sequence of events, data on violence, mediators, and the HIV test results were ascertained from sequential rounds. Analyses were done using violence data from one round, mediator data from the next round, and HIV data from the next round. Analyses were also done using violence data from one round and mediator and outcome data from the next round, to ensure adequate power and given uncertainty regarding the relevant timing of the effects of the mediator on the outcome.

To look for effect modification for women who were not married and for women in types of relationships other than marriages and consensual unions, repeated measures analyses were used to assess associations using Baron and Kenny's criteria as described above. Sobel-Goodman mediation tests were also performed to calculate the indirect effect.

5.5 Results

5.5.1 Descriptive analysis

Of women who were sexually active at baseline, most reported never having used a condom in the past year, as shown in Table 14. More than 90% of sexually active women reported only one

partner in the past year, in the baseline round. Chi square tests for the percentages of people who did and did not acquire HIV were significant for both categories of condom use and number of sexual partners in the past year. Chi square test for the percentages of people who did and did not experience violence over the course of the study were also significant for both variables.

Table 14. Frequency of sexual risk factors over past year at baseline, by HIV acquisition and experience of IPV over the course of the study

Risk factor		Did not acquire HIV		Acquired HIV		p value*	No violence over study		Violence over study		p value*
		N	%	N	%		N	%	N	%	
Condom use	Never	6407	76.8	318	70.2	0.01	2683	71.3	4178	80.2	0.000
	Sometimes	1287	15.4	88	19.4		625	16.6	764	14.7	
	Always	654	7.8	47	10.4		455	12.1	266	5.1	
Sexual partners	One	8002	93.7	419	89.5	0.000	3641	94.4	4949	93.0	0.01
	More than one	540	6.3	49	10.5		215	5.6	374	7.0	

*for chi square test of association

5.5.2 Tests of mediation

As shown in Tables 15 and 16, repeated measures analyses indicated that for all exposure periods, neither condom use nor number of partners mediated the association between IPV and HIV infection, since the association between IPV and HIV did not change appreciably on controlling for these potential mediators. (Of note, estimates of the magnitude of association between IPV and HIV differ from the associations identified in Chapter 4, since these analyses look at the association between IPV in one round and HIV infection two rounds later).

After adjusting for confounders, always using a condom tended to be associated with a decreased odds of HIV compared to never using a condom, though this was not statistically significant.

Sometimes using a condom was consistently associated with an increase in odds of HIV infection. Violence was not associated with sometimes using condoms. The association between violence and always using condoms was inconsistent across periods of exposure to violence, with a significant negative association for violence in the past year and always using condoms, and no significant association for violence over the study or violence ever or over the study and always using condoms.

Table 15. Repeated measures analysis of condom use in the past year as a mediator of the association between IPV and HIV

Exposure	Association*		OR	95%CI	p value	N in model†
Current year	*c*		1.03	0.65, 1.63	0.90	11209, 4514
	a	Never	1			16446, 6994
		Sometimes	0.99	0.89, 1.11	0.88	
		Always	0.69	0.55, 0.85	0.001	
	b	Never	1			11163, 4499
		Sometimes	1.88	1.07, 3.29	0.03	
		Always	0.53	0.17, 1.62	0.26	
	c'		1.02	0.64, 1.62	0.93	
During study	*c*		2.48	1.62, 3.79	0.000	11769, 4748
	a	Never	1			17515, 7327
		Sometimes	1.19	0.98, 1.44	0.08	
		Always	1.09	0.76, 1.56	0.65	
	b	Never	1			11723, 4733
		Sometimes	1.97	1.27, 3.04	0.002	
		Always	0.66	0.28, 1.55	0.34	
	c'		2.37	1.55, 3.62	0.000	

-continued-

Table 15 continued

Exposure	Association*		OR	95%CI	p value	N in model†
Ever known	*c*		2.03	1.32, 3.13	0.001	11758, 4743
	a	Never	1			17500, 7322
		Sometimes	1.06	0.86, 1.31	0.56	
		Always	1.01	0.69, 1.48	0.98	
	b	Never	1			11715, 4730
		Sometimes	1.97	1.27, 3.06	0.002	
		Always	0.63	0.27, 1.49	0.29	
	c'		2.00	1.30, 3.09	0.002	

**c*= the predictor and outcome association, *a*=the predictor and mediator association, *b*=the mediator and outcome association while controlling for the predictor, *c'*=the predictor and outcome association while controlling for the mediator. Adjusted for marital status and difference in age between participant and her partner. †N in model is number of observations, number of groups (women).

As shown in Table 16, violence was significantly associated with number of partners for each of the three periods of exposure to violence. Number of partners in the past year was also positively associated with HIV infection for each of the three exposure periods, and these associations were also statistically significant.

Table 16. Repeated measures analysis of number of partners in the past year as a mediator of the association between IPV and HIV

Exposure	Association*	OR	95%CI	p value	N in model†
Current year	*c*	1.03	0.65, 1.63	0.90	11209, 4514
	a	1.93	1.53, 2.42	0.000	18300, 7544
	b	4.10	1.47, 11.44	0.01	11208, 4513
	c'	1.00	0.63, 1.59	1.0	
During study	*c*	2.48	1.62, 3.79	0.000	11769, 4748
	a	2.23	1.46, 3.41	0.000	19510, 7907
	b	4.10	1.95, 8.63	0.000	11768, 4747
	c'	2.37	1.55, 3.62	0.000	
Ever known	*c*	2.03	1.32, 3.13	0.001	11758, 4743
	a	1.81	1.13, 2.90	0.01	19490, 7898
	b	4.29	2.06, 8.94	0.000	11757, 4742
	c'	1.96	1.27, 3.01	0.002	

**c*= the predictor and outcome association, *a*=the predictor and mediator association, *b*=the mediator and outcome association while controlling for the predictor, *c'*=the predictor and outcome association while controlling for the mediator. Adjusted for marital status and difference in age between participant and her partner. †N in model is number of observations, number of groups (women).

Looking at logistic regression of the most recently available three sequential rounds of data, as shown in Table 17 for condom use and in Table 18 for number of partners in the past year, neither condom use nor number of partners mediated these associations using Baron and Kenny's criteria or the Sobel-Goodman estimate of the size of the indirect effect. For all of these models, the association between violence and HIV infection did not change appreciably with the addition of the putative mediator to the model, and the estimate of the indirect effect by the Sobel-Goodman test was an odds ratio of one. The results were similar for models in which data on the mediator and outcome were taken from the same round (not shown).

Table 17. Logistic regression analysis of condom use in past year as a mediator of the association between IPV and HIV

Exposure	Association*		N	Condom use, sometimes or always compared with none			Indirect effect by Sobel-Goodman test and bootstrapping			
				OR	95%CI	p value	Size	95% CI normal distribution	95% CI boot-strapping†	% of total effect
Current year‡§	*c*		3727	1.42	0.97, 2.07	0.07	1.00	1.00, 1.00	1.00, 1.00	-6.2%
	a	Never	3985	1						
		Sometimes		1.15	0.96, 1.37	0.12				
		Always		0.61	0.43, 0.89	0.01				
	b	Never	3723	1						
		Sometimes		1.65	1.09, 2.50	0.02				
		Always		0.83	0.39, 1.77	0.63				
	c'			1.39	0.95, 2.04	0.09				
During study‡§	*c*		3769	1.46	1.01, 2.13	0.05	1.00	1.00, 1.00	1.00, 1.00	-9.3%
	a	Never	4027	1						
		Sometimes		1.16	0.98, 1.37	0.08				
		Always		0.75	0.56, 1.01	0.05				
	b	Never	3765	1						
		Sometimes		1.67	1.11, 2.52	0.01				
		Always		0.89	0.43, 1.83	0.75				
	c'			1.44	0.99, 2.10	0.06				

-continued-

Table 17 continued

Exposure	Association*		N	Condom use, sometimes or always compared with none			Indirect effect by Sobel-Goodman test and bootstrapping			
				OR	95%CI	p value	Size	95% CI normal distribution	95% CI boot-strapping†	% of total effect
Ever known‡	*c*		3766	1.39	0.94, 2.04	0.1	1.00	1.00, 1.00	1.00, 1.00	-12.5%
	a	Never	4024	1						
		Sometimes		1.12	0.94, 1.32	0.21				
		Always		0.78	0.58, 1.04	0.09				
	b	Never	3762	1						
		Sometimes		1.68	1.11, 2.54	0.01				
		Always		0.89	0.43, 1.83	0.75				
	c'			1.36	0.92, 2.00	0.12				
Ever§	*c*		2402	1.60	1.12, 2.28	0.01	1.00	1.00, 1.00	1.00, 1.00	2.9%
	a	Never	2573	1						
		Sometimes		1.17	0.93, 1.47	0.17				
		Always		1.02	0.67, 1.54	0.93				
	b	Never	2256	1						
		Sometimes		1.44	0.93, 2.24	0.10				
		Always		1.54	0.78, 3.02	0.21				
	c'			1.54	1.07, 2.21	0.02				

**c*= the predictor and outcome association, *a*=the predictor and mediator association, *b*=the mediator and outcome association while controlling for the predictor, *c'*=the predictor and outcome association while controlling for the mediator. Adjusted for marital status and difference in age between participant and her partner. †Percentile confidence interval. ‡These analyses use data from the most recent three rounds on which data are available. §Questions about ever having experienced all three types of violence were included only in round 8, so data on violence are only taken from round 8. Data on potential mediators are from round 9 and data on HIV outcome are from rounds 10 to 13, *i.e.* HIV status is positive if the outcome is positive in any of rounds 10 to 13, or else HIV status is negative.

Table 18. Logistic regression analysis of number of partners as a mediator of the association between IPV and HIV

Exposure period	Association*	N	Number of partners, one compared with more than one			Indirect effect by Sobel-Goodman test and bootstrapping			
			OR	95%CI	p value	Size	95% CI normal distribution	95% CI boot-strapping†	% of total effect
Current year‡	*c*	3727	1.42	0.97, 2.07	0.07	1.00	1.00, 1.01	1.00, 1.01	27.8
	a	3992	2.22	1.54, 3.18	0.000				
	b	3727	3.49	1.94, 6.28	0.000				
	c'		1.33	0.91, 1.96	0.14				
During study‡	*c*	3769	1.46	1.01, 2.13	0.05	1.00	1.00, 1.00	1.00, 1.00	15.7
	a	4034	1.70	1.16, 2.48	0.01				
	b	3769	3.64	2.04, 6.52	0.000				
	c'		1.43	0.98, 2.08	0.07				
Ever known‡	*c*	3766	1.39	0.94, 2.04	0.10	1.00	1.00, 1.00	1.00, 1.00	17.9
	a	4031	1.65	1.12, 2.45	0.01				
	b	3766	3.73	2.08, 6.66	0.000				
	c'		1.35	0.92, 1.99	0.13				
Ever§	*c*	2402	1.60	1.12, 2.28	0.01	1.00	1.00, 1.00	1,00, 1.00	1.2
	a	2577	1.51	0.91, 2.51	0.11				
	b	2259	1.85	0.83, 4.12	0.13				
	c'		1.54	1.07, 2.21	0.02				

**c*= the predictor and outcome association, *a*=the predictor and mediator association, *b*=the mediator and outcome association while controlling for the predictor, *c'*=the predictor and outcome association while controlling for the mediator. Adjusted for marital status and difference in age between participant and her partner. †Percentile confidence interval. ‡These analyses use data from the most recent three rounds on which data are available. §Questions about ever having experienced all three types of violence were included only in round 8, so data on violence are only taken from round 8. Data on potential mediators are from round 9 and data on HIV outcome are from rounds 10 to 13, *i.e.* HIV status is positive if the outcome is positive in any of rounds 10 to 13, or else HIV status is negative.

Calculation of the difference in odds ratios between models including and excluding the potential mediators found that the difference was smaller than 0.00.

5.5.3 Potential effect modifiers

The association between violence and HIV did not change on controlling for condom use in women who were not married or in women in types of relationships other than marriages and consensual relationships, across periods of exposure to violence. Sobel-Goodman tests revealed odds ratios of 1 for the indirect effect of condom use in both of these subgroups.

5.6 Discussion

In these analyses, neither condom use nor number of partners in the past year functioned as a mediator of the association between IPV and HIV infection, based on Baron and Kenny's criteria and Sobel-Goodman test estimates of the size of the indirect effect. There was an inconsistent association across exposure periods between IPV and always using condoms and sometimes using condoms, respectively, and a positive association between IPV and number of partners. There was a non-significant association between always using condoms and HIV infection, and statistically significant positive associations between sometimes using condoms and number of partners, respectively, and HIV infection. There was no modification of the lack of mediation by marital status or type of relationship.

Although there has been no explicit assessment of condom use and number of partners as mediators of the association between IPV and HIV in the scientific literature, indirect evidence from other studies largely corroborates the findings of this Chapter, which suggests that these findings may be generalizable to women in other regions in sub-Saharan Africa, Asia, and potentially elsewhere. In a study by Dunkle *et al.* in South Africa from 2001 to 2002,[20] having ever used condoms was not significantly associated with HIV infection, with an unadjusted odds ratio of 0.94 (0.75, 1.19), and was not significantly associated with IPV (categorized as having

experienced IPV more than once compared with one time ever or never), with an odds ratio of 1.09 (0.86, 1.37). In contrast, having five or more male partners was associated with IPV and also with HIV infection. In a study by Jewkes et al. in South Africa between 2002 and 2003,[21] women with HIV were more likely to have had more partners in the past year than women without HIV, but no different in terms of likelihood of condom use. IPV was not associated with correct condom use during most recent intercourse but was associated with having three or more partners in the past year. In a prospective study in South Africa by Jewkes *et al.* from 2002 to 2006,[26] additional adjustment for condom use at last intercourse during the study period did not affect the adjusted association between IPV and HIV, with a negligible change in the adjusted relative risk from 1.51 (1.04, 2.21) to 1.51 (1.03, 2.21). Similarly, adjustment for number of partners during the period of follow up resulted in a minimal change in the adjusted relative risk to 1.50 (1.03, 2.19), with number of partners categorized as a binary variable of having two or more partners compared to one partner. In the Silverman *et al.* study of married women in India from 2005 to 2006,[16] neither lifetime condom use nor lifetime number of sexual partners were associated with HIV infection in women, using the criterion that 95% confidence intervals for odds ratios overlapped with 1. In a study by Decker *et al.* using these same data but focused on husband-wife dyads,[24] IPV in women was significantly associated with having never used condoms and with having multiple sex partners, and there was no association between women's HIV infection and sexual risk behaviours including number of partners and condom use. In summary, in these studies, there was a lack of association between condom use and HIV infection in women, an inconsistent association between IPV and condom use, an inconsistent association between number of partners and IPV, and an inconsistent association between the number of partners and HIV.

In consideration of the Baron and Kenny criteria for mediators,[74] there should be an association between exposures and mediators and an association between mediators and outcomes, which is clearly not consistently true in the literature for the relationships between IPV as the exposure, condom use and number of partners as mediators, respectively, and HIV infection as the outcome. However, these associations might only be present after adjusting for relevant confounders, and several of these studies present only unadjusted data. Another criterion is that the association between the exposure and outcome should decrease on controlling for the

potential mediator, which did not happen in the Jewkes *et al.* study;[26] notably the explicit intent of these analyses in that study was to examine for confounding, however, the procedure of adding condom use to the model of the adjusted relative risk of HIV for women experiencing IPV compared to those not experiencing IPV (specifically, women who experienced IPV more than once compared with women who experienced IPV once or not at all) would be the same as the procedure used to assess a putative mediator. Limitations to the data summarized include that they differ in how they define condom use and number of partners in terms of time period considered and categorization; that most of these data come from cross-sectional analyses, so the temporal associations are not clearly defined; that, as noted, most of these associations are from bivariate analyses and do not control for key confounders; and that these findings are from varying contexts which may reflect different underlying associations.

