A Meta-analysis of the Association between Intimate Partner Violence and Age Disparity in sub-Saharan Africa

by

Fanuel Omondi Otieno

Thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Mathematical Statistics in the Faculty of Science at Stellenbosch University

Department of Statistics & Actuarial Science,
University of Stellenbosch,
Private Bag X1, Matieland 7602, South Africa.

Supervisor: Prof. Wim Delva

December 2017

Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Signature: ....
Fanuel Omondi Otieno

Date: November 22, 2017 ....

Abstract

A Meta-analysis of the Association between Intimate Partner Violence and Age Disparity in sub-Saharan Africa

Fanuel Omondi Otieno

Department of Statistics & Actuarial Science,
University of Stellenbosch,
Private Bag X1, Matieland 7602, South Africa.

Thesis: MSc. (Mathematical Statistics)

November 2017

Intimate partner violence (IPV) is the most common form of violence against women and a worldwide human rights and public health problem. IPV against women can be emotional, physical, and sexual in nature. The current body of research has identified multiple risk factors for IPV including age disparity between women and their partners. Studies that have looked at age disparity as a risk factor of IPV show conflicting results. We conducted a meta-analysis to examine the association between IPV against women experienced within 12 months before the survey and age disparity using survey data from Demographic and Health Surveys (DHS) collected in 21 sub-Saharan African countries. Two-stage sample weights were proportionally used to represent the different countries. The age disparity was divided into two groups: relationships where the age difference (age of the male partner minus age of the woman) was less than five years and those where the age difference was five or more years. Three generalized linear models were used to estimate relative risk (RR) of the association between IPV and age disparity. These models were: modified Poisson regression, logistic regression model where RR was estimated from odds ratio, and log-binomial model. Modified Poisson regression proved to be a better model after comparing the three models using DHS data. The RR from modified Poisson regression model were pooled in a meta-analysis. A random-effects model was used in the meta-analyses. We found that weighted relative risk averages (WRRAs) from the meta-analysis were less than 1, and significant at alpha = 0.05 level for less severe and severe physical violence, which suggest that having an older partner has a protective effect against physical IPV. This study also indicates high country heterogeneity. For instance, results from Burkina Faso, and Sierra Leone indicated that having an older partner is protective against emotional and less severe IPV, while the results show that having an older partner puts a woman at a higher risk of experiencing emotional and less severe IPV in Kenya. We also calculated the prevalence of IPV against women and found that there is high prevalence of IPV against women in sub-Saharan Africa. In conclusion, this study shows an association between IPV and age disparity but the association is country dependent. We speculate that heterogeneities in underlying socio-cultural and economic histories and current realities explain dependence. Therefore, IPV prevention programmes should be country dependent when considering age disparity as a risk factor for IPV.

Keywords: Intimate partner violence, age disparity, meta-analysis, modified Poisson regression, generalized linear models.

Opsomming

'n Meta-analise van die verband tussen intieme lewensmaat geweld en ouderdomsverskille in sub-Sahara Afrika

(" A Meta-analysis of the Association between Intimate Partner Violence and Age Disparity in sub-Saharan Africa ")

Fanuel Omondi Otieno

Departement Statistiek en Aktuariële Wetenskap,
Stellenbosch Universiteit,
Privaatsak X1, Matieland 7602, Suid Afrika.

Tesis: MSc. (Wiskundige Statistiek)

November 2017

Intieme lewensmaat geweld (IPV in Engels) is een van die mees algemene vorme van geweld teenoor vroue en is wêreldwyd 'n menseregte- en openbare gesondheidsprobleem. IPV teenoor vroue kan emosioneel, fisies en seksueel van aard wees. Die huidige navorsingsliggaam het risikofaktore vir IPV geïdentifiseer, insluitende ouderdomsongelykheid tussen paartjies. Studies wat ouderdomsongelykheid as risikofaktor ondersoek het, toon teenstrydige resultate. In hierdie studie is 'n meta-analise gedoen om die verband tussen IPV teenoor vroue in die 12 maande voor die opname en die ouderdomsverskille tussen paartjies te bepaal, met behulp van die Demografiese en Gesondheidsopname (DHS in Engels) in 21 sub-Sahara lande. Twee-stadium steekproefgewigte was proporsioneel gebruik om die verskillende lande te verteenwoordig. Ouderdomsongelykheid is in twee groepe verdeel: verhoudings met ouderdomverskille (ouderdom van manlike metgesel minus ouderdom van die vrou) minder as vyf jaar en ouderdomsverskille van vyf en meer jare. Drie veralgemeende lineêre modelle is gebruik om relatiewe risiko (RR) van die verband tussen IPV en ouderdomsverskil te beraam. Hierdie modelle was: gewysigde Poisson regressie, logistieke regressie model waar RR benader is deur die odds verhouding, en log-binomiaal model. Gewysigde Poisson-regressie was 'n beter model nadat die drie modelle met behulp van DHS data vergelyk is. Die RR van gewysigde Poisson regressiemodel is in 'n meta-analise saamgevoeg. 'n Ewekansige-effekmodel is in die meta-analises gebruik. Ons het gevind dat die geweegde relatiewe risiko gemiddeldes (WRRAs in Engels) van die meta-analise minder as 1 was, en betekenisvol by 'n alfa = 0,05 vlak vir minder ernstige en ernstige fisiese geweld, wat aandui dat ouer metgeselle 'n beskermende effek teen fisiese IPV het. Hierdie studie dui ook op hoë heterogeniteit tussen verskillende lande. Byvoorbeeld, resultate van Burkina Faso en Sierra Leone het aangedui dat 'n ouer lewensmaat beskermend is teen emosionele en minder ernstige IPV, terwyl die resultate toon dat 'n ouer lewensmaat dui op 'n hoër risiko vir emosionele en minder ernstige IPV in Kenia. Ons het ook die voorkoms van IPV teen vroue beraam en het gevind dat daar 'n hoë voorkoms van IPV teen vroue in sub-Sahara Afrika is. Ten slotte toon hierdie studie 'n verband tussen IPV en ouderdomsverskil, maar die sterkte van die verband is afhanklik van die land. Daar word dus gespekuleer dat die heterogeniteit onderliggend aan die sosio-kulturele en ekonomiese geskiedenisse, asook huidige realiteite, hierdie afhanklikheid verduidelik. Gevolglik word voorgestel dat IVP voorkomings programme landsgebonde moet wees wanneer ouderdomsongelykhede binne verhoudings as risikofaktor vir IPV beskou word.

Sleutelwoorde: Intieme lewensmaat geweld, ouderdomsongelykheid, meta-analise, gewysigde Poisson regressie, veralgemeende lineêre modelle.

Acknowledgements

First and foremost, I would like to thank my supervisor, Prof. Wim Delva for his valuable guidance in the analysis. I am grateful to Prof. Paul Mostert for his indispensable guidance through the review of the statistical models and for his vital comments in the write-up. I owe a great debt of gratitude to Roxanne Beauclair for her valuable comments and guidance in writing this thesis. I would also like to thank SACEMA administration for providing a good environment and facilities to complete this work. Special gratitude goes to all SACEMA internal students who have been my friends for their support and encouragement. Heartfelt appreciation goes to Sylvia Masaku for her emotional support. In addition, I extend my gratitude to Dr. Gavin Hitchcock for proofreading this thesis. Finally, thanks to my family for constant love and prayers. Above all, utmost appreciation goes to the almighty God for the divine intervention in this academic endeavour.

Dedications

This thesis is dedicated to:
My late mother: Lucy Achieng.
My father: George Otieno
My siblings: Finious, Lydia, Oscar, Pauline, Stanley, and Derrick.

Publications

The following is a title of an extract from this thesis, which is a work-in-progress and will be published:

1. Intimate partner violence and age disparity in sub-Saharan Africa: a meta-analysis of 21 demographic and health surveys.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

Intimate partner violence (IPV) is one of the most common forms of violence and a worldwide human rights and public health issue (Garcia-Moreno *et al.*, 2006). IPV occurs in all settings and among all cultural, religious and socio-economic groups. Moreover, the huge burden of IPV is borne by women. Women can also be perpetrators of violence in relationships with men, and violence sometimes occurs in same-sex relationships, but the most common perpetrators of violence against women are male intimate partners or ex-partners (WHO, 2012). Consequently, this study considers data from sub-Saharan Africa where women are the victims of IPV perpetrated by their male intimate partners.

Prevalence of IPV against women of reproductive age varies globally from 23.2% in Europe (high income region) to 37.7% in South East Asia region (García-Moreno, 2013). Africa comes second after Asia with a prevalence of 36.6%. Even though IPV is a concern in its own right, IPV is associated with various mental, physical, sexual and reproductive health consequences. Therefore, there is a need to design an effective prevention programme, which involves identification of IPV risk factors.

The current body of research on IPV has yielded much information regarding the IPV risk factors including age disparity in relationships (Jewkes, 2002; Luke *et al.*, 2007; Xu *et al.*, 2005). Studies that have looked at age disparity as a risk factor of IPV show conflicting results regarding the direction of association. It is in response to these conflicting results in the current literature that we carried out a meta-analysis to investigate the relationship that exists between IPV and age disparity in 21 Sub-Saharan African countries using data from Demographic and Health Surveys (DHS).

1.1 Definition and background of intimate partner violence

The World Health Organization (WHO) defines IPV as one of the forms of violence against women and includes emotional abuse, physical and sexual abuse and controlling behaviour of an intimate partner (Cronholm *et al.*, 2011; WHO, 2012).

Three forms of IPV were considered in this study: emotional IPV, physical IPV and sexual IPV. Emotional IPV (also known as emotional violence) includes acts such as humiliation, degradation, name-calling, threatening with harm, insulting, presenting false information to the partner, and exploitation of partner's vulnerability (Mazza *et al.*, 1996). These acts can result into trauma, including chronic depression, anxiety, or post-traumatic stress disorder (Saltzman *et al.*, 1999).

Physical IPV (also known as physical violence) is classified into two indicators: less severe physical violence (or less severe violence) and severe physical violence (or severe violence). Less (moderate) severe violence involves acts such as pushing, grabbing, shaking, slapping, shoving, or throwing something at a person (Crowell *et al.*, 1996). Severe violence, according to the Conflict Tactics Scales, includes acts such as hitting, kicking, biting, beating, hitting with fist, choking, threatening with a knife or gun, using a knife or gun on a person (Straus *et al.*, 1996).

WHO defines sexual IPV (also known as sexual violence) as "any sexual act, attempt to obtain a sexual act, unwanted sexual comments or advances, or acts to traffic or otherwise directed against a person's sexuality using coercion, by any person regardless of their relationship to the victim, in any setting, including but not limited to home and work" (WHO, 2012). Specifically, in this study, sexual IPV refers to the sexual acts that were committed by an intimate partner without the consent of the woman. Sexual violence acts include forced sexual intercourse and other forms of sexual harassment (Straus *et al.*, 1996).

Finally, age disparity is referred to as the age difference or age gap between intimate partners. This study defines age disparity as the male intimate partner's age minus female partner's age. The relationships where the there is an age difference of five or more years between intimate partners are called age-disparate (AD) relationships, while relationships in which age-difference are less that five years are known as non-age disparate (non-AD) relationships (Beauclair & Delva, 2013).