It is also important to consider that for several reasons, condom use may not be an appropriate indicator of either mechanism B, *i.e.* the inability of women who experience IPV to negotiate safer sex, or of mechanism C, *i.e.* that women who experience IPV may have riskier sexual behaviours. First, the majority of women (53.0%) included in these analyses reported being in monogamous marriages, as per Table 1. For these women, condoms may not be indicated for the prevention of STIs (as opposed to for contraception), though of course women may not report that their partners have multiple partners because they are not aware of their partners having other partners or because of potential stigma. Second, less than one quarter of women reported any condom use in the past year, as shown in Tables 1 and 14. While this could reflect mechanisms B or C, as described, *i.e.* that women are not using condoms because of IPV, this could also reflect a lack of use of condoms in general in this population, which could be due to social norms or barriers to condom access. If women are not using condoms in this population, then it follows that condom use would not mediate the association between IPV and HIV. Assessing other potential indicators of mechanisms B and C in addition to further assessment of condom use as a potential mediator in other contexts would be helpful to be able to determine whether these mechanisms are important, and whether condom use is a strong indicator of either or both of these mechanisms.

While, as stated, the findings of this study are supported by other studies on the association between IPV and HIV, this study contributes new knowledge because of its explicit focus on mediation, as well as strengths in its design and analyses. First, since the associations described in other studies were largely descriptive and part of an assessment for putative confounding (and not mediation), there was little discussion in these studies about how these findings would either support or refute a hypothesis that number of partners and condom use may mediate the association between IPV and HIV. In contrast, the assessment of potential mediators is the explicit objective for this study, and so this is the focus of the analysis and discussion throughout the Chapter. Second, given that the data used in this study were longitudinal, it was possible to model the temporal associations appropriately, with consistent results whether modelling exposure, mediator, and outcome in three sequential rounds, or the exposure in one round and the mediator and outcome in the subsequent round. Finally, using the Baron and Kenny criteria,[74] with adjustment for confounding variables, and in particular modelling the association between IPV and HIV while controlling for the putative mediator, is a valid method to assess these two potential mediators. These analyses therefore provide the first clear assessment of these two variables as potential mediators of the association between IPV and HIV, with results that are important for understanding the nature of the association between IPV and HIV, in the context of the Rakai District and likely more broadly.

That notwithstanding, there are several noteworthy limitations to the analyses in this Chapter. The assessment of putative mediators was limited by the data collected, *i.e.* there are other proposed mediators which would be interesting and important to assess quantitatively which were not included in RCCS surveys, such as whether women are engaging in unwanted sex, whether women are engaging in relatively risky sexual activities such as anal sex, and indicators of immune system function.

Regarding analyses, because of limitations in software, it was not possible to conduct Sobel-Goodman tests to estimate the indirect effects with repeated measures analyses. This would lead to the inclusion of fewer observations, and therefore of less power in these analyses. It is also possible that the subset of data used in the Sobel-Goodman analyses differs from the full dataset,

which could affect the estimates of the associations. It was also not possible to control for potentially confounding variables in the Sobel-Goodman analyses, again due to limitations in the software. However, the consistency of results when using the Baron and Kenny criteria and the estimates of indirect effects from the Sobel-Goodman tests suggests that the finding of no mediation by either of these two variables is valid.

A specific area which deserves comment is the estimate of the indirect effect as a percentage of the total effect from the Sobel-Goodman tests, for example the estimate from logistic regression of the indirect effect of IPV ever or during the study on HIV infection with condom use as a mediator, as shown in Table 17, which indicates that the indirect effect is -12.5% of the total effect. This negative estimate reflects the fact that the betas for the direct effect and the indirect effect have different signs, *i.e.* one is positive and one is negative. Overall, however, since the estimates of the indirect effect are a beta of approximately zero (or an odds ratio of one, as presented in the Tables), the estimates for the percentage of the total effect may not be meaningful.

Overall, there are several ways to interpret the findings of these mediation analyses. First, it is possible that either or both of condom use and number of partners in the past year truly function as a mediator of the association between violence and HIV, and that random or systematic error led to not being able to detect their role as a mediator in these analyses, *i.e.* to Type II error. Specifically, sources of bias could be that women have difficulty with recall of these variables or do not want to truthfully report behaviours which may be stigmatized. However, neither of these factors would likely vary by HIV acquisition status, especially since women would not likely have had an HIV test prior to answering the survey questions (and women are excluded from the dataset after testing positive for the first time). Further, it is possible that the questions asked or the way in which these variables were coded fail to adequately represent the relevant risk behaviours.

It is also possible that neither condom use nor number of partners in the past year mediates the relationship between violence and HIV infection, which is supported by the limited evidence which can be gleaned from the literature on the association between IPV and HIV. This may be true in general or only in this population, *i.e.* in women in Rakai District or more broadly in women involved in relationships influenced by similar interpersonal and cultural dynamics.

Further work is clearly required to investigate the role of mediators, including to either validate or refute the findings of these analyses and to explore the role of other potential mediators. This should include explicit consideration in study designs and analyses of the role of variables which may function as mediators as well as functioning as confounders, and the collection and assessment of data on potentially mediating variables.

6 Chapter Six: Quantifying Risk Factors for Intimate Partner Violence

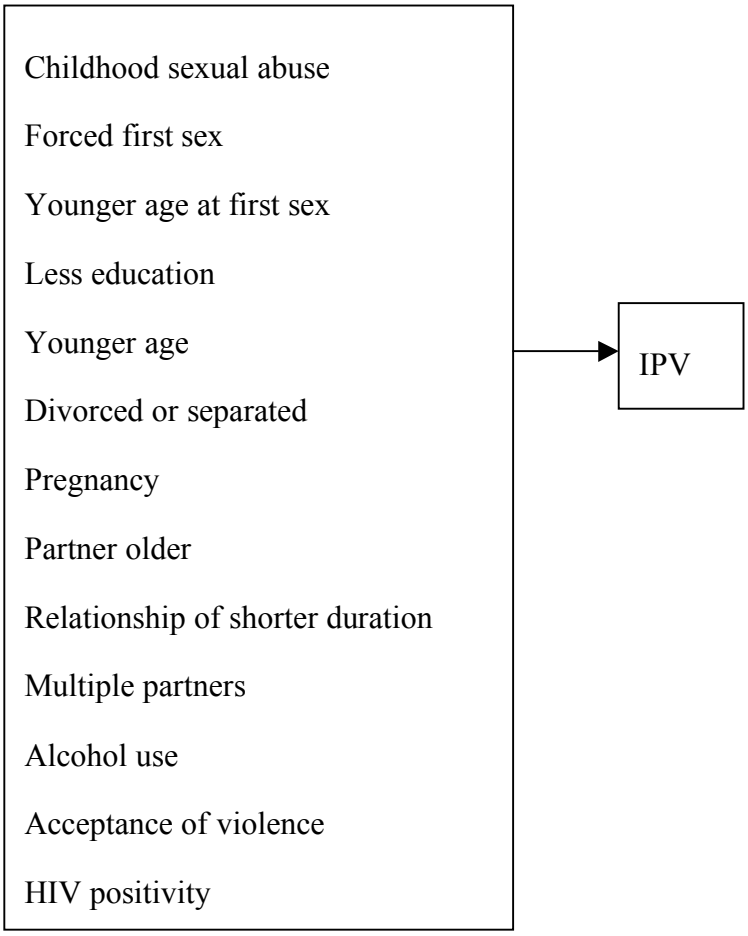
6.1 Objective 3

To quantify risk factors for intimate partner violence in women in Rakai, Uganda.

6.2 Hypothesis

Violent experiences in childhood, younger age at first sex, younger age, less education, being divorced or separated, being pregnant, having an older partner, being in a relationship of shorter duration, having multiple partners, alcohol use by women and their partners, thinking violence is acceptable, and being HIV positive are associated with experiences of IPV in adulthood.

Figure 6. Hypothesized risk factors for IPV in women in Rakai, Uganda



6.3 Justification

Knowledge of context-specific risk factors for violence is important to be able to appropriately focus efforts in the primary, secondary and tertiary prevention of IPV, including in relevant population subgroups. A recent World Health Organization (WHO) review of risk factors for IPV noted the lack of data from longitudinal studies and from low and middle income countries.[2] This brings into question whether many of the factors identified to date are true risk factors as opposed to variables which are associated with or perhaps even consequences of violence, and also whether existing research is valid in low and middle income countries.

Risk factors for women experiencing IPV identified in the WHO review are individual level factors such as younger age, low socio-economic status (including income), low education, separated or divorced marital status, pregnancy, exposure to intra-parental violence in childhood, sexual abuse, depression, harmful use of alcohol, illicit drug use, acceptance of violence, and exposure to prior abuse or victimization; relationship level factors such as educational disparity, number of children, and marital dissatisfaction or discord; community level factors such as acceptance of traditional gender roles, unemployment, poverty, female literacy, acceptance of violence, low proportion of women with high level of autonomy, low proportion of women with higher education, and weak community sanctions (*i.e.* communities which lack legal sanctions and where women lack access to shelters and family support, and in which there is less moral pressure for neighbours to intervene if a woman is beaten); and societal level factors such as divorce regulations by government, a lack of legislation on IPV within marriage, protective marriage laws, and traditional gender and social norms.[2]

Considering previous analyses of data from the RCCS, a cross-sectional study using data from 1998 to 1999 identified the following significant risk factors for sexual coercion: younger age, having primary schooling compared to having eight or more years of schooling, having a partner who works in business or trading compared to a partner who works in agriculture, having a partner who is a husband or being in a consensual union compared to having a boyfriend, early age at first intercourse, having a partner who consumes alcohol before sex, and a woman's perception that her partner was at risk of HIV infection.[8] Religion, length of partnership, age difference between partners, and consuming alcohol before sex did not significantly predict sexual coercion.[8] Another cross-sectional study using data from 2000 to 2001 found that lower level of education, greater number of living children, being married or in a consensual union compared to having a boyfriend, shorter duration of relationship, younger age at first intercourse, consumption of alcohol by women prior to sex, consumption of alcohol by partners prior to sex, and a woman's perception of her male partner's HIV risk significantly predicted physical or verbal IPV, whereas age, religion, partner's occupation, pregnancy status, use of modern contraception, and difference in age between partners did not significantly predict physical or verbal IPV.[7]

In this Chapter, longitudinal data from the RCCS were used to assess several of these known risk factors and also to explore hypothetically important risk factors for IPV.

6.4 Methods

6.4.1 Sample

Women aged 15 to 49 who participated in at least one study round between 2000 and 2009 and reported at least one sexual partner over the period of study participation were included.

6.4.2 Variables

Definitions of variables included in data analyses and information on the rounds in which data on these variables were collected are provided in Appendix 3.

6.4.2.1 Outcome

IPV was defined as any physical, sexual, or verbal violence by a sexual partner, using the same questions as used in objectives 1 and 2 (as described in Chapters 4).

6.4.2.2 Exposures

Putative risk factors were identified on the basis of factors assessed and identified in the scientific literature, as well as on theoretical grounds. Since characteristics and experiences in early life may cause some of the experiences and characteristics in adulthood and specifically, risk factors for IPV in adulthood may be on the causal pathway from early factors to IPV,[79] risk variables were separated into early factors and contemporary factors. These two groups of

variables were analysed separately. Early factors included sexual abuse (asked only of those participating in round 10 who had already participated in another round), [25] age at first intercourse (asked in all rounds), [13, 23] whether first intercourse was coerced (asked of those who had already participated in another round in rounds 8, 9, and 10, and of new participants in rounds 11, 12, and 13), and education level (asked in all rounds). [16, 17, 21, 23-25, 27, 28, 31, 41] Contemporary factors included demographic variables such as age, [16, 17 18, 19, 21, 22, 24, 27, 28, 31] marital status,[18, 19, 22, 25, 27, 28, 31, 41] religion, [16, 22, 24, 41] occupation,[22, 28, 31] partner's occupation, and pregnancy status;[18, 27, 29] relationship variables such as type of relationship with partner, [27] length of primary sexual partnership,[19, 27] difference in age between the participant and her partner, [17, 19, 21, 22, 27] number of sexual partners in past year, [13, 16, 18, 20, 23, 24, 31, 36, 40] alcohol use before sex by the participant, [13, 20, 21] alcohol use before sex by the participant's partner, [17, 22, 25] attitudes toward violence, and HIV status.[11, 17-19, 22, 23, 25, 27, 28, 31] All the contemporary factors were determined in all rounds, except attitudes toward violence, which was asked of those who had already participated in a round in rounds 7, 8, and 9, and of all participants in rounds 11, 12, and 13.

Childhood or adolescent sexual abuse was defined as having ever been sexually abused by a male before the age of 18. Coerced first intercourse was defined as force having been used the first time a participant had sex. Pregnancy status was self-reported. Alcohol use before sex was defined as drinking alcohol before sex. A variable for attitudes toward violence was derived from a series of questions about whether a man is justified in beating his wife or partner in several situations, with acceptable defined as responding yes to any of these questions and not acceptable defined as responding no to all these questions, which were: she neglects household responsibilities, she disobeys the instructions of her husband/elders, she uses contraception without permission, she refuses her husband sex, he learns about his wife's partner's positive HIV serostatus, he learns about his positive HIV serostatus, argues over money, is unfaithful, or another reason. HIV status was defined as a positive result on two enzyme immunoassays, confirmed by Western blot or RT-PCR. If HIV status was missing or the test result was indeterminate in a round in which the subject participated and negative in a subsequent round, HIV status was assumed to be negative. For participants who reported multiple partners in the past year, data about the partner with whom the participant reported having had sex most recently was used for the variables type of relationship with partner, alcohol use by partner,

length of sexual partnership, and difference in age with partner; it was not possible to determine which specific partner (if any) had perpetrated violence.

6.4.2.3 Potential effect modifier

Number of partners was considered as a potential modifier of the associations between various contemporary risk factors and violence, based on theoretical considerations.

6.4.3 Statistical analysis

The prevalence of violence and of risk factors was described. Linear regression was used to look at trends in violence over time by survey round. For early factors, simple logistic regression was used to look at bivariate and multivariable associations between each variable and whether any violence occurred during the period of study participation, given the hypothesis that these characteristics and experiences preceded study participation. Descriptive analyses were performed to check whether age when sexually abused and age at first sex were less than the age when study participation began, to ensure that these early factors preceded IPV during the study, which is an assumption of the models for early factors. For contemporary factors, longitudinal random effects models were used to look at bivariate and multivariable associations, treating the individual as a cluster to account for repeated measures for each person and using an exchangeable correlation matrix. Models were run to look at the associations between each variable and violence in the subsequent year, with separate models for each type of violence and for any violence.

For each of early factors and contemporary factors, since there were multiple predictors of interest and to minimize the risk of Type I error of conventional backward selection models, an Allen-Cady modified backward selection procedure was used for the multivariable models.[60] Candidate variables were identified *a priori* as being of greater importance on the basis of known associations with violence, including sexual abuse in childhood or adolescence, coerced first sex,

and education for early factors, and age, marital status, pregnancy status, difference in age with partner, use of alcohol, number of partners in past year, and attitudes toward violence for contemporary factors.[2, 36, 80] Additional variables hypothesized to be relevant were then ranked in order of putative importance, which in ascending order of importance for contemporary factors were relationship type, length of relationship, women's occupation, partner's occupation, religion, and HIV status. For early variables, this included only age at first sex. Variables from the second group were deleted in order of ascending importance until the first variable was encountered with a p value of $p<0.1$, either by Wald test or by likelihood ratio test, depending on whether the variable was continuous or binary, or categorical.

Separate models were run to look at the associations between contemporary factors and risk of violence in the same year, recognizing that certain associations, such as the temporal association between pregnancy and violence, might not be adequately captured when looking at exposure and outcome data from sequential years.

Analyses were specifically done to look at whether contemporary factors associated with HIV would vary for women with one partner in the past year or more than one partner in the past year, *i.e.* whether number of partners might modify the effect of various risk factors on IPV. Analyses were also conducted to look at risk factors in women experiencing incident violence, *i.e.* women who had never previously experienced violence. Finally, the prevalence of violence was calculated for women who developed HIV infection over the course of the study, specifically looking at the rate of violence in the year prior to diagnosis, in the year of diagnosis, and in the year subsequent to diagnosis, as a means of exploring mechanism F, as shown in Figure 1 (Chapter 2), *i.e.* that women with HIV infection are more likely to experience IPV subsequent to diagnosis.

6.5 Results

Of the 20,584 women who participated in the study, 17,232 (83.7%) were included in these analyses. One hundred twenty women were excluded because they were younger than 15 or older than 49 during the period under study, four women were excluded because they had a positive HIV test result and subsequent negative tests, and 3,228 women were excluded because they were not sexually active during the period under study.