1.2 Prevalence of IPV

International research has provided increasing evidence of the high prevalence of IPV, specifically IPV perpetrated by intimate male partner against their female partners. Around fifty population-based studies carried out in 35 countries around the world before 1999 found out that 10% to 52% of women had been physically abused by their male partners at some point in their lives, and 10% to 30% of women had experienced sexual IPV by their male partners (Heise *et al.*, 1999). More studies of prevalence of IPV have been carried out from 2000 onwards. A study carried out by Garcia-Moreno *et al.* (2006) to estimate the extent of IPV against women in 15 sites (rural and urban) in Bangladesh, Brazil, Ethiopia, Japan, Namibia, Peru, Samoa, Serbia and Montenegro, Thailand, and Tanzania showed that lifetime prevalence of sexual and/or physical IPV, among ever-partnered women, varied between sites from 15% to 71%. In addition, an analysis of Demographic and Health Survey (DHS) data from nine countries reported that the prevalence of physical or sexual violence by intimate partners ranged from 18% in Cambodia to 48% in Zambia for physical violence, and 4% to 17% for sexual violence (Kishor & Johnson, 2004). In another analysis of DHS data from 10 countries, physical or sexual violence reported ranged form 17% in Dominican Republic to 75% in Bangladesh (Hindin *et al.*, 2008; WHO, 2012). A study by Roman and Frantz (Roman & Frantz, 2013) indicated that the prevalence of IPV in African countries (South Africa, Liberia, Kenya, Malawi, Rwanda, and Zambia) ranged from 26.5% to 48%. In a systematic review of prevalence of IPV in African countries, Shamu *et al.* (2011) reported that the prevalence of IPV within 12 months before the survey ranged from 14.2% to 43.4%.

Jewkes *et al.* (2002) took a closer look at the prevalence of IPV in Africa where they indicated that the lifetime prevalence of physical violence from a current or ex-husband or boyfriend was 24.6% and, the prevalence in the last year was 9.5% . A study by Emenike *et al.* (2008) indicated a lifetime prevalence of IPV at 25% in South Africa, 30% in Uganda, 30% in Egypt, 47% in Kenya, and 48% in Zambia. Karamagi *et al.* (2006) in their study of IPV in Uganda reported a lifetime prevalence of 54% and prevalence of physical IPV in the last year at 14%. Watts and Mayhew (Watts & Mayhew, 2004) reported that 13-49% of women have ever been physically assaulted by their intimate partner, with 5-29% having experienced physical violence within 12 months before the survey. Results of surveys conducted by Watts *et al.* (1998) in Zimbabwe and Koenig *et al.* (2003) in Uganda reported 26% and 59% of sexual violence, respectively, with 20% and 40% reported having experienced sexual IPV in the last year. Another study by Karamagi *et al.* (2006) indicated that IPV prevalence in Sub-Saharan Africa ranges from 20%

to 70% . IPV against women is still viewed by many countries as a private issue rather than a public concern, yet it has adverse social effects and public health consequences.

1.3 Consequences of IPV and risk factors

IPV against women affects women's physical and mental health through direct pathways such as injury and chronic health problems that come from prolonged stress. The physical injuries that arise from IPV include abdominal or thoracic injuries, fracture and broken bones, welts and bruises, abrasions and laceration, head injury/injuries, strangulation, neck and back injury (Bonomi *et al.*, 2006). Stress related conditions include chronic pain syndrome, gastrointestinal symptoms, exacerbation of asthma and fibromyalgia (WHO, 2012). Women who suffer from IPV suffer from higher levels of depression, phobias and anxiety compared to women who do not experience IPV. Thoughts of suicide and attempted suicide are higher among women who have ever experienced IPV (physical and sexual violence) compared to those who have not (Heise & Garcia-Moreno, 2002). Moreover, IPV has been linked to unsafe sexual behaviour, poor self-esteem, alcohol and drug abuse, physical inactivity, as well as sleep and eating disorders (WHO, 2012).

In addition, IPV can result into adverse sexual and reproductive health problems for women. Some of the adverse effects include unwanted or unintended pregnancy, abortions (whether safe or unsafe), sexually transmitted diseases such as HIV, urinary tract infections, sexual dysfunction, and pregnancy complications (Campbell, 2002; Campbell & Soeken, 1999). IPV during pregnancy can be associated with a range of health problems including stillbirth, premature labour and birth, fetal injury, low-birth weight, and miscarriage (Mayhew *et al.*, 2002; WHO, 2012). These consequences indicate that IPV is a serious health problem not to be ignored.

In order to design an effective IPV prevention programme, identification of risk factors is needed. Several IPV risk factors have been identified, those that point to the characteristics of the victims and perpetrators, household characteristics, life experience of both the victim (history of abuse) and the perpetrator, and nature of the relationship between the woman and the man (Abramsky *et al.*, 2011; Hindin *et al.*, 2008). Risk factors that point to the characteristics of the woman include the age of the woman, education level of the woman, current marital status, work status, age at first marriage (Kishor & Johnson, 2004). Some of the risk factors associated with the characteristics of the perpetrator are education level, alcohol use, occupation, and work status (Breiding *et al.*, 2008). The risk factors related to the characteristics of the relationship include age difference, education difference, and marital duration (Kishor & Johnson, 2004). Finally, factors related to household characteristics include residence (urban or rural), family structure (nuclear and non-nuclear), wealth quintile (lowest, second, middle, fourth, and highest) (Kishor & Johnson, 2004).

Age disparity has been identified as a risk factor and the current state of evidence is discussed in chapter 2.

1.4 Motivation and objectives of the study

Studies have reported that young women in sexual relationships with older men are at increased risk of HIV-1 infections in women and men in Sub-Saharan African countries (Gregson *et al.*, 2002; Kelly *et al.*, 2003). Gregson *et al.* (2002) emphasize that breaking the transmission of HIV-1 from older men to younger women should become a pivotal focus of HIV prevention strategies. Therefore, AD relationships are often discouraged in order to prevent HIV-1 infections. However, the study by (Beauclair & Delva, 2013) found that women prefer AD relationships because younger men or men of the same age tend to be abusive and disrespectful. It is not clear whether or not the women's concerns about IPV in non-AD relationships are warranted.

Moreover, studies that have looked at the association between IPV and age disparity have reported conflicting results. For instance, Jewkes *et al.* (2002) found that having an older partner is protective against IPV among South African women. However, other studies have shown that having an older partner may not be protective against IPV compared to having a partner of the same age or younger (Coker *et al.*, 2000; Fageeh, 2014). Some studies also found no evidence of association between IPV and age disparity (Koenig *et al.*, 2003; Tumwesigye *et al.*, 2012).

This thesis was guided by the following objectives:

- to report the prevalence of intimate partner violence (IPV) among heterosexual intimate partners in 21 sub-Saharan African countries.
- to investigate the association between intimate partner violence and age disparity in sub-Saharan Africa. This was achieved by
  - comparing the generalised linear models for binary outcome.
  - carrying out a meta-analysis of relative risks.

1.5 Organisation of the study

This study is organised into seven chapters. Chapter 2 is used to examine the existing literature on the association between IPV and age disparity. Chapter 2 also looks at the IPV correlates used as confounders in the analysis of IPV and age disparity. Chapter 3 presents the research methods, comprising the methods of data collection, source of data and the countries under study, and ethical considerations. Chapter 4 is devoted to the estimation of relative risk. The review of meta-analysis models is covered on chapter 5. Chapter 6 contains the results of the prevalence of IPV and the results of the association between IPV and age disparity. Finally, discussion and conclusion are presented in chapter 7. Chapter 7 also highlights the directions for future research.

Chapter 2

Review of IPV risk factors

The main aim of this study is to investigate the relationship that exists between intimate partner violence and age disparity. Several studies have been carried out to identify the risk factors associated with IPV, and age difference between intimate partners is one of the factors. Findings emanating from these studies show conflicting results. This chapter is aimed at comparing previous studies on IPV and age disparity.

2.1 Relationship between IPV and age disparity

Studies have been carried out to investigate the relationship between IPV and age disparity, but conflicting results have been found. A qualitative study carried out by Beauclair & Delva (2013) in Cape Town, South Africa, to investigate the risks and benefits of age-disparate (AD) relationships among women found that some women claimed that they are less inclined to be in an intimate relationship with a younger man or man of the same age because these men are viewed as abusive or disrespectful. The Beauclair & Delva (2013) paper presented a qualitative evidence, which warrants further investigation. Moreover, only 23 women participated in this study, which is not representative of the women in Cape Town.

Similarly, a cross-sectional study carried out by Jewkes *et al.* (2002) about risk factors of IPV using data from South Africa indicated that women abused by their male partners were less likely to have had an intimate partner more than five years older than them. Jewkes *et al.* (2002) study was undertaken in three out of the nine South African provinces, raising the question whether the sample was sufficiently representative for the results to be generalized to the entire South African population.

Moreover, Kishor & Johnson (2004) considered DHS data from Cambodia, Egypt, Dominican Republic, Haiti, India, Nicaragua, Peru, Colombia, and Zambia, where they reported varying results about IPV and age difference between intimate partners. The authors indicated that intimate partner violence was significantly associated with age gap in six out of the nine countries. Women who were older than their intimate partners were most likely to report having experienced violence from their intimate partners. The finding was particularly striking in Dominican Republic, where 27% of women who were married to younger men reported having experienced IPV compared to 18% of women who married partners older than themselves (Kishor & Johnson, 2004). Kishor & Johnson (2004) also indicated that there is a high negative correlation between age difference and IPV in India. Considering the recent violence data (experienced IPV within 12 months before the survey), Kishor & Johnson (2004) states that IPV tends to be higher for women older or similar in age to their intimate partners. This study considered DHS data carried out between 1998 to 2002 and from different continents.

A different DHS study carried out by Hindin *et al.* (2008) investigated the same questions as Kishor & Johnson (2004), but considered the extent to which the characteristics of the husband/intimate partner influence the risk of a woman experiencing IPV independent of the characteristics of the woman . Moreover, Kishor & Johnson (2004) considered ever-married women while Hindin *et al.* (2008) considered currently married/cohabiting women. The study by Hindin *et al.* (2008) was on predictors and health outcomes of IPV among couples in 10 DHS countries and looked at the age difference between intimate partners as a risk factor for IPV. Hindin *et al.* (2008) grouped the age difference into husband/partner 5-9 years older than the woman, 10+ years older than the woman, and others. They found out that, among the countries they considered, women in Zambia whose intimate partner was at least 5 years older than them had a lower risk of IPV than for women who were closer in age to their partner or older than their partners. The association of IPV and age disparity was not significant in other countries.

As mentioned, the study by Kishor & Johnson (2004) used DHS data to examine the association between IPV and age disparity, among other risk factors of IPV, but only included Zambia from sub-Saharan Africa and used data collected between 1998 to 2002. Hindin *et al.* (2008) considered only five sub-Saharan African countries and used data collected between 2001-2006. This study is different from Kishor & Johnson (2004) and Hindin *et al.* (2008) studies in the sense that the recent DHS data from 21 sub-Saharan African countries collected between 2008-2014 were used.