IPV was common in this population, as shown in Table 19. More than half of women experienced any violence over the course of the study, with 41.5% reporting verbal violence, 31.6% reporting sexual violence, and 31.3% reporting physical violence. Looking at the prevalence of violence reported in each round, there seemed to be a slight decrease in the amount of any violence reported per year, with a linear regression model suggesting a decrease of 2.7% per year (2.5, 3.0), likely primarily reflecting a decrease in sexual violence of 3.8% (3.5, 4.0%), since rates of physical violence did not decrease and rates of sexual violence did not appreciably decrease over this period.

Table 19. Reported frequency of IPV by study participants, n/N (%)

Type of violence	Past year*	Over study period
Any intimate partner violence	4367/15081 (29.0)	7504/14557 (51.6)
Any sexual violence	2278/12046 (15.9)	4528/14324 (31.6)
Any verbal violence	3502/15050 (23.3)	6250/15050 (41.5)
-Minor	3489/15050 (23.2)	6222/15050 (41.3)
-Severe	250/15050 (1.7)	893/15050 (5.9)
Any physical violence	2637/15050 (17.5)	4713/15050 (31.3)
-Minor	2531/15050 (16.8)	4575/15050 (30.4)
-Severe	1115/15050 (7.4)	2164/15050 (14.4)

*Data from last round on which violence data were available for each individual.

Most women who experienced violence reported experiencing more than one form of violence (66%). In the last round of participation for the 4367 women who reported any violence, 1064 women (24.4%) reported experiencing verbal violence only, 322 (7.4%) reported sexual violence only, and 94 women (2.2%) reported physical violence only. Six hundred eighty-three women (15.6%) experienced verbal and physical violence only, 218 (5.0%) women reported verbal and sexual violence only, and 443 (10.1%) reported physical and sexual violence only, while 1289 women (29.5%) reported all three forms of violence.

6.5.1 Early factors

Women commonly reported a history of sexual abuse in childhood or adolescence and that their first sexual intercourse was coerced, with 31.3% of 1784 women reporting sexual abuse and 17.5% of 11607 reporting coerced first sex, as shown in Table 20. The majority of women (67.9%) were between 15 and 19 years old at the time of first sex, though more than a quarter were younger than 15. There was only one participant for whom age at first sex was greater than her age when she began to participate in the study, and the relevant observation was not excluded

from analyses since in that same round, the participant also reported having had sex and being married; this suggests that there may have been either a reporting or coding error with respect to her age at first sex. There were no participants for whom age when sexually abused was greater than age at the start of study participation.

Table 20. Frequency of early factors

Early factor		n	%
Sexual abuse in childhood or adolescence*	No	1225	68.7
	Yes	559	31.3
Education†	<5 years	4604	26.9
	5-7 years	7086	41.3
	Secondary or higher	5456	31.8
Age at first sex	<15	4302	26.7
	15-19	10952	67.9
	20-24	822	5.1
	>24	59	0.4
Coerced first sex	No	9581	82.6
	Yes	2026	17.5

*Only asked about in one of seven study rounds, so the data on sexual abuse are from this round. †Data on education are taken from the baseline round, *i.e.* the first round of participation.

Sexual abuse in childhood or adolescence and coerced first sex prior to the study were both statistically significant risk factors for any IPV over the course of the study and for each of physical, verbal, and sexual violence over the course of the study, as shown in Table 21. Women with higher levels of education tended to be less likely to experience violence, with a decrease in risk across the categories of less than five years of education, five to seven years of education, and secondary school education and higher. Women who were younger at the time of their first

sexual intercourse were at the greatest risk of experiencing IPV, with a decrease in odds of IPV per year increment of age of experiencing any violence of 0.92 times (0.92, 0.94).

Table 21. Bivariate associations between early factors and IPV during the study, OR (95% CI), p value

Early factor		Physical violence	N	Verbal violence	N	Sexual violence	N	Any violence	N
Sexual abuse in childhood or adolescence *	No	1	1584	1	1583	1	1583	1	1532
	Yes	1.52 (1.22, 1.88) 0.000		1.52 (1.22, 1.88) 0.000		1.62 (1.30, 2.02) 0.000		1.57 (1.26, 1.96) 0.000	
Education†	<5 years	1	9904	1	9903	1	8885	1	9782
	5-7 years	0.89 (0.81, 0.99) 0.03		0.87 (0.79, 0.96) 0.01		0.92 (0.83, 1.02) 0.13		0.89 (0.81, 0.98) 0.02	
	Secondary or higher	0.65 (0.58, 0.73) 0.000		0.63 (0.56, 0.70) 0.000		0.65 (0.58, 0.73) 0.000		0.61 (0.55, 0.68) 0.000	
Age at first sex	Continuous	0.91 (0.90, 0.93) 0.000	9336	0.93 (0.91, 0.94) 0.000	9334	0.92 (0.90, 0.94) 0.000	8387	0.92 (0.90, 0.94) 0.000	9219
Coerced first sex	No	1	8178	1	8177	1	7206	1	8134
	Yes	1.74 (1.55, 1.96) 0.000		1.61 (1.44, 1.80) 0.000		8.72 (7.57, 10.0) 0.000		4.17 (3.67, 4.76) 0.000	

*Only asked about in one of seven study rounds, so the data on sexual abuse are from this round. †Data on education are taken from the baseline round, *i.e.* the first round of participation.

In a multivariable model including all early factors (Model 1 in Table 22), greater education was associated with a lower risk of violence, with an odds ratio of 0.92 (0.69, 1.22) for people with five to seven years of education and of 0.65 (0.48, 0.89) for those with secondary education or

higher, compared to those with less than five years of education. Younger age at first intercourse was associated with experiencing violence, with an odds ratio of 0.96 (0.90, 1.01) per year, though the association was not statistically significant. Coerced first intercourse and childhood or adolescent sexual abuse were both statistically significantly associated with an increased risk of violence, with odds ratios of 3.66 (2.54, 5.28) and 1.66 (1.31, 2.11), respectively. Removing age at first sex from the model resulted in a significant likelihood ratio test as per the pre-specified criteria, so no variables were removed from the full model. A second model (Model 2 in Table 20) was run controlling for age at study baseline, with results very similar to those of Model 1, except that age at first sex emerged as statistically significantly associated with violence with an odds of 0.92 times (0.87, 0.98) per increase in one year of age.

Table 22. Multivariable models of early factors and violence during the study, N=1370

Early factor		Model 1: all early factors OR (95% CI), p value	Model 2: all early factors, adjusted for age at study baseline OR (95% CI), p value
Sexual abuse in childhood or adolescence	No	1	1
	Yes	1.65 (1.29, 2.11), 0.000	1.68 (1.31, 2.15), 0.000
Education	<5 years	1	1
	5-7 years	0.92 (0.69, 1.22), 0.55	0.97 (0.73, 1.30), 0.86
	Secondary or higher	0.65 (0.48, 0.89), 0.008	0.68 (0.50, 0.93), 0.02
Age at first sex	Continuous	0.96 (0.90, 1.01), 0.13	0.92 (0.87, 0.98), 0.01
Coerced first sex	No	1	1
	Yes	3.66 (2.54, 5.28), 0.000	3.54 (2.45, 5.12), 0.000

6.5.2 Contemporary factors

The frequency of characteristics and behaviours was examined, as shown in Table 23, using data from the baseline round. Almost thirty percent of women were in each of the age groups of 15 to 19, 20 to 24, and 25 to 34. Almost half of women were currently married and in a monogamous

relationship, and most women were Catholic (59.0%), with a sizeable minority of Protestant (21.1%) and Muslim (15.8%) populations. The majority of women worked in agriculture (56.0%). Regarding the occupations of their partners, about a quarter of women reported that their partners worked in agriculture and another quarter reported that their partners worked in trade. About one fifth of women were pregnant (21.0%). Eighty-eight point six percent of women were in a relationship with a man who was older, and for almost half of these women, the man was five or more years older. Less than one in ten women reported having more than one partner in the past year (9.1%). More than one quarter of women reported using alcohol before sex (27.4%) and half of women reported that their partner used alcohol before sex (50.3%). The majority of women indicated thinking that it would be acceptable for a man to beat his partner in at least one of a variety of situations (85.6%). Twelve point five percent of women were HIV-positive.

Table 23. Frequency of contemporary factors at baseline

Contemporary factor		N	%
Age	15-19	4865	28.2
	20-24	5027	29.2
	25-34	5021	29.1
	35-49	2324	13.5
Marital status	Never married	3777	21.9
	Previously married	2287	13.3
	Currently married- polygamous	2611	15.2
	Currently married- monogamous	8562	49.7
Religion	Catholic	10115	59.0
	Protestant	3613	21.1
	Muslim	2713	15.8
	Other	708	4.1
Occupation	Agriculture	9601	56.0
	Shopkeeper/trading/vending	1510	8.8
	Housework	1334	7.8
	Professional	1171	6.8
	Student	1283	7.5
	Home brewing/bar worker/owner	444	2.6
	Other	1797	10.5

-continued-

Table 23 continued

Contemporary factor		N	%
Partner's occupation	Agriculture	4506	27.4
	Shopkeeper/trading/vending	4409	26.8
	Professional	2028	12.3
	Student	485	3.0
	Home brewing/bar worker/owner	161	1.0
	Trucker	707	4.3
	Other	4169	25.3
Pregnancy status	Not pregnant	10838	79.0
	Pregnant	2877	21.0
Type of relationship	Husband	7502	44.9
	Current consensual partner	3981	23.8
	Boyfriend	4941	29.5
	Other	301	1.8
Length of time in relationship	<4 years	5881	43.4
	4-6 years	2774	20.5
	>6 years	4907	36.2
Partner age difference	Same age	991	7.4
	≥10 years older	2098	15.8
	5-9 years older	3703	27.8
	<5 years older	5988	45.0
	<5 years younger	440	3.3
	≥5 years younger	97	0.7

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Table 23 continued

Contemporary factor		N	%
Number of partners in past year	1	14653	90.9
	2 or more	1473	9.1
Woman's use of alcohol before sex	No	12086	72.6
	Yes	4563	27.4
Partner's use of alcohol before sex	No	7722	49.7
	Yes	7826	50.3
Attitudes toward violence	Not acceptable	1551	14.4
	Acceptable	9187	85.6
HIV status	Negative	14143	87.5
	Positive	2013	12.5

Bivariate models were run to look at the associations between contemporary factors in the past year and violence in the current year, as shown in Table 24. In general, the magnitudes of association were similar across types of violence, and the same factors tended to be statistically significantly associated with violence. The factors which were significantly and positively associated with any violence were younger age; being previously married, currently in a polygamous marriage, or currently in a monogamous marriage, compared to never having been married; working in home brewing or in a bar as a worker or owner compared to working in agriculture; being pregnant; being in a relationship with a partner who is a current consensual partner compared to a husband; having a partner who is less than five years younger compared to a partner who is the same age; having more than one sexual partner in the past year compared to one partner; using alcohol before sex; having a partner who uses alcohol before sex; and reporting that violence is acceptable in a marriage. The factors which were significantly negatively associated with IPV (*i.e.* were protective) were being Muslim compared to being Catholic; working as a shopkeeper or in trading or vending, being a professional, student, or "other," compared to working in agriculture; having a partner whose main occupation is as a

professional, student, or trucker; being in a relationship with a partner who is a boyfriend, compared to a husband; and being in a relationship lasting six or more years years.

Table 24. Bivariate associations between contemporary factors in the past year and IPV in the current year

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Age	Continuous	0.98 (0.97, 0.98) 0.000	29266, 10895	0.98 (0.98, 0.99) 0.000	29258, 10889	1.00 (0.99, 1.01) 0.997	29650, 10953	0.99 (0.98, 0.99) 0.000	29659, 10954
Marital status	Never married	1	29266, 10895	1	29258, 10889	1	29650, 10953	1	29659, 10954
	Previously married	1.4 (1.14, 1.72) 0.002		1.27 (1.05, 1.52) 0.01		1.73 (1.45, 2.07) 0.000		1.50 (1.28, 1.75) 0.000	
	Currently married-polygamous	2.1 (1.74, 2.53) 0.000		2.27 (1.92, 2.67) 0.000		1.82 (1.55, 2.15) 0.000		2.11 (1.82, 2.44) 0.000	
	Currently married-monogamous	2.43 (2.06, 2.87) 0.000		2.65 (2.29, 3.07) 0.000		1.69 (1.46, 1.95) 0.000		2.24 (1.97, 2.54) 0.000	
Religion	Catholic	1	29199, 10839	1	29191, 10833	1	29583, 10897	1	29592, 10898
	Protestant	0.86 (0.76, 0.99) 0.03		0.97 (0.87, 1.10) 0.66		0.97 (0.87, 1.10) 0.68		0.98 (0.88, 1.09) 0.74	
	Muslim	0.64 (0.55, 0.75) 0.000		0.71 (0.62, 0.82) 0.000		0.76 (0.66, 0.87) 0.000		0.77 (0.68, 0.87) 0.000	
	Other	0.92 (0.68, 1.23) 0.56		0.89 (0.68, 1.16) 0.38		0.93 (0.71, 1.21) 0.57		0.90 (0.71, 1.15) 0.41	

Table 24 continued

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Occupation	Agriculture	1	29265, 10894	1	29257, 10888	1	29649, 10952	1	29658, 10953
	Shopkeeper/ trading/ vending	0.85 (0.73, 0.999) 0.049		0.91 (0.79, 1.04) 0.16		0.86 (0.74, 0.99) 0.04		0.83 (0.73, 0.94) 0.004	
	Housework	0.98 (0.80, 1.21) 0.87		1.08 (0.90, 1.30) 0.4		0.91 (0.74, 1.10) 0.33		1.03 (0.87, 1.22) 0.72	
	Professional	0.62 (0.5, 0.77) 0.000		0.61 (0.50, 0.74) 0.000		0.74 (0.61, 0.89) 0.002		0.62 (0.52, 0.73) 0.000	
	Student	0.31 (0.22, 0.43) 0.000		0.37 (0.3, 0.48) 0.000		0.33 (0.25, 0.45) 0.000		0.33 (0.26, 0.42) 0.000	
	Home brewing/bar worker/owner	1.72 (1.28, 2.30) 0.000		1.34 (1.02, 1.76) 0.04		1.27 (0.96, 1.68) 0.09		1.36 (1.06, 1.75) 0.02	
	Other	0.83 (0.71, 0.98) 0.03		0.77 (0.67, 0.90) 0.001		0.82 (0.70, 0.95) 0.000		0.78 (0.68, 0.89) 0.000	

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Table 24 continued

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Partner's occupation	Agriculture	1	28788, 10621	1	28780, 10615	1	29162, 10681	1	29171, 10682
	Shopkeeper/ trading/ vending	0.99 (0.89, 1.11) 0.91		0.91 (0.82, 1.01) 0.08		1.03 (0.93, 1.15) 0.55		0.93 (0.85, 1.02) 0.15	
	Professional	0.74 (0.62, 0.87) 0.000		0.69 (0.60, 0.81) 0.000		0.84 (0.74, 0.98) 0.03		0.75 (0.66, 0.86) 0.000	
	Student	0.22 (0.12, 0.40) 0.000		0.28 (0.18, 0.45) 0.000		0.40 (0.25, 0.63) 0.000		0.34 (0.23, 0.49) 0.000	
	Home brewing/bar worker/owner	1.42 (0.96, 2.09) 0.08		1.29 (0.90, 1.84) 0.17		1.48 (1.03, 2.14) 0.04		1.34 (0.97, 1.87) 0.08	
	Trucker	0.83 (0.64, 1.07) 0.15		0.62 (0.49, 0.77) 0.000		0.82 (0.65, 1.04) 0.10		0.69 (0.57, 0.85) 0.000	
	Other	1.07 (0.95, 1.20) 0.29		1.03 (0.93, 1.14) 0.61		0.96 (0.86, 1.07) 0.49		0.97 (0.88, 1.07) 0.51	
Pregnancy status	No	1	25910, 9683	1	25902, 9678	1	26245, 9733	1	26263, 9734
	Yes	1.20 (1.08, 1.34) 0.001		1.13 (1.02, 1.24) 0.02		1.07 (0.96, 1.19) 0.20		1.15 (1.05, 1.25) 0.002	

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Table 24 continued

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Type of relationship	Husband	1	28877, 10645	1	28869, 10639	1	29256, 10704	1	29265, 10705
	Current consensual partner	1.30 (1.17, 1.44) 0.000		1.16 (1.05, 1.27) 0.002		0.88 (0.80, 0.98) 0.02		1.04 (0.95, 1.13) 0.37	
	Boyfriend	0.62 (0.54, 0.70) 0.000		0.52 (0.47, 0.59) 0.000		0.76 (0.68, 0.85) 0.000		0.61 (0.55, 0.69) 0.000	
	Other	0.51 (0.29, 0.90) 0.02		0.34 (0.20, 0.58) 0.000		1.31 (0.86, 1.99) 0.21		0.72 (0.48, 1.07) 0.10	
Length of time in relationship	<4 years	1	26707, 9895	1	26703, 9891	1	27042, 9955	1	27050, 9956
	4-6 years	0.82 (0.72, 0.92) 0.001		0.93 (0.84, 1.04) 0.19		0.99 (0.88, 1.11) 0.81		0.92 (0.83, 1.02) 0.11	
	>6 years	0.76 (0.68, 0.85) 0.000		0.80 (0.72, 0.88) 0.000		0.97 (0.87, 1.07) 0.52		0.81 (0.74, 0.89) 0.000	

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Table 24 continued

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Partner age difference	Same age	1	23607, 9607	1	23602, 9601	1	23882, 9680	1	23887, 9682
	≥10 years older	1.16 (0.92, 1.47) 0.2		1.39 (1.13, 1.70) 0.002		1.03 (0.84, 1.27) 0.78		1.13 (0.94), 1.35) 0.19	
	5-9 years older	1.18 (0.95, 1.47) 0.13		1.32 (1.09, 1.60) 0.004		0.98 (0.81, 1.19) 0.84		1.14 (0.96, 1.35) 0.14	
	<5 years older	1.21 (0.99, 1.49) 0.07		1.32 (1.10, 1.59) 0.003		0.94 (0.78, 1.14) 0.54		1.07 (0.91, 1.26) 0.38	
	<5 years younger	1.41 (1.03, 1.92) 0.03		1.46 (1.10, 1.93) 0.01		1.16 (0.87, 1.55) 0.30		1.31 (1.02, 1.68) 0.04	
	≥5 years younger	1.49 (0.85, 2.63) 0.16		1.35 (0.80, 2.26) 0.26		1.04 (0.60, 1.78) 0.90		1.40 (0.90, 2.26) 0.13	
Number of partners in past year	1	1	27664, 10306	1	27657, 10297	1	27885, 10419	1	27892, 10419
	2 or more	1.65 (1.38, 1.98) 0.000		1.21 (1.02, 1.43) 0.03		1.53 (1.28, 1.82) 0.000		1.37 (1.17, 1.60) 0.000	
Woman's use of alcohol before sex	No	1	28693, 10623	1	28685, 10617	1	29072, 10685	1	29081, 10686
	Yes	1.48 (1.35, 1.62) 0.000		1.36 (1.25, 1.47) 0.000		1.61 (1.48, 1.76) 0.000		1.45 (1.35, 1.56) 0.000	

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Table 24 continued

Contemporary factor		Physical IPV		Verbal IPV		Sexual IPV		Any IPV	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*
Partner's use of alcohol before sex	No	1	25144, 10306	1	25137, 10301	1	25516, 10380	1	25525, 10381
	Yes	1.74 (1.59, 1.91) 0.000		1.65 (1.52, 1.80) 0.000		1.68 (1.54, 1.83) 0.000		1.67 (1.55, 1.80) 0.000	
Attitudes toward violence	Not acceptable	1	21768, 9479	1	21760, 9476	1	22081, 9540	1	22088, 9541
	Acceptable	1.44 (1.26, 1.66) 0.000		1.49 (1.33, 1.68) 0.000		1.79 (1.57, 2.04) 0.000		1.68 (1.51, 1.87) 0.000	
HIV status	Negative	1	28318, 10559	1	28310, 10552	1	28668, 10619	1	28677, 10620
	Positive	1.21 (1.03, 1.41) 0.02		1.08 (0.93, 1.24) 0.31		1.08 (0.93, 1.24) 0.31		1.03 (0.91, 1.17) 0.64	

*N in model is number of observations, number of groups (*i.e.* women).

All variables were initially included in multivariable models. For physical violence and verbal violence, relationship type was removed from the model as per the specified criteria. For any violence and sexual violence, the likelihood ratio test was significant on removing relationship type, so all variables were retained in the final model. Most associations were consistent across types of violence, as shown in Table 25. Factors which were significantly and positively associated with any violence at a level of $p<0.05$ were being a woman who uses alcohol before sex with an odds ratio of 1.28 (1.14, 1.43) and having a partner who uses alcohol before sex with an odds ratio of 1.63 (1.45, 1.84), and thinking that a man beating his wife is acceptable in certain situations, with an odds ratio of 1.58 (1.38, 1.81). Factors that were significantly and negatively associated with any violence at a level of $p<0.05$ (*i.e.* were protective) were older age with an odds ratio of 0.99 (0.98, 0.996) per increasing year of age; having a partner who is a

professional with an odds ratio of 0.78 (0.65, 0.94); being in a relationship with a consensual partner as compared with a husband with an odds ratio of 0.84 (0.74, 0.96); being in a relationship for a longer period of time with an odds ratio of 0.79 (0.69, 0.92) for a relationship of 4 to 6 years and 0.74 (0.63, 0.87) for a relationship longer than 6 years compared to a relationship of less than 4 years; and having a partner who is older with an odds ratio of 0.78 (0.62, 0.99) for 5 to 9 years older and 0.79 (0.63, 0.99) for less than 5 years older, compared with a partner of the same age. Pregnancy status was not associated with violence, with odds ratios between 0.97 and 1.06 across types of violence. HIV positivity was only associated with physical violence, though the odds ratio for this association is quite small and of borderline significance at 1.25 (1.01, 1.56). Marital status, religion, and number of partners in the past year were also not significantly associated with IPV.

Table 25. Multivariable associations between factors in the past year and violence in the current year, OR (95% CI), p value

Contemporary factors		Physical IPV 13451 observations, 6876 women	Verbal IPV 13447 observations, 6872 women	Sexual IPV 13529 observations, 6915 women	Any IPV 13533 observations, 6916 women
Age	Continuous	0.98 (0.96, 0.99) 0.000	0.98 (0.97, 0.99) 0.000	1.00 (0.98, 1.01) 0.08	0.99 (0.98, 1.00) 0.01
Marital status	Never married	1	1	1	1
	Previously married	1.29 (0.86, 1.93) 0.23	0.99 (0.70, 1.40) 0.96	1.23 (0.86, 1.76) 0.11	1.11 (0.82, 1.50) 0.51
	Currently married-polygamous	3.07 (2.15, 4.39) 0.000	2.40 (1.78, 3.23) 0.000	2.09 (1.09, 4.01) 0.03	1.61 (0.92, 2.82) 0.10
	Currently married-monogamous	2.88 (2.06, 4.04) 0.000	2.35 (1.78, 3.11) 0.000	1.66 (0.87, 3.17) 0.12	1.42 (0.82, 2.48) 0.22
Religion	Catholic	1	1	1	1
	Protestant	0.90 (0.75, 1.07) 0.22	0.96 (0.82, 1.11) 0.58	1.08 (0.92, 1.27) 0.36	1.03 (0.89, 1.18) 0.70
	Muslim	0.73 (0.58, 0.92) 0.01	0.72 (0.59, 0.87) 0.001	0.93 (0.76, 1.15) 0.53	0.85 (0.71, 1.02) 0.08
	Other	1.13 (0.76, 1.66) 0.55	0.94 (0.66, 1.33) 0.74	1.21 (0.84, 1.74) 0.31	1.01 (0.74, 1.38) 0.95
Occupation	Agriculture	1	1	1	1
	Shopkeeper/trading /vending	0.98 (0.78, 1.23) 0.87	1.11 (0.92, 1.36) 0.28	0.85 (0.68, 1.06) 0.14	0.89 (0.74, 1.07) 0.21
	Housework	1.05 (0.75, 1.45) 0.79	1.08 (0.81, 1.45) 0.58	0.92 (0.67, 1.27) 0.61	0.97 (0.74, 1.27) 0.85
	Professional	0.92 (0.68, 1.26) 0.61	0.88 (0.67, 1.15) 0.35	1.01 (0.76, 1.34) 0.95	0.84 (0.66, 1.07) 0.16
	Student	$2.64x10^{-16}$ (0, -) 1.0	1.72 (0.39, 7.48) 0.47	$4.81x10^{-8}$ (0, -) 0.99	1.03 (0.25, 4.28) 0.97
	Home brewing/bar worker/owner	1.65 (1.05, 2.58) 0.03	1.21 (0.80, 1.83) 0.37	0.91 (0.59, 1.42) 0.69	1.16 (0.79, 1.68) 0.45
	Other	0.98 (0.77, 1.25) 0.88	0.96 (0.77, 1.18) 0.67	1.04 (0.83, 1.30) 0.72	1.01 (0.84, 1.23) 0.88

Table 25 continued

Contemporary factors		Physical IPV 13451 observations, 6876 women	Verbal IPV 13447 observations, 6872 women	Sexual IPV 13529 observations, 6915 women	Any IPV 13533 observations, 6916 women
Partner's occupation	Agriculture	1	1	1	1
	Shopkeeper/trading /vending	0.99 (0.84, 1.17) 0.93	0.87 (0.75, 1.00) 0.05	0.98 (0.84, 1.14) 0.79	0.89 (0.78, 1.01) 0.07
	Professional	0.78 (0.61, 0.99) 0.04	0.67 (0.54, 0.82) 0.000	0.96 (0.77, 1.20) 0.73	0.78 (0.65, 0.94) 0.01
	Student	0.88 (0.15, 5.08) 0.89	0.66 (0.15, 3.02) 0.6	0.33 (0.03, 3.07) 0.33	0.70 (0.18, 2.68) 0.61
	Home brewing/bar worker/owner	1.58 (0.94, 2.67) 0.09	1.09 (0.67, 1.77) 0.74	1.64 (0.99, 2.72) 0.06	1.20 (0.76, 1.88) 0.44
	Trucker	0.90 (0.63, 1.31) 0.59	0.74 (0.53, 1.02) 0.06	0.94 (0.67, 1.32) 0.73	0.79 (0.59, 1.05) 0.10
	Other	0.98 (0.83, 1.15) 0.77	0.94 (0.81, 1.08) 0.37	0.98 (0.83, 1.15) 0.78	0.92 (0.80, 1.05) 0.80
Pregnancy status	No	1	1	1	1
	Yes	1.06 (0.90, 1.23) 0.49	1.01 (0.88, 1.16) 0.91	0.97 (0.83, 1.15) 0.70	1.02 (0.90, 1.16) 0.71
Type of relationship	Husband	-	-	1	1
	Current consensual partner	-	-	0.68 (058, 0.80) 0.000	0.84 (0.74, 0.96) 0.01
	Boyfriend	-	-	0.93 (0.52, 1.69) 0.82	0.63 (0.38, 1.06) 0.08
	Other	-	-	3.92 (1.14, 13.52) 0.03	1.26 (0.39, 4.07) 0.70
Length of time in relationship	<3 years	1	1	1	1
	4-6 years	0.70 (0.58, 0.83) 0.000	0.80 (0.68, 0.94) 0.01	0.85 (0.71, 1.01) 0.07	0.79 (0.69, 0.92) 0.002
	>6 years	0.75 (0.63, 0.91) 0.003	0.78 (0.66, 0.92) 0.004	0.85 (0.70, 1.02) 0.08	0.74 (0.63, 0.87) 0.000

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Table 25 continued

Contemporary factors		Physical IPV 13451 observations, 6876 women	Verbal IPV 13447 observations, 6872 women	Sexual IPV 13529 observations, 6915 women	Any IPV 13533 observations, 6916 women
Partner age difference	Same age	1	1	1	1
	≥10 years older	0.81 (0.59, 1.10) 0.17	0.89 (0.69, 1.17) 0.42	0.89 (0.67, 1.17) 0.40	0.79 (0.62, 1.00) 0.05
	5-9 years older	0.87 (0.65 1.16) 0.33	0.82 (0.63, 1.17) 0.12	0.87 (0.66, 1.14) 0.31	0.78 (0.62, 0.99) 0.04
	<5 years older	0.94 (0.71, 1.24) 0.66	0.86 (0.67, 1.10) 0.24	0.86 (0.66, 1.11) 0.25	0.79 (0.63, 0.99) 0.04
	<5 years younger	1.19 (0.79, 1.80) 0.41	0.92 (0.64, 1.34) 0.67	1.24 (0.85, 1.82) 0.27	1.03 (0.74, 1.44) 0.85
	≥5 years younger	1.14 (0.54, 2.40) 0.72	1.30 (0.68, 2.50) 0.43	0.99 (0.49, 2.00) 0.99	1.28 (0.70, 2.33) 0.42
Number of partners in past year	1	1	1	1	1
	2 or more	2.03 (1.42, 2.91) 0.000	1.42 (1.01, 1.98) 0.04	1.33 (0.92, 1.91) 0.12	1.35 (0.98, 1.86) 0.06
Woman's use of alcohol before sex	No	1	1	1	1
	Yes	1.32 (1.14, 1.52) 0.00	1.22 (1.08, 1.39) 0.002	1.44 (1.26, 1.66) 0.000	1.28 (1.14, 1.43) 0.000
Partner's use of alcohol before sex	No	1	1	1	1
	Yes	1.68 (1.45, 1.95) 0.000	1.64 (1.44, 1.87) 0.000	1.52 (1.32, 1.75) 0.000	1.63 (1.45, 1.84) 0.000
Attitudes toward violence	Not acceptable	1	1	1	1
	Acceptable	1.47 (1.24, 1.75) 0.000	1.43 (1.23, 1.66) 0.000	1.77 (1.50, 2.09) 0.000	1.58 (1.38, 1.81) 0.000
HIV status	Negative	1	1	1	1
	Positive	1.25 (1.01, 1.56) 0.04	1.11 (0.91, 1.34) 0.30	1.15 (0.94, 1.40) 0.18	1.04 (0.87, 1.23) 0.69

As shown in Appendices 7 and 8, bivariate and multivariable models were also conducted to examine the relationships between contemporary factors in the current year and IPV in the current year. In multivariable models, many of the associations were qualitatively similar, and of note, pregnancy was not a risk factor for violence in the same year, and in fact was associated with a lower risk of IPV with an odds ratio of 0.88 (0.80, 0.98).

Analyses were conducted to assess whether the results of a multivariable model of any violence were different when stratified by whether women had had more than one partner per year, which revealed similar results in terms of the magnitudes of association and which relationships were statistically significant for women with only one partner in the past year (13234 observations on 6790 women). For women with more than one partner in the past year (299 observations on 264 women), the associations were not significantly different from those for women with only one partner for age, alcohol use before sex by the woman, alcohol use before sex by the partner, or attitudes toward violence, however, these associations were no longer statistically significant. The associations was qualitatively different and statistically significant for HIV positivity, showing that people with HIV were less likely to experience violence, which was statistically significant with an odds ratio of 0.25 (0.08, 0.82), and for having a partner who is a shopkeeper, trader, or vendor, with an odds ratio of 3.17 (1.02, 9.86). The association was also qualitatively different for being married in a monogamous relationship, with an odds ratio of 0.87 (0.16, 4.88), which was not statistically significant. The results were otherwise similar to the non-stratified model, *i.e.* the associations were similar for religion, occupation, pregnancy status, relationship length, relationship type, and age difference with partner.

Analyses were also conducted to look only at women who reported never having previously experienced any form of violence (in round 8) and excluding women from the dataset after they reported having experienced violence for the first time (data not shown). This model included 3550 observations on 1730 women, and found that the associations between the participant's use of alcohol and the partner's use of alcohol in the past year, respectively, remained significantly positively associated with violence in the current year, while having a partner who was 10 or more years older was associated with a decreased odds of violence, with an odds ratio of 0.57

(0.32, 0.98). The odds of violence for age and attitudes toward violence maintained a similar odds of infection but were no longer statistically significant. Variables and categories which changed their direction of association to being positively associated include being in a relationship 4 to 6 years in duration compared to a relationship 3 or fewer years in duration and having a current consensual partner or boyfriend, respectively, compared to having a husband, though none of these associations were significant.