An analysis carried out by Lawoko *et al.* (2007) using DHS data from Kenya collected in 2003 reported a mixed picture on the association between IPV and age disparity based on the IPV indicators. They reported that women older than their partners were at higher odds (OR:2.12; 95% CI:1.09-4.14) of experiencing physical IPV compared to women of the same age as their partners. Moreover, they indicated that women less than 10 years younger than their partners had higher odds of experiencing physical IPV (OR:1.65; 95% CI:1.02-2.69) and sexual IPV (OR:2.45; 95% CI:1.12-5.36) compared to women of the same as their intimate partners. The odds of experiencing physical, sexual, and emotional IPV was not significantly different between women who had partners of the same age and women who had partners at least 10 years older than them. Analogous to the studies by Kishor & Johnson (2004) and Hindin *et al.* (2008), the study by Lawoko *et al.* (2007) is nationally-representative, allowing for conclusions to cover the entire country.

Another study that used DHS data was carried out in Nigeria by Antai (2011). Antai reported that 19.3% of women having older partners reported having experienced IPV, while women older than their partners and women of the same age as their partners each reported that 7.6% had experienced IPV. Although, the data was nationally representative, this study did not include age difference in the logistic regression, therefore, readers and policy makers do not know if there are odds/risks of women experiencing IPV relative to the age difference between them and their male intimate partners.

Moreover, another study carried out by Tumwesigye *et al.* (2012) in Uganda using 2006 DHS data reported a prevalence of physical IPV at 49.2% of women who had partners of the same age or older than their partners, women 1-4 years younger reported 49.6%, women 5-9 years younger reported 45.5% and women 10 or more years younger than partners reported 46.1%. A chi-squared test showed that there was no significant difference in the prevalence of physical IPV among the different age difference levels (Tumwesigye *et al.*, 2012). Tumwesigye *et al.* (2012) only considered physical IPV, thus, there is a need to study emotional and sexual IPV using recent DHS data.

Abramsky *et al.* (2011), just like Hindin *et al.* (2008), published mixed association between IPV and age disparity. They used survey data from WHO to examine the role of age disparity as one of the risk factors of IPV. They considered 15 sites (urban and rural) around the world. They indicated that the relationship between IPV and age disparity was not consistent across all sites. They further iterated that a woman being older than her intimate partner was often associated with increased risk of IPV. However, three out of the 15 sites reported that an older age of the intimate partner was associated with increased risk of experiencing IPV.

An analysis of longitudinal data from seven survey rounds of the Rakai Community Cohort Study (RCCS) between 2000 and 2009 in Uganda reported that women five to nine years (OR: 0.83; 95% CI: 0.69-0.99) and women less than five years (OR: 0.83; 95% CI: 0.70-0.99) younger than their partners were protective against IPV compared to women of the same age as their partners (Kouyoumdjian *et al.*, 2013). Also, women having partners at least 10 years older gave odds ratio of 0.83 (95% CI: 0.69-1.00), which is not significantly different from that of women who had partners of the same age (Kouyoumdjian *et al.*, 2013). Further, a study that used RCCS data from 1998-1999 reported that age disparity was not significantly related to sexual IPV (Koenig *et al.*, 2004).

Furthermore, a study in Uganda reported no evidence of association between IPV and age disparity. A survey carried out by Koenig *et al.* (2003) reported that a male partner more than 9 years older may not be protective against physical IPV in Uganda with odds ratio of 1.01 (95% CI: 0.79-1.28), but the effect is not statistically different from the reference group (male partner one to nine years older than the woman). Koenig et al. also pointed out that having a younger partner or a partner of the same age may be protective against physical IPV with an odds ratio of 0.82(0.59-1.14), which is not statistically different from the reference group. This study has one potential limitation that it omitted questions on sexual and emotional IPV, therefore calling for further studies that includes all the indicators of IPV.

Elsewhere, Luke *et al.* (2007) in their survey about couple attributes and attitudes and marital violence in Vietnam considered age disparity as one of the couple characteristic variables. They subtracted the wife's age from the husband's age and constructed three categories of age differences: the husband younger or the same age as the wife, the husband one to three years older than the wife, and the husband more than three years older (the reference group). The study indicated that the male partner who were three or more years older than the women were the least likely to have ever perpetrated violence compared to partners in the other two categories. The odds that a man one to three years older would have perpetrated violence increased from 60% to 80% relative to the reference group .

In addition, Parish *et al.* (2004) conducted a national-representative survey in China to investigate the risk factors of IPV and the associated health problems. They divided couples into two categories: males less than or equal to two years older (reference group) and males 3-11 years older than the woman. The study reported that women with intimate partners 3-11 years older were less likely to experience IPV with odds ratio of 0.71 (95% CI: 0.50 - 0.99) compared to the reference group. This study has two limitations. The first limitation is that women were not asked about all the specific measures of IPV (as indicated in section 3.3.1), women were only asked if they were ever hit by their intimate partners. Secondly, they considered lifetime experience of IPV in the current relationship, which brings in the aspect of recall bias, especially when the woman is asked about the age of the intimate partner.

A telephone survey conducted by Tang (1999) reported that Chinese women were likely to experience physical abuse when the intimate partners were more than 20 years older than them. Even though telephone interviews are widely accepted (it is a principal survey technique), there is a low response rate compared to face-to-face interviews (Novick, 2008).

Moreover, a cross-sectional survey carried out in Saudi Arabia between 2011-2012 in three tertiary hospitals indicated that women with older partners were more likely to experience IPV compared to women of the same age as their partner or older than their partners (Fageeh, 2014). This study considered lifetime prevalence of IPV, which is associated with recall bias. Furthermore, the study cannot be generalized to the entire nation because non-clinical cases were not part of the sample. Another survey conducted among patients attending Al-Wazarat Healthcare Center (WHC) in Saudi Arabia reported that women in relationships with older partners were more likely to experience IPV (Barnawi, 2015).

The association between IPV and age disparity has also been studied in some South American countries. A cross-sectional study carried out by Coker *et al.* (2000) in Colombia on the correlates of IPV types shows that there is a correlation between IPV and an age difference of more than 9 years between couples. The study reported an odds ratio of 1.7 (1.0-2.7) implying that women whose intimate partners are more than 9 years older than them may be at higher odds of experiencing physical and sexual IPV. Coker *et al.* (2000) considered women aged 18-65 who had been in a relationship for at least three months. The study population consisted of women who were insured through either Medicaid or a managed care provider, therefore making this study limited in terms of the ability to generalize to the the rest of the population without a medical aid.

A different study performed by Jones & Ferguson (2009) in Colombia using 2005 DHS data showed that age difference have a strong effect on the log-odds of a woman experiencing IPV. Unlike most of the studies on IPV and age disparity, this study did not categorize the age differences, therefore limiting the interpretation, that is, how the effect of age disparity on IPV differs between couples where the male partner is older, female partner is older or the couples are of the same age.

In conclusion, these studies show that there is no agreement on the association between IPV and age disparity. Consequently, more research still needs to be done using current data on IPV. In addition, the association between IPV and age disparity is reported using odds ratio, which is often misinterpreted as risk, which is difficult to communicate and is incomprehensible to many policy makers and key stakeholders (Lee, 1994). Therefore, there is a need to use a better statistic that is easy to communicate and comprehend. This study report the association between IPV and age disparity in terms of relative risk (RR). RR is considered a statistic for easy and better communication (Schmidt & Kohlmann, 2008).

2.2 Relationship between IPV and age of the woman

The age of the woman is documented as one of the IPV risk factors by several studies. A review of IPV risk-markers in China reported that younger women are at a higher risk of experiencing IPV compared to the older women (Tang & Lai, 2008). Another study carried by Abramsky *et al.* (2011) using survey data from WHO reported that younger age of the woman was strongly associated with increased risk of experiencing IPV in the last year in 12 of the 15 sites studied. Moreover, Hindin *et al.* (2008) studied DHS data from 10 countries in which they found out that the relationship between IPV and age of the woman is country dependent and only significant in three countries. In Malawi, the oldest category of women had lower rates of violence at 20% compared to the younger women at 27-28%. Younger women in Rwanda were the least likely to experience IPV (26%) compared to the oldest group at 37%.

Furthermore, a longitudinal survey carried out in Uganda among women aged 15-24 between 2001-2003 reported that women aged 20-24 were more likely to experience physical IPV with odds ratio of 1.56 (95% CI: 1.34-1.82) compared to women aged 15-19 (Zablotska *et al.*, 2009). A study carried out in Malawi that reported the relationship betwen IPV and age of the woman indicated different findings per forms of IPV. Women aged 15-19 in Malawi were less likely to report emotional IPV compared to women aged 45-49 (Bazargan-Hejazi *et al.*, 2012). Women aged 25-29 were more likely to report physical IPV compared to women aged 45-49. Women aged 30 to 34 were more likely to report sexual IPV compared to women aged 45-49.

Another study indicated no evidence of association between IPV and age of the woman. A study carried in Uganda that divided the age of the woman in 3 categories: less than 25 years, 25-34 years and more than 34 years (reference group) reported no evidence of association (Koenig *et al.*, 2003). OR of 1.28 (95% CI: 0.92 - 1.80) and 1.17 (95% CI: 0.90-1.53) was reported for less than 25 years group and 25-34 years group respectively.

Finally, a study carried out in 2004 using DHS data from 10 countries indicated older women were less likely to experience IPV compared to younger women in most of the countries (Kishor & Johnson, 2004). For instance, Egypt reported that younger women are more likely (21%) to experience IPV compared to the older women (5%). A similar outcome was observed in Zambia with younger women reporting 35% and older women reporting 15.8%. However, Cambodia reported that older women were more likely to experience IPV at 18% compared to younger women at 4.0% (Kishor & Johnson, 2004). Moreover, a survey carried out in the U.S. found that women aged 18-24 were at a higher risk of experiencing IPV than older women aged 25 years and above (Thompson *et al.*, 2006).

2.3 Other IPV risk factors

We used four risk factors as covariates in the analysis of the association between IPV and age disparity. The risk factors were: age group of the woman, education level of the woman, education level of the woman, and employment status of the woman. This section is devoted to reviewing the relationship between the last three factors and IPV.

2.3.1 Education level of the victim

A survey carried out in Uganda reported that women who went to school for more that 8 years were less likely to experience IPV compared to women who did not go to school (Koenig *et al.*, 2003). Secondly, a different study carried out in Rakai, Uganda reiterated that attaining secondary or higher education level was protective against IPV (Zablotska *et al.*, 2009). Thirdly, a study carried out by Kishor & Johnson (2004) using DHS data documented that women with no education were more likely to report spousal violence compared to women with primary, secondary or higher level of education in most countries. Moreover, a survey carried out in the U.S. showed that non-high school graduates are at higher odds of experiencing IPV (OR : 3.52; 95% CI: 2.36-5.26) compared to the high school graduates (Walton-Moss *et al.*, 2005). Also, college graduates were less likely to experience IPV compared to non-college graduates (OR :0.32; 95% CI: 0.24, 0.43). Similar findings were reported elsewhere (Bonomi *et al.*, 2006; Klomegah, 2008). In summary, women who have achieved higher level of education are less likely to experience IPV.

2.3.2 Education level of the male intimate partner

Studies have shown that the education level of the man is correlated with the likelihood of perpetrating IPV. A survey carried out by Luke and colleagues in Vietnam found that higher levels of educational attainment among husbands were significantly associated with a lower likelihood of IP (Luke *et al.*, 2007). Another study carried out in Zambia indicated that male intimate partners with higher education level are less likely to be perpetrators of IPV (Klomegah, 2008). The association between IPV and age of the man is also demonstrated in other studies, which demonstrates that higher education level of the man is associated with lower risk of committing violence against women (Abramsky *et al.*, 2011; Hindin *et al.*, 2008).

2.3.3 Employment status of the victim

Kishor & Johnson (2004) found that the association between employment status of a woman and IPV is country dependent. They reported that women in Egypt who are not employed are more likely to experience IPV. Peru, India and Colombia indicated that employed women were more likely to experience IPV. Abramsky *et al.* (2011) also reported mixed findings. They reported that, compared to cases where both couples are employed, a woman is at a higher odds of experiencing IPV in 6/14 settings where only the woman is employed.

Moreover, a study carried out in Rwanda indicated that women in employment were 1.04 times more likely to be abused by their intimate partners compared to the women who are not working (Klomegah, 2008). Another survey carried out in 8 Southern African countries indicated that women who are not employed are more likely to experience physical violence compared to women who are employed (Andersson *et al.*, 2007).

Chapter 3

Research methods

The information about Demographic and Health Survey (DHS) data is provided in this chapter. The design of this study was meta-analysis of data from DHS, which collected data between 2008 and 2014. Meta-analysis is defined as a way of combining data from many different research studies, thereby increasing the overall sample size and the ability of the investigator to study effects of interest (Barendregt *et al.*, 2013). This type of study is elaborated in chapter 5. The research methods were chosen to aid the investigation of the relationship between intimate partner violence and age disparity. The procedures used by DHS to collect the data is provided in section 3.2. The measures of IPV is provided in section 3.3. The information about the independent variable is provided in section 3.4. Selection probability and sampling weight, design-based approach to inference, and how the IPV prevalence was calculated are provided in the subsequent sections.

3.1 Data Source

The data used in this study was obtained from DHS. This sections describes the procedures used by DHS.

3.1.1 Research Design

DHS studies are cross-sectional and are repeated approximately every five years in low and middle income countries. The surveys are organised and conducted by the National Bureau of Statistics from host countries and Inner City Fund (ICF) international in collaboration with organisations and development partners in these countries.

3.1.2 Sampling Procedure

DHS utilises two-stage cluster sampling procedures when collecting data on domestic violence. A cluster is a group of adjacent households that serves as the primary sampling unit (PSU). In most of the surveys, a cluster was an enumeration area (EA) with a measure of size equal to the number of households or the population in the EA, provided by the population census (DHS, 2012 (accessed December 3, 2016).

The first sampling stage involved a stratified sample of EAs selected with probability proportional to size. Specifically, in each stratum, a sample of a predetermined number of EAs was selected independently with probability proportional to the measure of size of the EAs (DHS, 2012 (accessed December 3, 2016). In the selected EAs, a listing procedure was performed such that all households were listed. In the second stage number of households was selected by equal probability systematic sampling technique in the selected EAs. In each of the selected households, a household questionnaire was completed to identify women aged 15-49. One eligible woman was then selected from a sampled household for the domestic violence (DV) module.

3.1.3 Data Collection instrument

DHS uses questionnaires as their main data collection instrument. Data collection on intimate partner violence involved the use of the DV module, a special questionnaire designed to collect data on domestic violence. The DV module involved the implementation of a Modified Conflict Tactics Scale (CTS) to get information on intimate partner violence (Kishor, 2005 (accessed December 7, 2016). The modified CTS used by DHS includes only about 13 standard acts of emotional, physical and sexual violence. If the respondent affirmed that any of the specific measures of types of IPV had been experienced, then she was considered to have experienced IPV.

3.1.4 Countries under study

We summarize the information pertaining to the countries included in the study in table 3.1. These countries were chosen based on the availability of data on domestic violence and the questions used in the DV module. The DHS surveys conducted in these countries used standard questions defined in the DV module, therefore, allowing comparison of the results between the countries.

Table 3.1: Countries under study by population size

Country Name	Population	Year of Survey	Region
Burkina Faso	15540000	2010–2011	West
Cameroon	21160000	2011	West
Comoros	717503	2012	East
DRC	67510000	2013–2014	Central
Côte d'Ivoire	19390000	2011–2012	West
Gabon	1633000	2012	Central
Gambia	1849000	2013	West
Ghana	23110000	2008	West
Kenya	39820000	2008–2009	East
Malawi	15010000	2010	Southern
Mali	14850000	2012–2013	West
Mozambique	24580000	2011	Southern
Namibia	2303000	2013	Southern
Nigeria	173600000	2013	West
Rwanda	10840000	2010	East
Sierra Leone	6092000	2013	West
Tanzania	46350000	2010	East
Togo	6817000	2013–2014	West
Uganda	35150000	2011	East
Zambia	14540000	2013–2014	Southern
Zimbabwe	13080000	2010–2011	Southern

3.1.5 Ethical considerations

The information collected in a DHS survey is very sensitive and personal in nature, for instance, IPV or the sexual behaviour of an individual (DHS, 2001 (accessed December 7, 2016; Kishor, 2005 (accessed December 7, 2016). As a result DHS has a standard procedure that meets international requirement of informed consent and privacy of information. Therefore, DHS did not disclose the names of any respondents in the dataset in order to take their privacy into account. Moreover, DHS follows safety and ethical procedures and guidelines in accordance to the world Health Organization ethical recommendation for research on domestic violence. The safety and ethical standards include:

- The interviewer should continue with the interview only if the privacy of the respondent is guaranteed.
- The interviewer should inform the woman what the sets of questions to be asked entail at the start of the interview and assure her that the answers she is going to give are completely confidential and no one will be informed of her response.

- Supervisors and interviewers are trained to sensitize women on the problem of IPV and the challenges they are likely to encounter when collecting information on the subject.
- Men who are interviewed are not asked questions based on domestic violence.
- Only one woman per household should receive the DV module.

3.2 Measures of IPV

This study used four types of IPV as given by DHS: emotional violence, less severe violence, severe violence, and sexual violence. Each of these types have specific measures (also known as specific acts of IPV) (DHS, 2013 (accessed December 7, 2016) as given in the bullets below.

a. Emotional violence

- Spouse ever humiliated her
- Spouse ever threatened her with harm
- Spouse ever insulted her or made her feel bad

b. Less severe violence

- Spouse ever pushed her, shook her or threw something at her
- Spouse ever slapped her
- Spouse ever punched her with fist or something harmful
- Spouse ever twisted her arm or pulled her hair

c. Severe violence

- Spouse ever kicked or dragged her
- Spouse ever tried to strangle or burn her
- Spouse ever threatened her with knife/gun or other weapon
- Spouse ever attacked her with knife

d. Sexual violence

- Spouse ever physically forced sex on her when not wanted

- Spouse ever forced other sexual acts on her when not wanted

The participants (women) were asked if they had ever experienced any measures of IPV and their response was either "No/Never" or "Yes". If the response was yes, they were to state the frequency within the last 12 months. The frequencies were: "often", "sometimes", "not at all in the last 12 months" and "yes, but not in the last 12 months/window/frequency missing".

This study involved two sets of outcome variables. Firstly, each of the specific measures of the types of IPV were used as outcome variables. Secondly, types of IPV, created by grouping together each of the specific measures of the types of IPV, were used as outcome variables. For instance, to form emotional violence, the responses for humiliation, threatened with harm and insulted or made to feel bad were combined.

3.3 Independent variable

The independent variable in this study was category of age disparity (AD) between intimate partners. AD is also known as the age gap or age difference between intimate partners. The age gap was obtained by subtracting the age of the woman respondent from the age of the man (intimate partner). The age gap was then converted to a categorical variable of two levels to allow for a more clear interpretation of the association between IPV and age disparity. The first group contained women who had partners less than five years older than them (Non-AD) and the second group contained women with partners at least five years older than them (AD). The table 3.2 summarises the percentage of women in both categories.

Table 3.2: Countries under study by age disparity

	Country	Non-AD	AD
1	Burkina Faso	22.25	77.75
2	Cameroon	26.65	73.35
3	Comoros	35.24	64.76
4	Dem. Rep. Congo	36.88	63.12
5	Côte d'Ivoire	26.81	73.19
6	Gabon	39.53	60.47
7	Gambia	12.15	87.85
8	Ghana	40.29	59.71
9	Kenya	35.04	64.96
10	Malawi	46.69	53.31
11	Mali	13.70	86.30
12	Mozambique	44.94	55.06
13	Namibia	50.16	49.84
14	Nigeria	20.13	79.87
15	Rwanda	59.80	40.20
16	Sierra Leone	26.13	73.87
17	Tanzania	37.76	62.24
18	Togo	35.47	64.53
19	Uganda	43.10	56.90
20	Zambia	39.87	60.13
21	Zimbabwe	43.03	56.97

3.4 Selection probability and sampling weight

DHS calculates sample weights to six decimals but these numbers are presented in the standard recode files without the decimal point. Analysts are required to divide the weights by 1000000 before use to approximate the number of cases (DHS, 2012 (accessed December 3, 2016). We used sampling weights to estimate the IPV prevalence. Sampling weights was also used in the regression model to estimate relative risks.

Sampling weights are defined by the number of units in a population represented by a sample member i (Pfeffermann, 1993). Sampling weights are needed to account for deviations in the sample that might lead to departures and bias between the sample and the population under study. The weights are needed to compensate for non-response, to compensate for unequal probabilities of selection and to adjust the weighted sample distribution for key variables of interest to make it conform to the known population distribution (Lohr, 2010; Pfeffermann, 1993). It is also a requirement by DHS that weight must be used for any analyses on their data. DHS calculates two-stage sampling weights as follows (DHS, 2012 (accessed December 3, 2016; Lohr, 2010):

Let,
N = number of primary sampling units (PSU) in population.
n = number of PSUs to be drawn in the first stage.
M_i = number of the secondary sampling units (SSU) in the $i-$th population.
m_i = number of SSUs to be drawn from $i-$th PSU in second stage.

The Weight is calculated as the reciprocal of the probability of its selection. For cluster sampling, the selection probability of the $j-$th element in the $i-$th PSU is as follows:

$\pi_{ij} = P(j-th \text{ SSU in } i-th \text{ PSU is selected}$
$\pi_{ij} = P(i-th \text{ PSU is selected}) \times P(j-th \text{ SSU is selcted}|i-th \text{ PSU selected})$
$\pi_{ij} = \frac{n}{N}\frac{m_i}{M_i}$
with the weight given by

$$w_{ij} = \frac{1}{\pi_{ij}}$$

3.5 Design-based approach to inference

Design-based approach is used for inference in the case of complex surveys. In the design-based inference, the population is regarded as fixed whereas the sample is considered as a realisation of a stochastic process (Lohr, 2010). The inferences are based on repeated sampling from the fixed population and the probability structure used for inference is that defined by the random variables indicating inclusion in the sample. This approach does not rely on any theoretical model, but weights are needed for estimating population means, totals and the regression coefficients (Lohr, 2010).

Lohr (2010) defined the situations when an analyst should use a design-based approach. These are, firstly, when performing a regression to generate official statistics that will be used to determine public policy, secondly, when a probability sample was taken, and thirdly, when the sample is large. The DHS data satisfies all these three conditions, in addition to being complex survey data.