Looking specifically at women who developed HIV over the course of the study, the prevalence of any IPV was 37.3% (146/391) in the round prior to developing HIV, 34.1% (168/493) in the round when HIV was diagnosed, and 32.0% (82/256) in the round subsequent to HIV diagnosis, suggesting that the level of violence does not vary significantly in the immediate period surrounding diagnosis.

6.6 Discussion

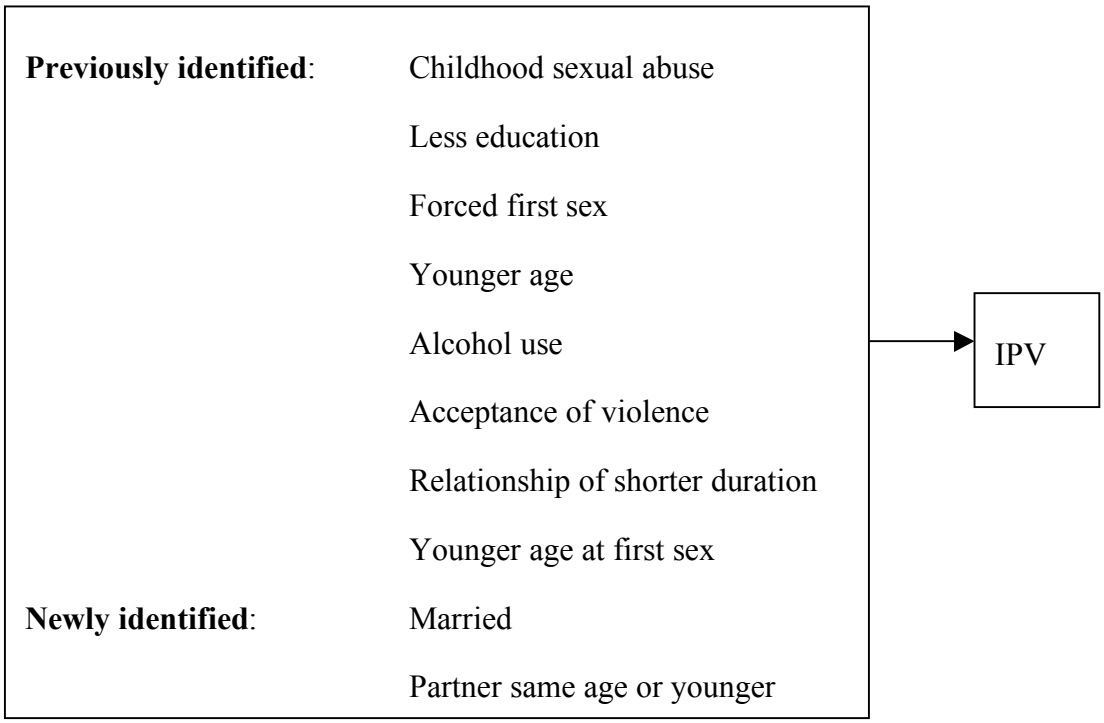
As found in diverse studies internationally, IPV was prevalent in this population and most women who experienced violence reported experiencing more than one form of violence simultaneously. Several of the risk factors identified in this study are consistent with existing evidence,[2] including sexual abuse in childhood or adolescence, less education, forced first sex, younger age, alcohol use by women and by their partners, being in a relationship of shorter duration, and thinking that violence is acceptable. Given this, the findings regarding the magnitudes of association between each of these risk factors and IPV may be externally generalizable to other settings in sub-Saharan Africa and elsewhere. Being married was found to increase the risk of violence compared to having a current consensual partner, as was having a partner who was older. The extent to which these factors may be relevant elsewhere is unclear, and would require more careful analysis of age at first sex, marital status and age difference with partner in other settings.

The results of this study were similar to those of previous cross-sectional analyses which used

data from the RCCS,[7, 8] except that being in a consensual relationship emerged as protective as compared to being in a relationship with a husband. Additional significant risk factors identified in this study were sexual abuse in childhood or adolescence, coerced first sex, and thinking that violence is acceptable.

In contrast with much of the literature on risk factors for IPV[2] but consistent with another analysis of RCCS data[7] and some other studies from sub-Saharan Africa,[11, 22] being pregnant was not associated with experiencing IPV in this study. There are several methodological factors which could lead to this inconsistency. First, longitudinal data were used in this study, so that the temporal sequence of pregnancy predating IPV could be appropriately modelled. However, it was not possible to determine the exact timing of the pregnancy relative to the outcome of IPV, since data on the timing of the pregnancy were not collected. This is relevant since studies have found that the rates of IPV vary prior to, during, and subsequent to pregnancy,[81, 82] and so the lack of specificity in the modelling of the timing of pregnancy relative to IPV may preclude the identification of an association if one exists. Second, in these analyses, other important variables were controlled for, such as acceptance of violence, younger age, and difference in age between partners, and these variables might otherwise positively confound the association between pregnancy and violence. Third, the definition of IPV used in various studies, *e.g.* which types of IPV were measured and modelled, may affect estimates of association. In this study, data on physical, verbal, and sexual IPV were included, however, there were no data collected on controlling behaviours, which could affect the magnitude of association identified if controlling behaviours were associated with pregnancy independently of other forms of IPV. Finally, the finding of a lack of association could reflect effect modification on the basis of geographical or cultural contexts, *i.e.* that the association between pregnancy and IPV may only be true in certain contexts.

Figure 7. Risk factors for IPV in women in Rakai, Uganda



Another important finding of this study is that the rate of IPV does not increase significantly in the immediate period after HIV infection. This suggests that in this population, the causal relationship from HIV to IPV, *i.e.* mechanism F in Figure 1, at least in this period after diagnosis, does not constitute a major component of the association found between IPV and HIV in cross-sectional analyses.

A relevant methodological consideration for these analyses is the choice of the logistic regression model. Given that the outcome of IPV is common in this population, the odds ratio does not provide an accurate estimate of the relative risk of IPV.[61] However, for a general public health audience, the odds ratio is a well-known and easily interpretable test statistic, so that the logistic model remains an appropriate selection.

The strengths of this study are its large size, high participation rates, prospective design, the inclusion of several important variables of interest as potential predictors, and the separation of early and contemporary factors in analyses. There are also, however, several limitations to this study. There are some risk factors which may be relevant which were not included, such as number of children, income level, the gap in income and education between partners, and prior experiences of violence, which may result in residual confounding of the associations between added variables and violence shown in the multivariable models. Some variables may not specifically identify risky behaviour, for example looking at use of any alcohol before sex as opposed to heavy alcohol use or more general problematic alcohol consumption, which may dilute the association and bias the estimate of the effects of problematic alcohol use toward the null. While it is a strength to be able to use longitudinal data to look specifically at whether each variable is associated with subsequent violence, it is unclear whether the time frame of consecutive years is the most appropriate way to model these associations, and for some variables such as pregnancy, a more specific time period might be more appropriate, for example the exact period when a woman is pregnant. Finally, some of the subanalyses, such as looking only at women with only one partner in the past year, women with more than one partner in the past year, or women who reported never having experienced violence previously, may have inadequate power.

In conclusion, the novel contributions of this Chapter are identifying risk factors for IPV in women living in rural areas of Uganda. This study confirms that certain established risk factors from other settings are associated with IPV in this setting, *i.e.* sexual abuse in childhood or adolescence, lower levels of education, forced first sex, younger age, alcohol use by women and their partners, being in a relationship of shorter duration and thinking that violence is acceptable; indicates that several hypothesized risk factors are not associated with IPV, *i.e.* pregnancy and HIV positivity; and also identifies novel risk factors for IPV in this setting, *i.e.* younger age at first sex, being married, and having a partner the same age or younger. These findings are particularly noteworthy given the strengths of the study design and analyses, especially the use of longitudinal and population-based data and the separation of early and contemporary factors. These findings are likely generalizable to other rural areas in sub-Saharan Africa and potentially

elsewhere, and have direct implications for public health action in terms of primary and secondary prevention of IPV.

There are various approaches to addressing violence against women,[2] and the risk factors identified in this study suggest the need to develop strategies at different levels. At the societal level, gender transformative programming and policies are needed to shift the norms and attitudes of communities and individuals with respect to violence and risk factors such as alcohol use, with the ultimate goal of changing the acceptance of violence and consequently the rates of violence ranging from childhood sexual abuse to forced first sex and on-going IPV. At an individual level, specific steps can be taken to decrease a woman's vulnerability to violence, which may include strategies as diverse as optimizing access to basic education and changing the built and social environments in which women and girls live to optimize their safety. Also, work can be done with male perpetrators or with males at high risk of perpetrating violence. Further research is needed to determine the effectiveness of specific interventions, in particular the relative effectiveness of various approaches in the context of low and middle income countries.[2]

7 Chapter Seven: Discussion

This discussion builds on the discussion presented in Chapters 4, 5, and 6, summarizes the overall findings, limitations, and significance of this research, and provides suggestions for future research.

7.1 Overall findings

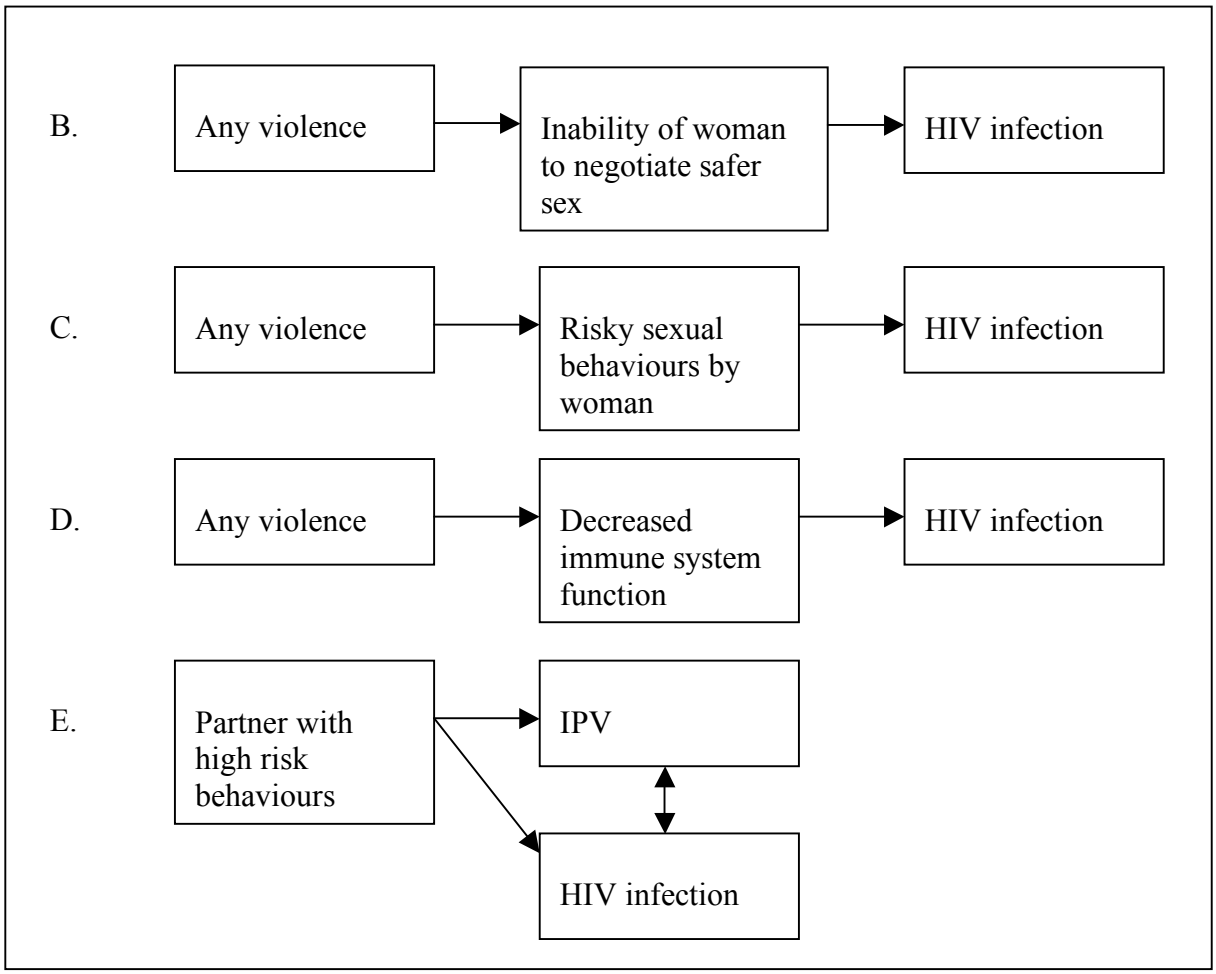
As discussed in Chapter 4, this study identified a significant independent association between IPV and incident HIV infection. This association was present and similar for different forms of violence, *i.e.* across sexual, verbal, and physical IPV, and across ways of modelling the period of exposure to violence. The odds of HIV infection tended to be stronger for longer periods of exposure to IPV, for severe forms of IPV compared with minor forms of IPV, and for more frequent exposure to IPV (for longer periods of exposure). The proportion of risk of HIV attributable to IPV after adjusting for confounding was 14.3% (2.8, 23.6). There is evidence that both sexual abuse in childhood and adolescence and pregnancy intent may modify the association between IPV and HIV, although this effect was not statistically significant.

In Chapter 5, the assessment of condom use and number of partners in the past year revealed no evidence that either of these two variables mediated the relationship between IPV and HIV.

In Chapter 6, analyses identified several risk factors for violence in women in Rakai, Uganda, specifically lower levels of education, younger age at first intercourse, coerced first intercourse and childhood or adolescent sexual abuse for early factors, and being married, having a partner the same age compared to an older partner, being in a relationship of shorter duration, using alcohol before sex, having a partner who used alcohol before sex, and thinking that a man beating his wife is acceptable for contemporary factors. Pregnancy and HIV positivity were not associated with an increased odds of IPV.

Considering the potential mechanism of the overall relationship between IPV and HIV, as illustrated in Figure 1, evidence from Chapter 4 showed that the magnitude of the association between incident HIV infection and each of sexual, verbal, and physical violence was similar, which suggests that mechanism A, *i.e.* that sexual violence leads to physical trauma which makes HIV infection more likely, is not likely to be a major pathway (though, as noted in Chapter 4, the overlap in types of violence experienced by many women complicates interpretation). Evidence from Chapter 6 suggests that the level of IPV did not increase in the immediate period after infection, and therefore mechanism F, *i.e.* that HIV infection leads to IPV, is not likely a major factor accounting for the association. The results of Chapter 5 fail to provide support for either mechanism B, *i.e.* that IPV limits a woman's ability to negotiate safer sex, or mechanism C, *i.e.* that experiencing IPV may lead a woman to have risky sexual behaviours. Importantly, however, these results also do not refute that mechanisms B and C are occurring and are important; as these analyses do not examine all potential mediators which may be relevant for each mechanism, both mechanisms remain plausible. Therefore, mechanisms B, C, D, and E all remain plausible explanations for the associations noted between IPV and HIV, as illustrated in Figure 8.

Figure 8. Revised hypothesized mechanisms for the relationship between IPV and HIV



Another way to consider how the results of this work explain the nature of the association between IPV and HIV is to look at criteria for causality,[83] specifically strength of association, temporality, consistency (within the study and across studies), plausibility, dose-response, specificity, and experiment. The strength of association is of a moderate size, *i.e.* in the range of 1.32 to 1.58 for any violence, depending on the period of exposure. The temporal sequence of exposure to IPV and infection with HIV has been demonstrated in general through the use of longitudinal data including only people who were HIV-negative at baseline, and in particular by modelling the period of exposure to IPV as prior to the year in which participants had their first positive HIV test result. Considering consistency within this study, there is consistency in findings of a moderately sized relationship across various types of IPV and periods of exposure to IPV. Across studies, the literature review reveals a lack of consistency in various studies

identifying an association between IPV and HIV and in the magnitude of the association detected, however, the methodological differences and limitations, as well as the variation in geographical and cultural context provide plausible reasons for these divergent findings. There are several hypothesized mechanisms which support the plausibility of an association between IPV and HIV, although as noted, it remains uncertain which mechanism or mechanisms are primarily responsible for this association. Although not clear, there is a suggestion of a dose-response relationship between more frequent violence and HIV infection, in particular for longer periods of exposure to violence. (Of note, demonstrating a dose-response relationship would not be necessary given that it is reasonable to think that there might be a threshold of exposure to violence after which risk of HIV infection might increase). Also, the fact that women who experienced severe forms of violence tended to be at higher risk than women who experienced minor forms of violence suggests that intensity of IPV may be relevant, which may be considered another form of dose-response. This study does not provide information on experiment; while ethical considerations would prevent most types of experiment relevant to this relationship (*e.g.* randomization of participants to IPV or no IPV), it would be possible to assess the impact of an intervention to decrease IPV on incident HIV infection. Specificity is not relevant in consideration of this particular relationship. These criteria notwithstanding, without data to examine the HIV infection rates and risk behaviours of women's partners, it is not possible to determine whether IPV functions as a marker of risk or as a cause of HIV infection.

7.2 Study strengths

As noted, the strengths of this study overall are its longitudinal nature, its size, high participation rates, the inclusion of questions on various relevant confounders, effect modifiers, and mediators, and the inclusion of questions on frequency and severity of three forms of IPV: sexual, verbal, and physical. Since the study is population-based, participation rates are high, and the samples included in these analyses are similar to the study population, the findings of these analyses are likely generalizable to other populations in Uganda and East Africa, and potentially elsewhere. Strengths of analyses include looking at each form of IPV separately as well as together and considering various periods of exposure to IPV, given that there is no clear empirical or theoretical basis for modelling IPV in one specific way, and the use of random effects models. In

the assessment of putative mediators, two methods were used which produced consistent results. In the assessment of predictors of IPV, the separate assessment of early and contemporary factors is important given that contemporary factors may be on the causal pathway between early factors and HIV infection.[79]

7.3 Study limitations

As noted in Chapters 4, 5, and 6, there are several limitations to these analyses.

7.3.1 Measurement of IPV

Having a valid measure of IPV is clearly important for accurate estimation of the association between IPV and HIV. As noted, the questions on IPV used in the Rakai Community Cohort Study were modified from the Revised Conflict Tactics Scales (CTS2).[56, 57] These IPV questions have not been validated in this population, and there are limitations to the CTS2 including that it does not provide information about the context in which acts of violence occur,[71] which may be relevant to understanding the experience of violence and its risks, and that it does not include questions on control as a form of IPV. These issues could lead to random or systematic error due to misclassification bias, or to obscuring patterns of risk if there is significant heterogeneity in risk of subgroups of people who experienced violence.

The lack of data collected in certain rounds on ever having experienced violence and on the frequency of violence across study rounds is another issue. This limits power in analyses of these factors, and as with the issue of a lack of data on the context of violence, could preclude the recognition of specific factors that contribute to risk for HIV infection. Further, no data were collected on the timing of violence over the course of the year, which might similarly contribute to an understanding of the risk, *e.g.* in the event that experiencing violence only in a single week or month confers a different level of risk than experiencing violence consistently over a longer time period.

As noted already, there is no consensus regarding the period of exposure to IPV which affects risk of HIV infection. Given this, various periods of exposure were considered in these analyses, which could potentially lead to Type I error. However, the consistency of findings across periods of exposure is reassuring that the association identified is valid.

There may be underreporting of violence because of its sensitive nature and of concerns about possible stigma. Procedures in the Rakai cohort have been developed which should minimize the likelihood of underreporting for this reason, including the development of a close rapport over time between interviewers and respondents, the expertise of interviewers at collecting sensitive information, and the efforts undertaken to ensure privacy and protect the confidentiality of all responses.[7] Further, given that women are excluded from the analyses after their first positive HIV test and that women are unlikely to find out their positive HIV status prior to their HIV test (*i.e.* they would be unlikely to know that they are HIV-positive at the time when they are taking the survey), any resulting bias would likely be random and therefore lead to an underestimate of the association between IPV and HIV.

Another potential issue is that the perpetration of violence by male partners is reported by women and there are no data available from men on their perpetration of IPV. This is important given that the concordance of reporting of IPV by partners is typically low.[84] Depending on how IPV and HIV are associated, however, women's subjective experience of IPV may be what is important in determining risk for HIV, for example if negotiating safer sex or developing risky sexual behaviours were the primary mechanisms.

7.3.2 Measurement of HIV status

As noted in Chapter 4, HIV test results were available for 87.4% of rounds of observation and 97.3% of women. However, HIV status was only ascertained at the time of each study round, so that it was not possible to identify the specific time at which women were infected with HIV. These data would be valuable in order to more clearly understand the nature of the association

between IPV and HIV, *e.g.* if the increase in risk begins simultaneously with exposure to IPV, however, it would not be feasible or desirable from a participant or an investigator perspective to collect samples from thousands of participants more frequently. Sensitivity analyses of the timing of HIV infection revealed similar results in terms of a positive association between IPV and HIV infection.

The high sensitivity and specificity of HIV testing and the fact that most women had repeated HIV tests as they participated in multiple rounds makes it unlikely that there is significant misclassification of outcome status.

7.3.3 Misclassification of other variables

Also relevant to the estimates of association is the potential misclassification of variables which function in these data as confounders, effect modifiers, and mediators. In particular, some variables may not appropriately capture risky behaviour, for example looking at use of any alcohol before sex as opposed to heavy alcohol use or more general problematic alcohol consumption. Misclassification of these variables would likely not be associated with HIV status, and therefore any bias would likely be toward the null.

7.3.4 Lack of relevant data

Data were not available to be able to test certain hypothesized mechanisms for the association between IPV and HIV (see Figure 1), including data on women's risky sexual behaviours, biological markers of immune function, and male partners' sexual risk behaviours. The lack of these data precludes a clear understanding of how IPV and HIV are associated. Importantly and as noted, given the existing hypotheses, data on male partners' sexual risk behaviours would allow the distinction of whether the experience IPV is in fact a marker of risk for HIV infection or is causally associated with HIV.

There are other variables which might be relevant for all three objectives which were not available. These include number of children, income level, and the gap in income and education between partners. Not having controlled for these potential confounders means there could be residual confounding of the associations found, which could be associated with an overestimate or underestimate of associations, depending on the direction of confounding (if it exists).

Certain variables were included only in certain rounds, *e.g.* sexual abuse in childhood or adolescence and forced first sex. Some variables were available in certain rounds only for women completing their baseline round or follow up rounds, *e.g.* attitudes toward violence and pregnancy intent. Both of these situations would decrease power as they would lead to fewer observations than if all variables had been included in all rounds, and might also lead to a lack of generalizability of the results obtained using these variables if the population for which data are available were different than the full population. However, the number of questions which can be included in each round is limited due to feasibility considerations.

7.3.5 Data analyses

In the analyses of condom use and number of partners in the past year as mediators, it was not possible to do repeated measures analyses or to adjust for confounders for Sobel-Goodman tests of the indirect effects, because of limitations in available software. As noted already, however, the consistency of results between findings from the two methods used, *i.e.* assessing the Baron and Kenny criteria and conducting Sobel-Goodman tests, and using different data, *i.e.* repeated measures or sequential data from either two or three rounds, suggests that the findings are valid.

As with modelling exposure to IPV for objective 1, it is difficult to determine the appropriate time period of exposure for the various risk factors assessed in objective 3. In fact, the relevant exposure period may differ between risk factors, *e.g.* pregnancy compared with occupation,

which is difficult to account for in regression analyses. Inappropriately modelling the time period of exposure could lead to underestimating the association, but not likely to overestimating the association.

An important methodological consideration is the choice of the logistic model for these analyses. The logistic model performs well in random effects models and does not present difficulties with mal-dispersion or failure to converge as are commonly observed with alternative models such as the log binomial or count models. The odds ratio is an easily interpretable statistic for an epidemiology or statistically literate research audience. Further, given that the outcome of HIV infection is uncommon in this population, the odds ratio is a close approximation of relative risk of HIV infection.[61] In contrast, as IPV is a common outcome, the odds ratio does not provide an accurate estimate of the relative risk of IPV, however, the odds ratio remains an appropriate statistic in this context. In specific instances in this thesis, relative risks and attributable risks are explicitly presented, *e.g.* for descriptive purposes and in the estimation of population attributable risk fraction in Chapter 4.

7.3.6 Loss to follow up

Analyses of data from objective 1 (in Chapter 4) revealed relatively high rates of loss to follow up, though notably this was over a period of many years for most participants. Sensitivity analyses indicate that estimates of the relative association between violence and HIV are not likely to change, and in particular would not be nullified, as long as the HIV incidence rate was higher or the same for people who experienced violence and were lost to follow up as for people who did not experience violence and were lost to follow up. Stratified analyses suggest that women who participated in fewer rounds have a similar odds ratio for the association between violence and HIV compared with women who participated in more rounds, however, it is not possible to determine whether the odds of infection may have changed over time in those women who did not participate in subsequent rounds. Multiple imputation was of limited value, however, results of analyses of multiply imputed data were similar to estimates using available data.

7.4 Significance

The findings of this study mark important progress in understanding the association between IPV and HIV infection. In addressing the three study objectives, this study has produced novel information which is valuable to understanding the associations between IPV and HIV and to preventing IPV and potentially HIV. This thesis makes five main contributions:

1. Quantification of the association between IPV and HIV: The use of longitudinal and population-based data, the use of a measure of IPV which includes three types of IPV, the appropriate treatment of confounders and mediators, and the modelling of different periods of exposure to IPV make this the most comprehensive assessment of the association between IPV and HIV to date. Given the strength of the study design and analyses, the findings from this study regarding the magnitude of association between IPV and incident HIV are less fraught with limitations and are therefore more credible than other estimates, in addition to being consistent with other estimates.[26, 27] The findings regarding the magnitude of association may be generalizable to other contexts, including other rural settings in sub-Saharan Africa, other countries in East Africa, and potentially elsewhere.

2. Elucidation of key characteristics of the association between IPV and HIV: Data collected by the RCCS between 2000 and 2009 allowed for assessment of important aspects of the association between IPV and HIV, including the association between periods of IPV exposure and HIV infection, the relative odds of HIV infection for severe IPV and minor IPV compared with no IPV, and the association between the frequency of IPV and HIV infection. Each of these characteristics had not been well explored in other studies, and the findings from this study are particularly notable given the study strengths as already indicated. Depending on the mechanism or mechanisms which are responsible for the association between IPV and HIV, these characteristics are likely generalizable to other settings.

3. Assessment of two proposed mediators: This study conducts the first explicit assessment of two putative mediators of the association between IPV and HIV. The fact that there

was no evidence that condom use in the past year or number of partners in the past year mediated the association between IPV and HIV is of particular note given the power of these analyses and the use of longitudinal data to ensure appropriate temporal modelling of these variables. As discussed in Chapter 5, the validity of this finding is supported by indirect evidence from other studies on IPV and HIV.

4. Understanding the mechanism of association for the relationship between IPV and HIV: Although it was not possible using the data available for this study to distinguish between IPV as a risk factor or IPV a risk marker for HIV infection, it was possible to examine several of the hypothesized mechanisms of the IPV-HIV association and to consequently deduce that certain pathways are likely less important. The results of Chapter 4 suggest that mechanism A in Figure 1, *i.e.* that trauma to the genital tract associated with rape increases risk of HIV infection with exposure, is at most a minor pathway. Data from Chapter 6 suggest that pathway F in Figure 1, *i.e.* that HIV infection precedes IPV, is not significant, at least in the immediate period surrounding diagnosis. Analyses in Chapter 5 fail to support either mechanism B or mechanism C, however the analyses also do not disprove that these mechanisms are important. In this way, this study provides some of the first empirical evidence regarding the hypothesized mechanisms.

   As illustrated in Figure 8 and suggested by evidence from another study,[24] this study's findings are consistent with the hypothesis that IPV may function as both a risk factor and a risk marker for HIV, and further that there may be several mechanisms for a causal association between IPV and HIV.

5. Identification and quantification of key risk factors for IPV in this setting: As noted, there is a lack of data from longitudinal studies and from developing countries about risk factors for IPV,[2] whereas the high prevalence of IPV in this context and elsewhere indicates the need for appropriate prevention strategies which should take into account risk factors. This study addresses these two limitations, and furthermore appropriately assesses early and contemporary risk factors separately, which putatively allows for a more accurate estimation of the associations of these factors with IPV. This study confirms that certain risk factors identified elsewhere are also associated with IPV in this setting, indicates that certain risk factors identified elsewhere are not associated with IPV

in this setting, and identifies risk factors for IPV which have not been identified in other settings, all of which is important for informing primary and secondary prevention strategies for IPV. The risk and protective factors for IPV identified in women in Rakai are likely relevant to other population of rural women in East Africa, communities with similar cultural and relationship contexts, and potentially elsewhere.

7.5 Implications for public health action

The findings of this study indicate the need for immediate public health action as well as for further research.

7.5.1 Primary prevention of IPV

The prevention of IPV is important as a goal in and of itself in addition to as a potential means for preventing HIV infection. IPV prevention efforts for women could target either risk factors for IPV or IPV itself (or both). Prevention programs should be tailored to the specific contexts in which they are to be implemented, and should be based on established best practices, especially where rigorous evidence exists for strong effects of interventions. Any prevention program should be evaluated to determine its effects in improving the proximal outcome of the relevant risk factor for IPV, and/or the distal outcome of IPV in adulthood, and ideally also the more distal outcome of HIV infection.

The analyses in this study reveal that early experiences of violence are associated with two important consequences, in addition to the varied health effects described in the scientific literature.[85] First, sexual abuse in childhood and adolescence seemed to modify the effect of IPV on HIV, though the association was not statistically significant, and second, sexual abuse in childhood and adolescence and forced first sex were associated with IPV in adulthood. The most commonly used strategies to prevent sexual abuse in childhood are offender management and school-based education programs, however, the evidence regarding their effectiveness is limited.[86] One strategy to prevent sexual violence in adolescence and early adulthood (which

could include forced first sex), which has shown some evidence of effectiveness is sexual violence prevention programs for school and college populations.[2] Other potential areas of focus are interventions to transform gender norms which could influence the use of violence in intimate relationships (and potentially decrease forced first sex in women) and changes in the built and social environments which could decrease the risk of sexual abuse in children.

Other early factors which may be modifiable and which have been shown to be associated with IPV are lower levels of education and earlier age at first sex. Measures to optimize educational attainment could include regulatory measures such as a mandatory schooling to a minimum age, economic incentives for staying in school (which have shown promise in a recent randomized controlled trial with respect to school enrollment as well as HIV and HSV-2 prevalence),[87] and health promotion and communication campaigns to educate youth and families about the benefits of staying in school and to influence social norms regarding staying in school. Regarding age at first sex, potential measures could include educational campaigns about the risks and benefits of sex, and programs to help youth develop skills in sexual decision-making and in communication with their partners.

IPV risk factors in adulthood which may be amenable to intervention include alcohol use before sex by women, alcohol use before sex by partners, and thinking marital IPV is acceptable. Each of these factors is strongly influenced by social norms, so potential interventions could focus on changing social norms. Examples may include working with youth to build skills on healthy communication in relationships, and community-based health promotion on the health consequences of substance abuse and IPV. For alcohol use in particular, there is evidence regarding the effectiveness of regulatory measures, including a minimum legal drinking age, taxation to increase the cost of alcohol, and limiting the availability of alcohol by reducing outlet density and hours of sale,[88, 89] and further evidence suggests that reducing access to and harmful use of alcohol reduces IPV.[2]

In terms of programs focused directly on the prevention of IPV, potential interventions with either established effectiveness, emerging evidence of effectiveness or an unclear level of effectiveness include school-based programs during adolescence and early adulthood to prevent dating violence; empowerment approaches for addressing gender inequality *e.g.* microfinance and gender equality training, and communication and relationship skills training; home-visitation programs with an IPV component; and changing social and cultural gender norms through the use of social norms theory, media awareness campaigns, and working with men and boys.[2]

7.5.2 Secondary prevention of IPV

The findings of this study also suggest that prevention strategies which target women who have experienced IPV and who continue to experience IPV could be effective in reducing incident HIV infection, assuming that a causal pathway from IPV to HIV exists. This is supported by the fact that the odds of HIV infection are greater for women experiencing IPV in models with longer exposure periods, which may indicate that there is a window of opportunity to intervene prior to HIV infection.