R software was used in this study. Specifically, the *survey* package which is designed for analyses of complex survey data was used (Lumley, 2011).

3.6 Calculating the IPV prevalence

The prevalence of each specific measure of the types of IPV within the the last 12 months before the survey was examined. Firstly, a binary variable for each specific measure was created by lumping together "often" and "sometimes" to form "yes", and "never" and "yes, but not in the last 12 months" to form "No" - resulting into "Yes" and "No" levels for all the specific measures of types of IPV. Secondly, the prevalence of the specific measures of types of IPV were calculated using the *svymean* function from the survey package in R.

The specific measures of the respective IPV types were combined to form the four types of IPV. The prevalence of types of IPV were calculated in a similar manner to their specific measures.

3.7 Statistical methods

The measure of association between IPV and age disparity used in this study is relative risk (RR). RR can be estimated using three generalised linear models: logistic regression models which yields odds ratios that are then converted to RR, log-binomial regression models, and modified Poisson regression models (MPRM). This study compared the three methods and then chose modified Poison regression models for reasons provided in chapter 4.

Firstly, MPRM was fitted to the specific measures of the types of IPV and then to the types of IPV using age disparity as independent variable. The MPRM also included education level of the woman (ELW), education level of the man (ELM), employment status of the woman, and age group of the women as covariates. These covariates have been shown in the literature as risk factors of IPV (see chapter 2).

The MPRM model was fitted in R software using the *svyglm* function in R in two phases: unstratified and stratified analyses. For the unstratified analysis, the data was not divided in terms of the age of the woman and all the covariates (age group of the woman, education level of the woman, education level of the woman and employment status of the woman) were used as covariates. A linear model was assumed for the log of the the probability ($\log(\pi_i)$) of experiencing any measure of IPV for a subject i

For the stratified analysis, the age of the woman was categorised into two levels and used as interaction term so as to establish if the effect of age disparity of IPV differs between the younger women and the older women. The levels were: women less than or equal to 25 years (defined as younger women) and women more than 25 years (defined as older women). The covariates used in the stratified analysis were: education level of the woman, education level of the man, employment status of the woman. These covariates together with the interaction between the age disparity and the age group of the women to linearly predict the log of the the probability ($\log(\pi_i)$) of experiencing any measure of IPV for a subject i. Finally, the three generalised linear models are discussed in detail in chapter 4.

Chapter 4

Estimation of relative risk

4.1 Introduction

Estimation of relative risk (RR), also known as risk ratio, has recently been given more attention than the odds ratio (OR). As reported by Davies *et al.* (1998) OR is the most common measure of the relationship between a binary outcome and an exposure variable. Bland & Altman (2000) gives three reasons for this. Firstly, OR measures association between two binary variables. Secondly, OR can be estimated from logistic regression even after adding covariates to the model. Finally, OR have a special and very convenient interpretation in case-control studies. The proponents of logistic regression emphasize that OR closely approximate RR if the outcome is rare. However, when events are not rare OR poorly approximates RR (Greenland, 1987; Katz, 2006). Despite this difference between RR and OR, researchers still misinterpret OR as RR. For instance, in a study published in the New England Journal, the authors and the New York Times, reported OR as though it were RR (Schulman *et al.*, 1999). Such confusion may influence physicians and patients to make incorrect assumptions about the risk or benefits of a treatment or diagnostic tests. Consequently, various studies have proposed the use of models that directly estimates RR (Diaz-Quijano, 2012; Nathanson & Higgins, 2008; Yelland *et al.*, 2011). Various aspects of RR are covered in this chapter, from definition and calculation, in comparison with OR, to the models that can be used to estimate RR in case of a binary outcome.

4.2 Relative risk and odds ratio

RR is the ratio of the probability of an event occurring in an exposed group to the probability of an event occurring in an unexposed group. On the other hand, OR is defined as the odds that an outcome of interest will occur given an exposure, compared to the odds that an outcome will occur in the absence of an exposure. According to Zhang & Kai (1998), RR has been accepted as one of the standard measures in various fields including biomedical research. OR is often interpreted as RR when RR cannot be calculated directly (for instance, in case-control studies). However, only under certain conditions does the OR approximate the RR. OR approximates RR when the incidences of outcome of interest in the study population is rare (or low), say less than 10% (Zhang & Kai, 1998). Zhang & Kai (1998), further states that the more the incidences of the outcome of interest the more the OR underestimates the RR when it is less than one or overestimates the RR when it is more than one.

4.2.1 Calculating RR

As stated earlier, the aim of this study was to find out the relative risk of a woman experiencing IPV given the age disparity. How RR is calculated and interpreted is covered here in comparison to the OR.

The unit of analysis was the woman. The response or outcome is whether the woman experienced any specific act of IPV indicator or the types of IPV. Therefore, a binary outcome, which consisted of yes and no responses was modelled. The exposure in this analysis was the age disparity.

Suppose we say that women in age-disparate relationships are in the the exposed group and the non-exposed group are women not in age-disparate relationships. Let us assume that the probability of experiencing IPV among the exposed group is 30% and among the unexposed group is 2%. Then considering table 4.1 obtained from (Zou, 2004), a = 30%, b = 70%, c = 2%, and d = 98%.

Table 4.1: Table showing occurrence of an event given an exposure

Entries in a 2-by-2 table			
	y=1(event)	y=0(no event)	Total
x=1 (exposed)	a	b	n_1=a+b
x=0 (unexposed)	c	d	n_0=c+d
			n=n_0+n_1

The relative risk of IPV associated with age gap is given by

$$RR = \frac{\frac{a}{a+b}}{\frac{c}{c+d}} = \frac{\frac{30}{100}}{\frac{2}{100}} = 15. \tag{4.2.1}$$

We then deduce that the exposed group is fifteen times more likely to experience IPV. Moreover, calculating the OR using the same numbers gives an OR of 21, which is greater than RR. Therefore, using OR and interpreting OR as risk would be misleading (Schmidt & Kohlmann, 2008; Zou, 2004). In the next section, three generalised linear models that can be used to estimate RR are reviewed.

4.3 Review of generalised linear models for binary outcome

In this section the generalised linear models (GLMs) for binary response variable (independent or outcome variable) are reviewed. GLMs are extensions of the classical (ordinary) linear regression model (Seber & Lee, 2012). Firstly, various aspects of the classical linear regression model are highlighted.

Consider a continuous response variable $\boldsymbol{Y}$, with n observations $Y_i, \ldots, Y_n$ and p explanatory variables. The classical linear regression model is given by

$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\epsilon} \tag{4.3.1}$$

where

$$\mathbf{Y} = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix},$$

$$\mathbf{X} = \begin{pmatrix} 1 & x_{11} & x_{12} & \cdots & x_{1p} \\ 1 & x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_{n1} & x_{n2} & \cdots & x_{np} \end{pmatrix},$$

with

$$\boldsymbol{\beta} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_p \end{pmatrix},$$

and

$$\boldsymbol{\epsilon} = \begin{pmatrix} \epsilon_1 \\ \epsilon_2 \\ \vdots \\ \epsilon_n \end{pmatrix}.$$

The continuous response variable $\mathbf{Y}$ in (4.3.1) is modelled by a linear function of independent variables $\mathbf{X}$ with a random error, $\boldsymbol{\epsilon}$. The $\boldsymbol{\beta}$ are the unknown parameters to be estimated in the model.

The classical linear regression model relies on the following assumptions (Hardin *et al.*, 2007):

- Random errors are normally distributed. $\epsilon_i \sim N(0, \sigma^2)$
- Random errors have a common variance, $\sigma_i^2 = \sigma^2$ for all i.
- The observations are randomly selected, which corresponds to independence of random errors.
- A direct relationship exist between the expected values of the response variable and the predictors as shown in (4.3.2).

$$E(\mathbf{Y}|\mathbf{X}) = \mathbf{X}\boldsymbol{\beta} \tag{4.3.2}$$

The classical linear regression model is very useful, but there are some situations where it is not appropriate, which include:

- the range of response variable $\mathbf{Y}$ is restricted, for instance, binary and count data.
- the variance of the response variable $\mathbf{Y}$ depends on the mean through a function

  $$Var(\mathbf{Y}) = \phi V(\boldsymbol{\mu}), \tag{4.3.3}$$

  where ϕ is a dispersion parameter.

The GLMs extend classical linear regression models to address situations where the response variable is restricted (and hence the response variable is not characterised by the Gaussian distribution) and the variance of the response variable depends on the mean (Agresti, 1996). The GLMs are formulated using the framework of the exponential family of distributions. Special cases of the exponential family include: Poisson, binomial, Bernoulli, and Gaussian distributions.

The exponential family of distributions has a probability density or mass function of the form

$$f(Y|\theta) = a(\theta)b(Y)exp[h(Y)Q(\theta)]. \tag{4.3.4}$$

According to Agresti (1996), GLM has three components as follows :

1. A random component that consists of a dependent variable $\mathbf{Y}$ with n independent observations $(Y_1, Y_2, ..., Y_n)$ from one of the natural exponential family of distributions.

2. A systematic component which consists of the explanatory variables as linear predictors expressed as

$$\mathbf{X}\boldsymbol{\beta}. \tag{4.3.5}$$

3. A link function that connects the random and systematic components above. Examples of link functions include the so called identity, log, reciprocal, logit and probit functions. Let the mean $\boldsymbol{\mu} = E(\mathbf{Y}|\mathbf{X})$. The link function describes how the mean depends on the linear predictor by $g(\boldsymbol{\mu})$, $g(\boldsymbol{\mu}) = E(\mathbf{Y}|\mathbf{X})$, where g is monotonic and differentiable function (Agresti, 1996).

Lindsey (2008) gives some examples of the link functions as shown in table (4.2).

Table 4.2: Distribution types and their link functions.

Distribution	Link functions		Mean function
Normal	Identity	μ	$\mu = \mathbf{X}\boldsymbol{\beta}$
Gamma	Reciprocal	$\frac{1}{\mu}$	$\mu = (\mathbf{X}\boldsymbol{\beta})^{-1}$
Binomial	Logit	$\log\left[\frac{\mu}{1-\mu}\right]$	$\mu = \frac{\exp(\mathbf{X}\boldsymbol{\beta})}{1+\exp(\mathbf{X}\boldsymbol{\beta})}$
Poisson	Log	$\log(\mu)$	$\mu = \exp(\mathbf{X}\boldsymbol{\beta})$
Inverse Gaussian	Reciprocal^2	$\frac{1}{\mu^2}$	$\mu = (\mathbf{X}\boldsymbol{\beta})^{-\frac{1}{2}}$

Apart from the three components , Hardin *et al.* (2007) mentions other two characteristics of GLMs:

- A variance function that relates the variance, $Var(\mathbf{Y})$ and the mean, which is given by 4.3.3.

- Iteratively reweighted least squares algorithm (IRLS) is used to estimate the coefficients for all the GLMs. IRLS provides an algorithm that uses weighted ordinary least squares, which can be easily implemented into any software (Hardin *et al.*, 2007).

In summary, GLMs are linear models for a transformed mean of a response variable that has a distribution in the exponential family. Agresti (1996) highlights some of the GLMs as summarised in table 4.3, together with their link functions.

Table 4.3: Types of GLMs.

Random component	Link function	Systematic component	Model
Normal	Identity	Continuous	Regression
Normal	Identity	Categorical	Analysis of variance
Normal	Identity	Mixed	Analysis of variance
Binomial	Logit	Mixed	Logistic regression
Poisson	Log	Mixed	Loglinear
Multinomial	Generalized logit	Mixed	Multinomial response

The choice of the link function and the probability distribution of the response variable leads to different classes of models that suits different forms of data. In this chapter, two classes of such models are covered: log-linear models which includes the log-binomial regression and the modified Poisson regression model, as well as the logistic regression model. The logistic regression model will be considered first.

4.3.1 Logistic regression model

The aim of logistic regression is to model how a categorical response variable $\mathbf{Y}$ depends on as set of p independent variables, which can either be continuous or categorical in nature (Hosmer & Lemeshow, 2000).

Logistic regression can be binomial, ordinal or multinomial. The binomial (also known as binary) logistic regression deals with cases in which the response variable has two possible outcomes, 0 and 1 (Hosmer & Lemeshow, 2000). Ordinary logistic regression deals with situations where the response variable takes more than two possible ordered outcomes. The multinomial logistic regression deals with cases where the response variable can take more than two possible outcomes that are not ordered. However, this review covers the case of a binary logistic regression.

Binary logistic regression has the following assumptions:

- It does not assume a linear relationship between the response variable **Y** and explanatory variables.
- The response variable must have two possible outcomes (categories or groups), 0 and 1.
- The categories must be mutually exclusive; a case can only be in one category or group.
- The binomial distribution describes the distribution of errors.
- The sample is large for the reliability of the estimates.
- The independent variable can either be interval or categorical.
- The conditional mean of **Y** in logistic regression is bounded between 0 and 1.

Let **Y** denote a binary response variable. The response variable take one of two outcomes, usually denoted 0 and 1. Let $\mathbf{x}_i = (1, x_{i1}, x_{i2}, \ldots, x_{ip})$ denote setting i of values of p explanatory variables, $i = 1, 2, \ldots, n$. The logistic regression model is given by (4.3.6)

$$\pi(\underline{\mathbf{x}}) = \frac{\exp(\mathbf{X}\boldsymbol{\beta})}{1 + \exp(\mathbf{X}\boldsymbol{\beta})}. \tag{4.3.6}$$

The link function that makes logistic regression a generalised regression model is found as follows:

The odds are given by

$$\frac{\pi(\underline{\mathbf{x}})}{1 - \pi(\underline{\mathbf{x}})} = \exp(\mathbf{X}\boldsymbol{\beta}). \tag{4.3.7}$$

Taking the logarithms both sides of (4.3.7) gives the log odds as

$$\log\left(\frac{\pi(\underline{\mathbf{x}})}{1 - \pi(\underline{\mathbf{x}})}\right) = \mathbf{X}\boldsymbol{\beta}. \tag{4.3.8}$$

Therefore, the link function of a logistic regression model is the log odds, which is also known as the logit link function and (4.3.8) can also be written as

$$\text{logit}[\pi(\underline{\mathbf{x}})] = \mathbf{X}\boldsymbol{\beta}. \tag{4.3.9}$$

In logistic regression, the distribution of the response variable is assumed to be binomial with $\pi(\mathbf{x}_i)$ as the probability of success and must fall between 0 and 1. The logit is the natural parameter of the binomial distribution and can be any real number (Agresti, 1996). The systematic component of the logistic model consists of the independent variables that are linear in the parameters.

4.3.1.1 Maximum likelihood estimator (MLE)

Fitting the logistic regression model requires the estimation of the regression parameters $\boldsymbol{\beta}$ (Hosmer & Lemeshow, 2000). These parameters are estimated through the maximum likelihood approach. We will consider two cases: a single explanatory variable and multiple explanatory variables.

Consider a sample of n independent observations of the response variable $\mathbf{Y}$ (coded 0 or 1) and an explanatory variable X with a vector of observations $\mathbf{x}' = (x_1, x_2, ..., x_n)$. The pairs of observations are denoted by (x_i, y_i). Let the vector of parameter to be estimated be given by $\boldsymbol{\beta}' = (\beta_0, \beta_1)$. In order to apply the maximum likelihood approach, we first construct the likelihood function. The resulting parameter estimators are those that maximizes the likelihood function (Hosmer & Lemeshow, 2000).

Since the response variable is coded 1 or 0, the conditional probability that $Y = 1$ given x is $P(Y = 1|x_i)$ and that $Y = 0$ is denoted by $P(Y = 0|x_i)$. The contribution of $P(Y = 1|x_i)$ to the likelihood function is $\pi(x_i)$ and the contribution of $P(Y = 0|x_i)$ is $1 - \pi(x_i)$ (Hosmer & Lemeshow, 2000). The contribution to the likelihood function for the independent observations can also be expressed as

$$\pi(x_i)^{y_i} [1 - \pi(x_i)]^{1-y_i} . \tag{4.3.10}$$

As a result the likelihood function is obtained as

$$l(\boldsymbol{\beta}) = \prod_{i=1}^{n} \left(\frac{\pi(x_i)}{1 - \pi(x_i)} \right)^{y_i} (1 - \pi(x_i)) . \tag{4.3.11}$$

The log of (4.3.11), known as the log likelihood, is defined as

$$L(\boldsymbol{\beta}) = \ln [l(\beta)] = \sum_{i=1}^{n} \{ y_i \ln [\pi(x_i)] + (1 - y_i) \ln [1 - \pi(x_i)] \} . \tag{4.3.12}$$

Recall that

$$\pi(x_i) = \frac{\exp(\beta_0 + \beta_1 x_i)}{1 + \exp(\beta_0 + \beta_1 x_i)}.$$

Differentiating (4.3.12) with respect to β_0 and β_1 and setting the resulting equations to 0 in order to find the estimates of β_0 and β_1 yields

$$\sum_{i=1}^{n} [y_i - \pi(x_i)] = 0. \tag{4.3.13}$$

and

$$\sum_{i=1}^{n} x_i \, [y_i - \pi(x_i)] = 0. \tag{4.3.14}$$

By definition, (4.3.13) and (4.3.14) are non-linear in β_0 and β_1, and therefore require special methods for their solution. These special methods are iterative; they have been programmed into available logistic regression software; and will be viewed as a solved computational problem (Hosmer & Lemeshow, 2000). The methods used by most software are explained by McCullagh & Nelder (1989). In summary, it is shown that $\boldsymbol{\beta}$ is estimated by the solution of (4.3.13) and (4.3.14) through an iterative weighted least squares procedure.

Similar to the univariate case, let the parameter vector be $\boldsymbol{\beta}' = (\beta_0, \beta_1, \beta_2, ..., \beta_p)$. Fitting the model requires that we obtain the MLE of $\boldsymbol{\beta}$. Suppose more than one observation occurs at a fixed $\mathbf{x_i}$ and the number of observations and successes are recorded. Let n_i be the number of observations, y_i be the number of successes rather than the individual binary response. The likelihood function is given by

$$l(\boldsymbol{\beta}) \propto \prod_{i=1}^{n} \pi(\mathbf{x}_i)^{y_i} \left[1 - \pi(\mathbf{x}_i)\right]^{n_i - y_i}. \tag{4.3.15}$$

$$= \left\{ \prod_{i=1}^{n} \exp\left[\log\left(\frac{\pi(\mathbf{x}_i)}{1 - \pi(\mathbf{x}_i)} \right)^{y_i} \right] \right\} \left\{ \prod_{i=1}^{n} [1 - \pi(\mathbf{x}_i)]^{n_i} \right\} \tag{4.3.16}$$

$$= \left\{ \exp\left[\sum_{i} y_i \log \frac{\pi(\mathbf{x}_i)}{1 - \pi(\mathbf{x}_i)} \right] \right\} \left\{ \prod_{i=1}^{n} [1 - \pi(\mathbf{x}_i)]^{n_i} \right\} \tag{4.3.17}$$

From (4.3.6) the i^{th} logit is

$$\sum_{j}^{p} \beta_j x_{ij}, \qquad i = 1, ..., n.$$

So, the exponential term in (4.3.17) equals

$$\exp\left[\sum_i y_i \left(\sum_j \boldsymbol{\beta}_j x_{ij}\right)\right] = \exp\left[\sum_j \left(\sum_i y_i x_{ij}\right) \boldsymbol{\beta}_j\right].$$

Since

$$[1-\pi(\mathbf{x}_i)] = \frac{1}{1+\exp(\sum_j \boldsymbol{\beta}_j)x_{ij}},$$

the log likelihood is given by

$$L(\boldsymbol{\beta}) = \sum_j^p \left(\sum_i^n y_i x_{ij}\right) \beta_j - \sum_i^n n_i \log\left[1+\exp\left(\sum_j^p \beta_j x_{ij}\right)\right] \tag{4.3.18}$$

for $j = 0, ..., p$.

The likelihood equations are then obtained by calculating the partial derivative of (4.3.18) with respect to each element in $\boldsymbol{\beta}$. The $p+1$ partial likelihood equations may be expressed as

$$\sum_{i=1}^n [y_i - \pi(\mathbf{x}_i)] = 0 \tag{4.3.19}$$

and

$$\sum_{i=1}^n x_{ij}\,[y_i - \pi(\mathbf{x}_i)] = 0 \tag{4.3.20}$$

for $1 = 1, 2, \ldots, n$.

As in the univariate model, the solution of (4.3.19) and (4.3.20) requires special algorithms that are available in most statistical software.

4.3.1.2 Calculating the odds ratio from the logistic regression model

Consider the case of a binary outcome Y and a single binary explanatory variable X, where

$$Y = \begin{cases} 1, & \text{if event occurs} \\ 0, & \text{no event} \end{cases} \tag{4.3.21}$$

and

$$X = \begin{cases} 1, & \text{if exposed} \\ 0, & \text{not exposed} \end{cases} \tag{4.3.22}$$

The results are also summarised in table 4.1
where the odds ratio (OR) is given by

$$OR = \frac{ad}{bc}. \tag{4.3.23}$$

The logistic model is given by

$$\text{logit}[\pi(x)] = \beta_0 + \beta_1 x,$$

where $\pi(x)$ is the probability of getting the event of interest for a given value of X.
For $x = 0$,

$$\text{logit}(\pi(x)) = \beta_0 + \beta_1(0) = \beta_0 \tag{4.3.24}$$

and for $x = 1$,

$$\text{logit}(\pi(x)) = \beta_0 + \beta_1(1) = \beta_0 + \beta_1. \tag{4.3.25}$$

Also, the odds of the event of interest among the exposed is given by

$$\frac{\pi(1)}{1 - \pi(1)}$$

and the odds of the event among the unexposed group is given by

$$\frac{\pi(0)}{1 - \pi(0)}$$

OR is then given by

$$\text{OR} = \frac{\frac{\pi(1)}{1-\pi(1)}}{\frac{\pi(0)}{1-\pi(0)}}.$$

Now, by using (4.3.24) and (4.3.25) it is shown that

$$\begin{aligned}\beta_1 &= \text{logit}(\pi(1)) - \text{logit}(\pi(0)) \\ &= \log\left(\frac{\pi(1)}{1-\pi(1)}\right) - \log\left(\frac{\pi(0)}{1-\pi(0)}\right) \\ &= \log(\left(\frac{\frac{\pi(1)}{1-\pi(1)}}{\frac{\pi(0)}{1-\pi(0)}}\right)) \\ &= \log(\text{OR}).\end{aligned}$$

Therefore the regression coefficient is the log(OR), hence the OR is obtained by getting the exponential of β_1 (Agresti, 1996). The same calculation applies for the models having more than one predictor variables.