Secondary prevention initiatives to identify IPV could be integrated into HIV testing and treatment programs,[90] with the goals of informing women about what is known about the association between IPV and HIV, and linking women who are experiencing IPV or who have experienced IPV with counseling, legal assistance, harm reduction programs, and other community services. Other opportunities for secondary prevention may include screening for IPV in primary care settings,[91] especially for women who are at high risk of IPV based on known risk factors.

7.5.3 Intervening in the pathways between IPV and HIV

Since it remains unclear whether IPV functions as a risk marker or a risk factor for HIV, it may seem premature to develop interventions to intervene in potential pathways that mediate the

association between IPV and HIV. However, in cases where there is strong evidence about the association between potential mediators (of the association between IPV and HIV) and HIV infection, interventions which target the putative pathways in which these mediators function could decrease incident HIV infection, which would be valuable even if it emerges that this particular pathway is not important with respect to the IPV and HIV association. Such interventions should collect and analyse data on IPV, potential mediators, and HIV infection, so that the hypothesized pathway or pathways could be assessed.

7.6 Future research

In general, any research on IPV and HIV should be prospective in nature, in particular in order to be able to assess potential mediators of the relationship between IPV and HIV as indicators of the mechanisms of association. IPV should be appropriately measured, which means validating existing instruments in the specific cultural and linguistic contexts in which research in conducted, and collecting comprehensive data, including when violence is experienced and which types of violence are experienced. Qualitative research would also be valuable to better understand the context of experiences of IPV and potential mechanisms for the association between IPV and HIV, for example the use of diaries over time.

Given the consistency of the findings of this study and other prospective studies[26, 27] regarding the magnitude of association between IPV and HIV, there is no need for further observational studies to quantify the association between IPV and HIV. As described above, there is a need for research on interventions to prevent the risk factors which are associated with IPV, to prevent IPV itself, and to prevent putative mediators of the IPV-HIV association which are known to be strongly associated with HIV. Data from these interventional studies could be used to validate findings regarding the magnitude of association between IPV and HIV (including in other settings) and to assess putative mediators of the association between IPV and HIV.

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Appendices

Appendix 1. University of Toronto Research Ethics Board Approval, 2010

UNIVERSITY OF TORONTO

OFFICE OF THE VICE PRESIDENT, RESEARCH

PROTOCOL REFERENCE # 25239

July 7, 2010

Dr. Liviana Calzavara
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Toronto, ON
M5T 3M7

Dr. Fiona Kouyoumdjian
Dalla Lana School of Public Health
155 College Street
Toronto, ON
M5T 3M7

Dear Drs. Calzavara & Kouyoumdjian:

Re: Your research protocol entitled, "Partner Violence as a Risk Factor for Incident HIV Infection in Women in Rakai, Uganda"

ETHICS APPROVAL	**Original Approval Date: July 7, 2010** **Expiry Date: July 6, 2011** **Continuing Review Level: 1**

We are writing to advise you that the HIV Research Ethics Board has granted approval to the above-named research study, for a period of **one year**. Ongoing projects must be renewed prior to the expiry date.

All your most recently submitted documents have been approved for use in this study.

Any changes to the approved protocol or consent materials must be reviewed and approved through the amendment process prior to its implementation. Any adverse or unanticipated events should be reported to the Office of Research Ethics as soon as possible.

Please ensure that you submit an Annual Renewal Form or a Study Completion Report 15 to 30 days prior to the expiry date of your study. Note that annual renewals for studies cannot be accepted more than 30 days prior to the date of expiry, as per federal and international policies.

If your research has funding attached, please contact the relevant Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your project.

Yours sincerely,

Dario Kuzmanovic
Research Ethics Analyst

Appendix 2. University of Toronto Research Ethics Board Renewal, 2011

UNIVERSITY OF TORONTO

OFFICE OF THE VICE PRESIDENT, RESEARCH

PROTOCOL REFERENCE # 25239 July 15, 2011

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Dr. Fiona Kouyoumdjian
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Dear Drs. Calzavara & Kouyoumdjian:

Re: Your research protocol entitled, "Partner Violence as a Risk Factor for Incident HIV Infection in Women in Rakai, Uganda" by Dr. L. Calzavara (supervisor), Dr. F. Kouyoumdjian (PhD candidate)

ETHICS APPROVAL	**Original Approval Date: July 7, 2010** **Expiry Date: July 6, 2012** **Continuing Review Level: 1** **Renewal: 1 of 4**

We are writing to advise you that you have been granted annual renewal of ethics approval to the above-referenced research study through the REB's delegated process. Please note that all protocols involving ongoing data collection or interaction with human participants are subject to re-evaluation after 5 years. Ongoing projects must be renewed prior to the expiry date.

Please ensure that you submit an Annual Renewal Form or a Study Completion Report 15 to 30 days prior to the expiry date of your study. Note that annual renewals for studies cannot be accepted more than 30 days prior to the date of expiry as per our guidelines.

Any changes to the approved protocol or consent materials must be reviewed and approved through the amendment process prior to its implementation. Any adverse or unanticipated events should be reported to the Office of Research Ethics as soon as possible. If your research has funding attached, please contact the relevant Research Funding Officer in Research Services to ensure that your funds are released.

Best wishes for the successful completion of your project.

Yours sincerely,

Marianna Richardson

Marianna Richardson
Research Ethics Coordinator

Appendix 3. Definitions of variables included in data analyses and rounds in which relevant data collected

Type of variable	Variable	Definition of variable as used in analyses	Rounds when data collected
HIV infection	HIV infection	Dichotomous variable: yes or no, with yes defined as a positive result on two enzyme immunoassays, confirmed by Western blot.	All
IPV	Physical IPV	any= Dichotomous variable, with yes defined as having experienced any minor or severe physical IPV. minor= Dichotomous variable, with yes defined as participant's partner having "pushed [her], pulled [her], slapped [her] or held [her] down." severe= Dichotomous variable, with yes defined as participant's partner having "punched [her] with a fist or with something that could hurt [her]," "kicked [her] or dragged [her]," "tried to strangle [her] or burn [her]," or "attacked [her] with a knife, gun or other weapon."	All for past year data, rounds 7 and 8 for ever data
	Verbal IPV	any= Dichotomous variable, with yes defined as having experienced any minor or severe verbal IPV. minor= Dichotomous variable, with yes defined as participant's partner having "verbally abused or shouted at [her]." severe= Dichotomous variable, with yes defined as participant's partner having "threatened [her] with a knife, gun, or other weapon."	All for past year data, rounds 7 and 8 for ever data
	Sexual IPV	any= Dichotomous variable, with yes defined as having experienced severe sexual IPV. severe= Dichotomous variable, with yes defined as participant's partner having "used verbal threats to force [her] to have sex when [she] did not want to," "physically forced [her] to have sex when [she] did not want to," or "forced [her] to perform other sexual acts [she] did not want to do."	All for past year data, rounds 8 and 9 for ever data

-continued-

Appendix 3 continued

Type of variable	Variable	Definition of variable as used in analyses	Rounds when data collected
IPV	Any IPV	any= Dichotomous variable, with yes defined as having experienced any physical, verbal, or sexual IPV. minor= Dichotomous variable, with yes defined as having experienced any minor physical or minor verbal IPV. severe= Dichotomous variable, with yes defined as having experienced any severe physical, severe verbal, or sexual IPV.	Derived (with data collected as above)
	Frequency of IPV in past year	Categorical variable: 0, 1, 2, 3-5, 6-10, 11-20, or >20 incidents.	Verbal and physical IPV in rounds 7, 8, 9, and 13, sexual IPV in rounds 8, 9, and 13
Socio-demographic variables	Age	Continuous variable.	All
	Marital status	Categorical variable: never married, previously married, currently married in a polygamous relationship, or currently married in a monogamous relationship.	All
	Education	Categorical variable: less than 5 years of school, 5-7 years of school, and secondary school or higher.	All
	Religion	Categorical variable: Catholic, Protestant, Muslim, or other.	All
	Occupation	Categorical variable: agriculture, shopkeeper/trading/vending, housework, professional, student, home brewing/bar worker/owner, or other.	All
	Partner's occupation	Categorical variable: agriculture, shopkeeper/trading/vending, professional, student, home brewing/bar worker/owner, trucker, or other.	All
Relationship *	Type of relationship	Categorical variable: husband, current consensual partner, boyfriend, or other.	All
	Length of relationship	Categorical variable: <3 years, 4-6 years, or >6 years.	All

-continued-

Appendix 3 continued

Type of variable	Variable	Definition of variable as used in analyses	Rounds when data collected
Relationship*	Difference in age between participant and her partner	Categorical variable: ≥10 years older, 5-9 years older, <5 years older, same age, <5 years younger, or ≥5 years younger.	All
Violence experiences	Sexual abuse in childhood or adolescence	Dichotomous variable: yes or no, with yes defined as having ever been sexually abused by a male while "growing up till 18 years [or the time of first sex]."	Round 10 for those who already participated in a round
	Coerced first intercourse	Dichotomous variable: yes or no, with yes defined as force having been used the first time the participant had sex.	Rounds 8, 9, and 10 for those who already participated in a round, rounds 11-13 for new participants
	Attitudes toward violence	Dichotomous variable: not acceptable or acceptable, with acceptable defined as responding that a man is justified in beating his wife or partner in at least one of several situations: she neglects household responsibilities, she disobeys the instructions of her husband/elders, she uses contraception without permission, she refuses her husband sex, he learns about his wife's partner's positive HIV serostatus, he learns about his positive HIV serostatus, argues over money, is unfaithful, or another reason. Not acceptable is defined as no to all these questions.	Asked of those who had already participated in a round in rounds 7, 8, and 9, and of all participants in rounds 11, 12, and 13
HIV risk factors	Condom use in past year	Categorical variable: never, sometimes, or always used condoms in the past 6 or 12 months.	All rounds
	Number of partners in past year	Dichotomous variable: 1 partner, >1 partner.	All
	Alcohol use before sex by participant	Dichotomous variable: yes or no, with yes defined as participant drinking alcohol before sex with this partner.	All

-continued-

Appendix 3 continued

Type of variable	Variable	Definition of variable as used in analyses	Rounds when data collected
HIV risk factors	Alcohol use before sex by partner*	Dichotomous variable: yes or no, with yes defined as participant's partner drinking alcohol before sex.	All
Reproductive health	Age at first intercourse	Continuous variable.	All
	Pregnancy status	Dichotomous variable: yes or no (self-reported).	All
	Pregnancy intent	Dichotomous variable: yes or no, with yes defined as "trying to become pregnant" for those not currently pregnant or having intended to have the pregnancy for those currently pregnant.	All

*Regarding relationship factors, for participants who reported multiple partners in the past year, data about the partner with whom the participant reported having had sex most recently was used to determine the type of relationship with partner, alcohol use by partner, length of sexual partnership, and difference in age with partner; it was not possible to determine which specific partner (if any) had perpetrated IPV.

Appendix 4. Sample from original dataset for objective 1

Sample	Number of participants in sample
Initial dataset	20584
Remaining after dropping observations for subjects <15 or >49	20464
Remaining after dropping those who have a positive test and subsequent negative tests	20460
Remaining after dropping those who are not sexually active over the course of the study	17232
Remaining after dropping those who only participated in one round	11612
Remaining after dropping those who were positive at baseline	10256

Appendix 5. Association between IPV and incident HIV infection,* stratified by potential effect modifiers

Exposure to violence	Presence of potential effect modifier	Sexual abuse in childhood or adolescence		Pregnancy intent	
		OR (95%CI) p value	N†	OR (95%CI) p value	N†
Current year‡	No	1.73 (1.01, 2.97) 0.05	3579, 1079	1.41 (1.12, 1.78) 0.004	19828, 8409
	Yes	1.21 (0.55, 2.66) 0.63	1635, 500	0.97 (0.30, 3.13) 0.97	2185, 1845
Past year‡	No	1.23 (0.64, 2.35) 0.53	2846, 921	1.34 (1.02, 1.77) 0.04	16003, 6877
	Yes	1.58 (0.60, 4.12) 0.35	1240, 421	2.10 (0.56, 7.92) 0.27	1704, 1462
Over study‡	No	1.17 (0.66, 2.07) 0.59	2988, 950	1.58 (1.17, 2.13) 0.003	17068, 7218
	Yes	5.00 (1.02, 24.40) 0.05	1322, 441	1.53 (0.45, 5.27) 0.50	1819, 1560
Ever/over study‡	No	1.24 (0.68, 2.25) 0.48	2985, 950	1.55 (1.14, 2.12) 0.01	17047, 7208
	Yes	4.17 (0.90, 19.37) 0.07	1321, 441	1.40 (0.41, 4.80) 0.59	1820, 1560
Ever§	No	1.50 (0.62, 3.63) 0.37	439	1.41 (0.99, 2.00) 0.06	2709
	Yes	4.67 (0.92, 23.68) 0.06	170	2.37 (0.67, 8.43) 0.18	267

*All analyses were adjusted for marital status and difference in age between the participant and her partner. †N is number of observations, number of groups (*i.e.* women) for current year, past year, over study, and ever/over study, and number of women for ever. ‡Repeated measures analyses. §Questions about ever having experienced all three types of violence were included only in round 8, so data on violence are only taken from round 8.

Appendix 6. Risk of HIV infection and attributable risk over the study by IPV exposure, based on presence of potential effect modifiers

Potential effect modifier		IPV over the study	HIV incidence over the study, % (n/N)	Attributable risk/ 100 (95% CI)
Sexual abuse	No	No	5.91 (29/491)	0
		Yes	6.91 (44/637)	1.00 (-1.99, 3.87)
	Yes	No	5.23 (9/172)	0
		Yes	6.69 (23/344)	1.46 (-3.45, 5.51)
Pregnancy intent	No	No	4.57 (168/3677)	0
		Yes	5.24 (237/4527)	0.67 (-0.28, 1.60)
	Yes	No	4.31 (10/232)	0
		Yes	8.33 (33/396)	4.02 (-0.08, 7.80)

Appendix 7. Bivariate associations between factors in the current year and IPV in the current year, OR (95% CI), p value

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model*	OR (95%CI) p value	N in model *
Age	Continuous	0.98 (0.98, 0.99) 0.000	41757, 15050	0.98 (0.98, 0.99) 0.000	41749, 15050	01.00(0.996, 1.01) 0.56	36977, 14324	0.98 (0.98, 0.99) 0.000	42172, 15081
Marital status	Never married	1	41757, 15050	1	41749, 15050	1	36977, 14324	1	42172, 15081
	Previously married	1.85 (1.56, 2.19) 0.000		1.60 (1.38, 1.86) 0.000		2.03 (1.73, 2.38) 0.000		1.75 (1.54, 2.00) 0.000	
	Currently married-polygamous	2.88 (2.46, 3.37) 0.000		3.29 (2.87, 3.78) 0.000		2.34 (2.02, 2.72) 0.000		2.97 (2.63, 3.35) 0.000	
	Currently married-monogamous	3.09 (2.68, 3.55) 0.000		3.42 (3.03, 3.87) 0.000		2.06 (1.81, 2.36) 0.000		2.85 (2.56, 3.18) 0.000	
Religion	Catholic	1	41571, 14933	1	41563, 14933	1	36791, 14207	1	41986, 14964
	Protestant	0.91 (0.81, 1.01) 0.08		0.95 (0.86, 1.05) 0.34		1.00 (0.90, 1.11) 0.96		0.96 (0.88, 1.06) 0.43	
	Muslim	0.69 (0.61, 0.79) 0.000		0.73 (0.65, 0.82) 0.000		0.77 (0.68, 0.87) 0.000		0.77 (0.69, 0.825) 0.000	
	Other	0.91 (0.73, 1.15) 0.44		0.85 (0.69, 1.05) 0.12		0.89 (0.71, 1.12) 0.33		0.83 (0.69, 1.01) 0.07	