4.3.1.3 Variance, standard error and the confidence interval

Estimating the variances and covariances of the model parameters follows from the theory of the maximum likelihood estimation. The theory states that the variance and covariance estimators are obtained from the matrix of second partial derivative of the log-likelihood function. The partial derivatives have the following general form:

$$\frac{\partial^2 L(\beta)}{\partial \beta_j^2} = -\sum_{i=1}^{n} x_{ij}^2 \pi(x_i)(1-\pi(x_i)) \tag{4.3.26}$$

and

$$\frac{\partial^2 L(\beta)}{\partial \beta_j \partial \beta_l} = -\sum_{i=1}^{n} x_{ij} x_{il} \pi(x_i)(1-\pi(x_i)) \tag{4.3.27}$$

where $j, l = 0, 1, 2, 3, ..., p$.

Let the matrix, $(p+1) \times (p+1)$, containing the negative of the terms in (4.3.26) and (4.3.27) be denoted by $I(\beta)$, and known as the observed information matrix. The variances and the covariances of the estimated coefficients are obtained from the inverse of $I(\beta)$, which is denoted by $I^{-1}(\beta)$. The diagonal elements of $I^{-1}(\beta)$ are the variances, while the off-diagonal elements denote the covariance between $\hat{\beta}_j$ and $\hat{\beta}_l$. The estimators of the variances and covariances are then obtained by evaluating each element of $I^{-1}(\beta)$ by $I^{-1}(\hat{\beta})$.

The estimated standard error is obtained as:

$$\widehat{SE}(\hat{\beta}) = \left[\widehat{Var}(\hat{\beta}_j)\right]^{1/2} \tag{4.3.28}$$

for $j = 0, 1, 2, 3, ..., p$.
The estimated confidence interval for the j^{th} parameter is given by

$$\hat{\beta}_j \pm z_{1-\alpha/2}\widehat{SE}(\hat{\beta}_j), \tag{4.3.29}$$

since MLE $(\boldsymbol{\beta}) \sim N\left(\beta, (nI(\beta))^{-1}\right)$ as $n \to \infty$ from the asymptotic result of the MLE.

4.3.1.4 Relative risk from odds ratio

The odds ratio (OR) is the measure of effect in logistic regression. However, when used, it is often misinterpreted as relative risk (RR). Zhang & Kai (1998) in their paper suggested a method for estimating RR from OR as highlighted below.

As discussed in (4.3.1.2), let π_0 indicate the occurrence of the outcome of interest in the non-exposed group and π_1 in the exposed group. Since OR is given by

$$OR = \frac{\frac{\pi_1}{1-\pi_1}}{\frac{\pi_0}{1-\pi_0}}$$

We have

$$\frac{\pi_1}{\pi_0} = \frac{OR}{[(1-\pi_0) + (\pi_0 \times OR)]}.$$

And since

$$RR = \frac{\pi_1}{\pi_0} \tag{4.3.30}$$

RR can be estimated using (4.3.31).

$$\widehat{RR} = \frac{OR}{(1-\pi_0) + (\pi_0 \times OR)}. \tag{4.3.31}$$

4.3.2 Log-binomial regression

Log-binomial regression (LBR) is used to model the relationship between a dependent variable and one or more independent variables when the parameter of interest is the relative risk (Williamson *et al.*, 2013). Log-binomial regression, similar to logistic regression, assumes a binomial distribution of the response variable $\mathbf{Y}$ with independent observations $Y_1, Y_2, ..., Y_n$. The LBR systematic component is as given in (4.3.5) (Blizzard & Hosmer, 2006). Unlike logistic regression, the LBR link function is the logarithm of the probability of success given by $\log(\pi(\mathbf{x}_i))$. Consider p independent variables, then the LBR model is given by

$$\log(\pi(\underline{\mathbf{x}})) = \mathbf{X}\boldsymbol{\beta} \tag{4.3.32}$$

LBR has the following assumptions:

- The response variable observations $Y_1, Y_2, ..., Y_n$ are independently distributed.
- A linear relationship between the $\log(\pi(\underline{\mathbf{x}}))$ and the explanatory variables as shown in (4.3.32).
- Errors are independent and follow a binomial distribution.

Just like other GLMs, the LBR uses a maximum likelihood estimation approach. Based on (4.3.32), the effect of each explanatory variable on the response variable can be expressed as a relative risk by $\exp(\boldsymbol{\beta}_j)$. The LBR has to satisfy certain restrictions to ensure that the probability of the event of interest lies between 0 and 1 (Janani *et al.*, 2015). Since $\pi(\mathbf{x}_i)$ is a probability, the left hand side of (4.3.32) is constrained to less than or equal to zero, while the right hand side is unbounded. These restrictions may cause model (4.3.32) to fail to converge (Janani *et al.*, 2015).

4.3.2.1 Maximum likelihood estimation for LBR

Similar to the logistic regression, maximum likelihood is the natural choice to estimate the parameter values $\boldsymbol{\beta}_j$ in (4.3.32). Considering multiple independent variables with n observations, the log-likelihood function of $\boldsymbol{\beta} = (\boldsymbol{\beta}_0, \boldsymbol{\beta}_1, \boldsymbol{\beta}_2, ..., \boldsymbol{\beta}_p)$ from (4.3.32) can be expressed as

$$L(\boldsymbol{\beta}) = \sum_{i=1}^{n} \left[y_i \log \pi(\mathbf{x}_i) + (1 - y_i) \log(1 - \pi(\mathbf{x}_i)) \right], \tag{4.3.33}$$

if $\pi(\mathbf{x}_i) = \exp\left\{\sum_{j=0}^{p} \boldsymbol{\beta}_j x_{ij}\right\}$. The log-likelihood function (4.3.33) can also be expressed as

$$L(\boldsymbol{\beta}) = \sum_{i=1}^{n} \left[y_i \sum_{j=0}^{p} \boldsymbol{\beta}_j x_{ij} + (1 - y_i) \log\left(1 - \exp \sum_{j=0}^{p} \boldsymbol{\beta}_j x_{ij}\right)\right] \tag{4.3.34}$$

The log-likelihood function (4.3.33) can be considered as the sum of two different terms: those associated with $\mathbf{Y} = 1$ and those associated with $\mathbf{Y} = 0$. The term associated with $\mathbf{Y} = 1$ are simply the linear combinations of the $\mathbf{x}_i' s$ and $\boldsymbol{\beta}' s$. In addition, $\log \pi(\mathbf{x}_i) \leq 0$, since $\pi(\mathbf{x}_i)$ is a probability, and y_i is either 0 or 1 (Wedderburn, 1976). Hence,

$$\sum_{i=1}^{n} y_i \log \pi(\mathbf{x}_i) \leq 0.$$

Furthermore,

$$\log(1 - \pi(\mathbf{x}_i)) \leq 0,$$

which implies that

$$\sum_{i=1}^{n} (1 - y_i) \log(1 - \pi(\mathbf{x}_i)) \leq 0.$$

The first derivative of the likelihood function (4.3.33) gives the gradient or the score function, $S(\boldsymbol{\beta})$. Using (4.3.33) it follows that the score function is (Blizzard & Hosmer, 2006)

$$S(\boldsymbol{\beta}_j) = \frac{\partial L(\boldsymbol{\beta})}{\partial \boldsymbol{\beta}_j} = \sum_{i=1}^{n} \frac{y_i \partial \pi(\mathbf{x}_i)}{\pi(\mathbf{x}_i) \partial \boldsymbol{\beta}_j} - \frac{(1 - y_i) \partial \pi(\mathbf{x}_i)}{(1 - \pi(\mathbf{x}_i)) \partial \boldsymbol{\beta}_j} = \sum_{i=1}^{n} x_{ij} \frac{y_i - \pi(\mathbf{x}_i)}{1 - \pi(\mathbf{x}_i)}, \quad (4.3.35)$$

for $j = 0, 1, \ldots, p$.

Let the parameter estimates maximising (4.3.35) be $\hat{\boldsymbol{\beta}}$, and the fitted values from the model be

$$\hat{\pi}(\mathbf{x_i}) = \exp(\mathbf{x_i}' \hat{\boldsymbol{\beta}}). \quad (4.3.36)$$

According to Blizzard & Hosmer (2006), the consequences of the solution of (4.3.35) for the intercept parameter is that the sum of the observed values is equal to the sum of the estimated odds over the subjects with the response 0 or no or absent, expressed as

$$\sum_{i=1}^{n} y_i = \sum_{i=1}^{n} (1 - y_i) \frac{\hat{\pi}(\mathbf{x_i})}{1 - \hat{\pi}(\mathbf{x_i})}, \quad (4.3.37)$$

which is different from the logistic regression for which the sum of the observed values is equal to the sum of the fitted values.

Under the theory of maximum likelihood, estimators of the covariance matrix of the parameter estimators, $\hat{\boldsymbol{\beta}}$, are functions of the matrix of the second partial derivative (spd) of the log-likelihood function (Blizzard & Hosmer, 2006). Consequently, in the LBR model, the general term in the matrix of the spd is expressed as

$$\frac{\partial^2 L(\boldsymbol{\beta})}{\partial\beta_j \partial\beta_k} = \sum_{i=1}^{n} x_{ij}x_{ik}\frac{\pi(\mathbf{x}_i)(1-y_i)}{[1-\pi(\mathbf{x}_i)}]^2, \tag{4.3.38}$$

which is also known as the observed information (OI) matrix. The spd (4.3.38) evaluated at $\hat{\boldsymbol{\beta}}$ can be written as

$$\widehat{\mathbf{OI}} = \mathbf{X}'\hat{\mathbf{W}}\hat{\mathbf{A}}\mathbf{X}, \tag{4.3.39}$$

where $\mathbf{X}$ is the $n \times (p+1)$ data matrix, $\hat{\mathbf{W}}$ is

$$diag\left[\frac{\hat{\pi}(\mathbf{x_i})}{(1-\hat{\pi}(\mathbf{x_i}))}\right], \tag{4.3.40}$$

and

$$\hat{\mathbf{A}} = diag\left[\frac{(1-y_i)}{(1-\hat{\pi}(\mathbf{x_i}))}\right]. \tag{4.3.41}$$

Under the assumption that

$$E(Y_i|\mathbf{x}_i) = \pi(\mathbf{x}_i), \tag{4.3.42}$$

the expected information (EI) matrix computed at $\hat{\boldsymbol{\beta}}$ is given by

$$\widehat{\mathbf{EI}} = \mathbf{X}'\hat{\mathbf{W}}\mathbf{X}. \tag{4.3.43}$$

It is clear that the OI and EI are not he same, which leads to two different covariance matrices of $\hat{\boldsymbol{\beta}}$. The observed covariance (OC) matrix is the inverse of (4.3.39):

$$\widehat{\mathbf{OC}} = \frac{1}{\mathbf{X}'\hat{\mathbf{W}}\hat{\mathbf{A}}\mathbf{X}} \tag{4.3.44}$$

and the expected covariance (EC) matrix is the inverse of (4.3.43), namely

$$\widehat{\mathbf{EC}} = \frac{1}{\mathbf{X}'\hat{\mathbf{W}}\mathbf{X}} \tag{4.3.45}$$