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Appendix 7 continued

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *
Occupation	Agriculture	1	41311, 14933	1	41303, 14933	1	36531, 14206	1	41726, 14964
	Shopkeeper/ trading/ vending	0.92 (0.82, 1.05) 0.21		0.85 (0.76, 0.95) 0.01		0.84 (0.74, 0.96) 0.01		0.85 (0.77, 0.94) 0.002	
	Housework	1 (0.85, 1.17) 0.95		0.87 (0.75, 1.00) 0.05		0.87 (0.74, 1.02) 0.08		0.84 (0.73, 0.95) 0.01	
	Professional	0.55 (0.46, 0.66) 0.000		0.52 (0.44, 0.61) 0.000		0.61 (0.51, 0.72) 0.000		0.57 (0.49, 0.65) 0.000	
	Student	0.23 (0.17, 0.31) 0.000		0.2 (0.15, 0.26) 0.000		0.27 (0.20, 0.36) 0.000		0.23 (0.18, 0.28) 0.000	
	Home brewing/bar worker/bar owner	1.59 (1.26, 2.02) 0.000		1.33 (1.07, 1.66) 0.01		1.60 (1.26, 2.04) 0.000		1.46 (1.19, 1.79) 0.000	
	Other	0.85 (0.75, 0.97) 0.02		0.76 (0.68, 0.86) 0.000		0.83 (0.73, 0.95) 0.01		0.81 (0.73, 0.90) 0.000	

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Appendix 7 continued

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *
Partner's occupation	Agriculture	1	40773, 14834	1	40765, 14834	1	36007, 14109	1	41186, 14867
	Shopkeeper/ trading/ vending	0.91 (0.83, 0.999) 0.049		0.88 (0.81, 0.95) 0.002		0.88 (0.80, 0.97) 0.01		0.91 (0.84, 0.98) 0.01	
	Professional	0.70 (0.62, 0.81) 0.000		0.68 (0.6, 0.76) 0.000		0.80 (0.70, 0.91) 0.001		0.75 (0.67, 0.83) 0.000	
	Student	0.17 (0.11, 0.27) 0.000		0.18 (0.13, 0.26) 0.000		0.23 (0.15, 0.34) 0.000		0.20 (0.15, 0.28) 0.000	
	Home brewing/bar worker/bar owner	1.22 (0.88, 1.70) 0.24		1.27 (0.94, 1.73) 0.12		1.16 (0.82, 1.64) 0.41		1.28 (0.96, 1.69) 0.09	
	Trucker	0.80 (0.66, 0.98) 0.03		0.74 (0.62, 0.89) 0.001		0.76 (0.62, 0.93) 0.01		0.74 (0.62, 0.87) 0.000	
	Other	1.12 (1.12, 1.24) 0.02		1.05 (0.96, 1.15) 0.25		1.00 (0.91, 1.11) 0.96		1.06 (0.98, 1.15) 0.14	
Pregnancy status	No	1	37252, 13391	1	37243, 13389	1	32881, 12702	1	37632, 13421
	Yes	1.00 (0.91, 1.10) 0.95		0.99 (0.91, 1.08) 0.8		0.94 (0.85, 1.04) 0.21		0.98 (0.91, 1.06) 0.59	

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Appendix 7 continued

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *
Type of relationship	Husband	1	41754, 15050	1	41746, 15050	1	36976, 14323	1	42169, 15081
	Current consensual partner	1.62 (1.49, 1.76) 0.000		1.32 (1.23, 1.43) 0.000		1.07 (0.98, 1.17) 0.13		1.30 (1.21, 1.39) 0.000	
	Boyfriend	0.53 (0.48, 0.59) 0.000		0.42 (0.38, 0.46) 0.000		0.64 (0.58, 0.70) 0.000		0.49 (0.45, 0.54) 0.000	
	Other	2.43 (1.67, 3.55) 0.000		0.87 (0.59, 1.28) 0.48		2.80 (1.92, 4.08) 0.000		1.33 (0.96, 1.86) 0.09	
Length of time in relationship	<4 years	1	38657, 13838	1	38650, 13836	1	34173, 13181	1	39063, 13891
	4-6 years	0.99 (0.9, 1.09) 0.87		1.13 (1.03, 1.23) 0.01		0.98 (0.89, 1.09) 0.75		1.06 (0.98, 1.15) 0.14	
	>6 years	0.84 (0.77, 0.92) 0.000		1.01 (0.93, 1.10) 0.81		1.06 (0.97, 1.16) 0.23		0.99 (0.92, 1.07) 0.86	

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Appendix 7 continued

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *
Partner age difference	Same age	1	34723, 13915	1	34714, 13914	1	31049, 13239	1	35031, 13962
	≥10 years older	1.30 (1.08, 1.56) 0.01		1.5 (1.27, 1.77) 0.000		1.29 (1.07, 1.54) 0.01		1.42 (1.22, 1.65) 0.000	
	5-9 years older	1.23 (1.03, 1.46) 0.02		1.35 (1.16, 1.58) 0.000		1.16 (0.97, 1.37) 0.1		1.28 (1.10, 1.47) 0.001	
	<5 years older	1.20 (1.02, 1.42) 0.03		1.23 (1.06, 1.42) 0.01		1.10 (0.93, 1.30) 0.26		1.18 (1.03, 1.35) 0.02	
	<5 years younger	1.62 (1.27, 2.06) 0.000		1.47 (1.18, 1.84) 0.001		1.50 (1.18, 1.92) 0.001		1.40 (1.14, 1.72) 0.001	
	≥5 years younger	2.07 (1.39, 3.09) 0.000		1.86 (1.28, 2.71) 0.001		1.15 (0.75, 1.78) 0.52		1.81 (1.28, 2.56) 0.001	
Number of partners in past year	1	1	40981, 15015	1	40980, 15015	1	35838, 14168	1	40983, 15015
	2 or more	2.42 (2.11, 2.78) 0.000		1.67 (1.47, 1.91) 0.000		1.86 (1.61, 2.15) 0.000		1.80 (1.58, 2.03) 0.000	
Woman's use of alcohol before sex	No	1	41532, 15028	1	41524, 15028	1	36752, 14302	1	41946, 15059
	Yes	1.64 (1.52, 1.76) 0.000		1.69 (1.58, 1.81) 0.000		1.84 (1.70, 1.99) 0.000		1.75 (1.64, 1.86) 0.000	

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Appendix 7 continued

Contemporary factors		Type of violence in current year							
		Physical		Verbal		Sexual		Any	
		OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *	OR (95%CI) p value	N in model *
Partner's use of alcohol before sex	No	1	37720, 14665	1	37712, 14663	1	32829, 13921	1	38008, 14687
	Yes	2.09 (1.94, 2.25) 0.000		2.18 (2.04, 2.34) 0.000		2.02 (1.87, 2.18) 0.000		2.13 (2.00, 2.27) 0.000	
Attitudes toward violence	Not acceptable	1	36614, 14764	1	36607, 14764	1	31877, 14049	1	37029, 14804
	Acceptable	1.55 (1.41, 1.71) 0.000		1.61 (1.47, 1.76) 0.000		1.69 (1.54, 1.87) 0.000		1.65 (1.53, 1.79) 0.000	
HIV status	Negative	1	39713, 14384	1	39705, 14382	1	35328, 13724	1	40082, 14415
	Positive	1.27 (1.13, 1.43) 0.000		1.10 (0.99, 1.23) 0.09		1.11 (0.99, 1.25) 0.09		1.11 (1.01, 1.23) 0.04	

*N in model is number of observations, number of groups (*i.e.* women).

Appendix 8. Multivariable associations between factors in the current year and IPV in the current year, OR (95% CI), p value

Contemporary factors		Type of violence			
		Physical 21727 observations, 10333 women	Verbal 21727 observations, 10333 women	Sexual 18556 observations, 9647 women	Any 21727 observations, 10333 women
Age	Continuous	0.97 (0.96, 0.98) 0.000	0.97 (0.96, 0.98) 0.000	0.98 (0.97, 0.99) 0.000	0.97 (0.96, 0.98) 0.000
Marital status	Never married	1	1	1	1
	Previously married	1.29 (0.97, 1.71) 0.08	1.16 (0.90, 1.51) 0.25	1.31 (0.97, 1.74) 0.06	1.19 (0.95, 1.50) 0.13
	Currently married-polygamous	0.94 (0.60, 1.47) 0.78	1.12 (0.74, 1.70) 0.60	0.95 (0.60, 1.49) 0.81	1.10 (0.75, 1.61) 0.62
	Currently married-monogamous	0.93 (0.60, 1.45) 0.75	0.99 (0.66, 1.50) 0.98	0.77 (0.49, 1.20) 0.25	0.92 (0.63, 1.33) 0.65
Religion	Catholic	1	1	1	1
	Protestant	1.02 (0.90, 1.17) 0.73	1.03 (0.91, 1.16) 0.68	1.10 (0.96, 1.25) 0.17	1.04 (0.93, 1.17) 0.49
	Muslim	1.08 (0.92, 1.28) 0.33	1.01 (0.87, 1.18) 0.88	1.14 (0.97, 1.35) 0.12	1.12 (0.98, 1.29) 0.10
	Other	1.15 (0.87, 1.51) 0.33	1.01 (0.78, 1.32) 0.92	1.25 (0.94, 1.66) 0.1	1.03 (0.81, 1.31) 0.83

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Appendix 8 continued

Contemporary factors		Type of violence			
		Physical 21727 observations, 10333 women	Verbal 21727 observations, 10333 women	Sexual 18556 observations, 9647 women	Any 21727 observations, 10333 women
Occupation	Agriculture	1	1	1	1
	Shopkeeper/trading/vending	0.93 (0.79, 1.09) 0.35	0.94 (0.81, 1.09) 0.38	0.79 (0.67, 0.94) 0.01	0.84 (0.73, 0.96) 0.01
	Housework	0.90 (0.73, 1.12) 0.34	0.97 (0.80, 1.18) 0.78	0.87 (0.70, 1.10) 0.24	0.88 (0.73, 1.05) 0.16
	Professional	0.77 (0.62, 0.97) 0.02	0.71 (0.57, 0.87) 0.001	0.67 (0.54, 0.85) 0.001	0.67 (0.56, 0.81), 0.000
	Student	1.22 (0.41, 3.69) 0.72	0.66 (0.22, 1.99) 0.46	1.54 (0.56, 4.21) 0.40	0.84 (0.33, 2.13) 0.72
	Home brewing/bar worker/bar owner	1.21 (0.87, 1.68) 0.26	1.20 (0.88, 1.64) 0.26	1.28 (0.92, 1.79) 0.15	1.26 (0.94, 1.68) 0.12
	Other	0.9 (0.75, 1.07) 0.24	0.94 (0.80, 1.11) 0.46	0.94 (0.79, 1.13) 0.53	0.92 (0.80, 1.17) 0.30
Partner's occupation	Agriculture	1	1	1	1
	Shopkeeper/trading/vending	0.92 (0.81, 1.04) 0.17	0.85 (0.76, 0.96) 0.01	0.90 (0.79, 1.02) 0.10	0.90 (0.81, 0.996) 0.04
	Professional	0.76 (0.64, 0.91) 0.003	0.75 (0.64, 0.89) 0.001	0.90 (0.75, 1.08) 0.26	0.85 (0.73, 0.99) 0.03
	Student	0.63 (0.19, 2.11) 0.45	0.65 (0.22, 1.92) 0.44	0.86 (0.27, 2.68) 0.79	0.78 (0.31, 1.95) 0.59
	Home brewing/bar worker/bar owner	1.07 (0.70, 1.62) 0.76	0.99 (0.66, 1.47) 0.95	0.96 (0.61, 1.51) 0.86	0.95 (0.65, 1.37) 0.77
	Trucker	0.81 (0.62, 1.06) 0.12	0.71 (0.55, 0.91) 0.01	0.74 (0.56, 0.98) 0.04	0.70 (0.55, 0.87) 0.002
	Other	1.09 (0.96, 1.23) 0.19	1.01 (0.90, 1.14) 0.82	1.01 (0.89, 1.16) 0.84	1.05 (0.94, 1.17) 0.42

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Appendix 8 continued

Contemporary factors		Type of violence			
		Physical 21727 observations, 10333 women	Verbal 21727 observations, 10333 women	Sexual 18556 observations, 9647 women	Any 21727observations, 10333 women
Pregnancy status	No	1	1	1	1
	Yes	0.87 (0.77, 0.99) 0.03	0.88 (0.79, 0.99) 0.03	0.87 (0.76, 0.99) 0.04	0.88 (0.80, 0.98) 0.02
Type of relationship	Husband	1	1	1	1
	Current consensual partner	1.34 (1.20, 1.50) 0.000	1.17 (1.05, 1.30) 0.01	0.93 (0.83, 1.05) 0.25	1.16 (1.05, 1.28) 0.003
	Boyfriend	0.38 (0.26, 0.56) 0.000	0.38 (0.26, 0.55) 0.000	0.43 (0.29, 0.65) 0.000	0.42 (0.30, 0.59) 0.000
	Other	1.53 (0.64, 3.65) 0.34	1.25 (0.54, 2.93) 0.60	1.17 (0.46, 2.98) 0.74	1.19 (0.54, 2.61) 0.67
Length of time in relationship	<4 years	1	1	1	1
	4-6 years	0.84 (0.74, 0.96) 0.01	0.95 (0.84, 1.07) 0.39	0.91 (0.79, 1.04) 0.17	0.92 (0.82, 1.03) 0.16
	>6 years	0.84 (0.73, 0.97) 0.02	0.92 (0.80, 1.05) 0.2	0.95 (0.82, 1.11) 0.54	0.93 (0.82, 1.05) 0.23
Partner age difference	Same age	1	1	1	1
	≥10 years older	0.94 (0.74, 1.18) 0.59	1.04 (0.84, 1.29) 0.73	0.97 (0.76, 1.23) 0.81	1.00 (0.82, 1.21) 0.99
	5-9 years older	0.92 (0.73, 1.14) 0.44	0.95 (0.77, 1.16) 0.61	0.99 (0.79, 1.25) 0.94	0.93 (0.77, 1.12) 0.42
	<5 years older	1.01 (0.82, 1.25) 0.92	0.93 (0.77, 1.14) 0.49	1.05 (0.84, 1.31) 0.68	0.94 (0.78, 1.12) 0.47
	<5 years younger	1.44 (1.06, 1.95) 0.02	1.35 (1.01, 1.80) 0.04	1.54 (1.13, 2.12) 0.01	1.34 (1.03, 1.74) 0.03
	≥5 years younger	1.57 (0.95, 2.61) 0.08	1.48 (0.91, 2.40) 0.11	0.88 (0.50, 1.54) 0.65	1.38 (0.88, 2.15) 0.16

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Appendix 8 continued

Contemporary factors		Type of violence			
		Physical 21727 observations, 10333 women	Verbal 21727 observations, 10333 women	Sexual 18556 observations, 9647 women	Any 21727 observations, 10333 women
Number of partners in past year	1	1	1	1	1
	2 or more	3.00 (2.36, 3.82) 0.000	2.22 (1.75, 2.82) 0.000	2.22 (1.72, 2.86) 0.000	2.14 (1.71, 2.68) 0.000
Woman's use of alcohol before sex	No	1	1	1	1
	Yes	1.21 (1.09, 1.35) 0.001	1.33 (1.20, 1.47) 0.000	1.40 (1.25, 1.57) 0.000	1.35 (1.23, 1.48) 0.000
Partner's use of alcohol before sex	No	1	1	1	1
	Yes	1.93 (1.73, 2.15) 0.000	1.93 (1.74, 2.13) 0.000	1.80 (1.60, 2.02) 0.000	1.92 (1.75, 2.11) 0.000
Attitudes toward violence	Not acceptable	1	1	1	1
	Acceptable	1.36 (1.21, 1.54) 0.000	1.43 (1.28, 1.6) 0.000	1.50 (1.33, 1.71) 0.000	1.45 (1.31, 1.61) 0.000
HIV status	Negative	1	1	1	1
	Positive	1.20 (1.03, 1.39) 0.02	1.11 (0.96, 1.27) 0.17	0.99 (0.84, 1.16) 0.88	1.08 (0.95, 1.23) 0.25