Moreover, according to Blizzard & Hosmer (2006), "information sandwich" is used to yield robustness to the misspecification. In the LBR model, the sandwich is based on the outer product of the matrix in (4.3.35) given by

$$\hat{\mathbf{M}}_{\mathbf{r}} = \mathbf{X}'(\hat{\mathbf{c}}\hat{\mathbf{c}}')\mathbf{X}, \tag{4.3.46}$$

where $\hat{\mathbf{c}}$ is a $n \times 1$ vector with general element

$$\frac{(y_i - \hat{\pi}(\mathbf{x}_i))}{(1 - \hat{\pi}(\mathbf{x}_i))}.$$

Therefore, the robust variance estimator using the OI matrix is

$$\hat{\mathbf{R}}_{\mathbf{OI}} = \left(\frac{1}{\mathbf{X}'\hat{\mathbf{W}}\hat{\mathbf{A}}\mathbf{X}}\right)\hat{\mathbf{M}}_{\mathbf{r}}\left(\frac{1}{\mathbf{X}'\hat{\mathbf{W}}\hat{\mathbf{A}}\mathbf{X}}\right), \tag{4.3.47}$$

and the robust version of the variance estimator using EI is expressed as

$$\hat{\mathbf{R}}_{\mathbf{EI}} = \left(\frac{1}{\mathbf{X}'\hat{\mathbf{W}}\mathbf{X}}\right)\hat{\mathbf{M}}_{\mathbf{r}}\left(\frac{1}{\mathbf{X}'\hat{\mathbf{W}}\mathbf{X}}\right). \tag{4.3.48}$$

4.3.3 Poisson regression with robust variance

Poisson regression is often used to model count response variable and the rate (Y/t) as the response variable, where t represents time. The Poisson regression model can also be used to model a binary response variable, which is the variable of interest in this thesis. However, when used to model binary data, the error for the estimated relative risk is overestimated. This problem is rectified by using a robust error variance procedure known as sandwich estimation, leading to a method called modified Poisson regression (Zou, 2004). The model can be expressed as

$$\log(\pi(\mathbf{x}_i)) = \mathbf{X}\boldsymbol{\beta}. \tag{4.3.49}$$

Poisson regression has the following assumptions:

- The errors are independent and follows a Poisson distribution.
- The observations are independent.

- There exist a linear relationship between the $\log(\pi(x))$ and the explanatory variables.

Consider a special case in which $x_i (i = 1, 2, \ldots, n)$ is a binary exposure with a value of 1 if exposed and a value of 0 if unexposed. Then, the data can be summarised in a 2-by-2 table as shown in Table 4.1.

Suppose that subject i has an underlying risk that is a function of x_i, say $\lambda(x_i)$. Since $\lambda(x_i) \geq 0$, the logarithm link function is the choice for modelling $\lambda(x_i)$, resulting in

$$\log[\lambda(x_i)] = \beta_0 + \beta_1 x_i. \tag{4.3.50}$$

The relative risk is given as $\exp(\beta_1)$. If the Poisson distribution is assumed for y_i, the log-likelihood is given by

$$l(\beta_0, \beta_1) = C \sum_{i=1}^{n} [y_i(\beta_0 + \beta_1 x_i) - \exp(\beta_0 + \beta_1 x_i)], \tag{4.3.51}$$

where C is a constant. Application of the likelihood theory results into

$$\exp(\hat{\beta}_0) = \frac{c}{n_0}, \tag{4.3.52}$$

$$\widehat{RR} = \exp(\hat{\beta}_1) = \frac{a n_0}{c n_1}, \tag{4.3.53}$$

with the estimated variance of $\widehat{RR}$ given by

$$\widehat{\text{Var}}(\widehat{RR}) = \frac{1}{a} + \frac{1}{c}. \tag{4.3.54}$$

Since the error term is overestimated when the underlying data are from a binomial distribution, the sandwich estimator is used to make the appropriate correction (Zou, 2004). The corrected variance can be expressed as

$$\text{Var}(\widehat{RR}) = \frac{1}{a^2} \sum_{i=1}^{n} [y_i - \exp(\beta_0 + \beta_1)]^2 + \frac{1}{c^2} [y_i - \exp(\beta_0)]^2, \tag{4.3.55}$$

which is estimated to be

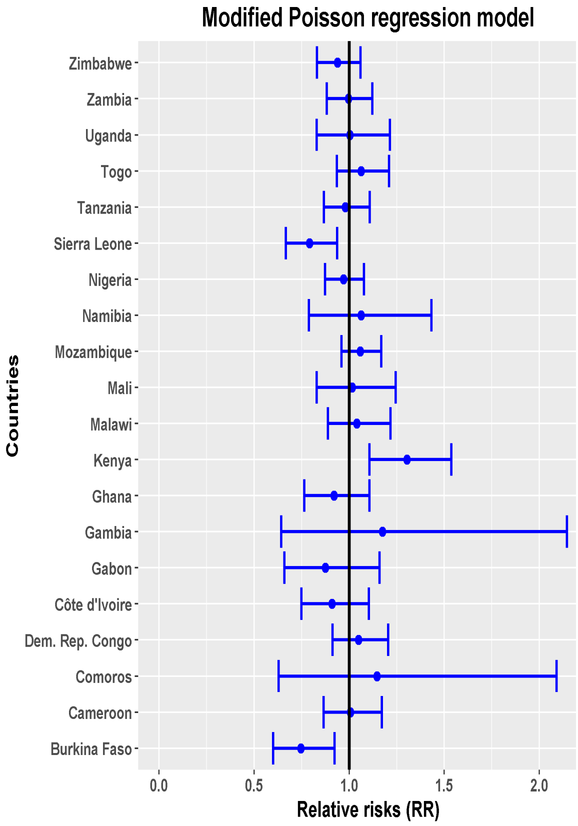
$$\widehat{\text{Var}}(\widehat{RR}) = \frac{1}{a} - \frac{1}{n_1} + \frac{1}{c} - \frac{1}{n_0}. \tag{4.3.56}$$

4.4 Comparing the GLM models using DHS data

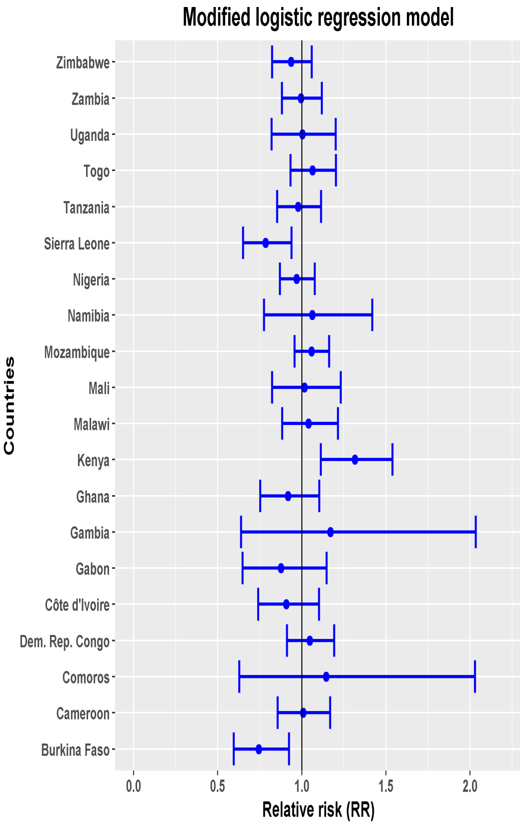
As indicated in section 4.3, there are three models that can be used to estimate RR for binary outcomes: logistic regression, log-binomial regression, and modified Poisson regression. The three regression models were fitted to the DHS data for each type of IPV (emotional IPV, less severe IPV, severe IPV, and sexual IPV) with the aim of choosing the model that yields the most reliable results. The results from the models are shown in figures 4.1 to 4.4. In addition, the standard errors and the p-values are shown in tables 4.4 to 4.15. These results show that the RR estimates and their confidence intervals (95%) from the three models are not meaningfully different. However, fitting a log-binomial model to the data on less severe violence led to non-convergence problem, which prompted the R software to give a warning that the results may not be reliable. This echoes the problem of non-convergence when fitting log-binomial model as discussed by Janani *et al.* (2015); Williamson *et al.* (2013); Yelland *et al.* (2011). Consequently, the results from the log-binomial model were not considered for meta-analysis.

The modified logistic regression (MLR) model used here is a combination of the logistic regression model and (4.3.31). The MLR model gave RR estimates without any non-convergence issues. However, McNutt *et al.* (1999) argues that the proposed way of calculating the confidence interval, (4.3.31), may produce narrower intervals than direct estimates. Moreover, (4.3.31) ignores the variance of the incidence of the outcome of interest from the non-exposed group (π_0). In addition, π_0 and OR may be highly correlated which affects the width of the confidence intervals. Lumley *et al.* (2006) also share similar views with McNutt *et al.* (1999), stating that the confidence interval from MLR are biased.

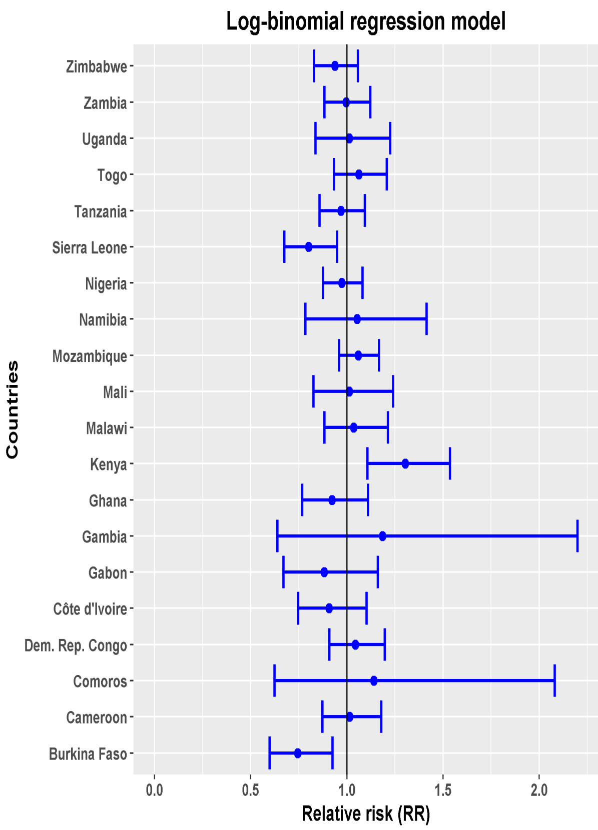
Similar to MLR, the modified Poisson regression model had no non-convergence issues. As supported by Zou (2004), the modified Poisson regression model gives consistent estimates and trustworthy confidence intervals. Consequently, the results from the modified Poisson regression model were used in the meta-analysis and the results presented in chapter 6.



(a)

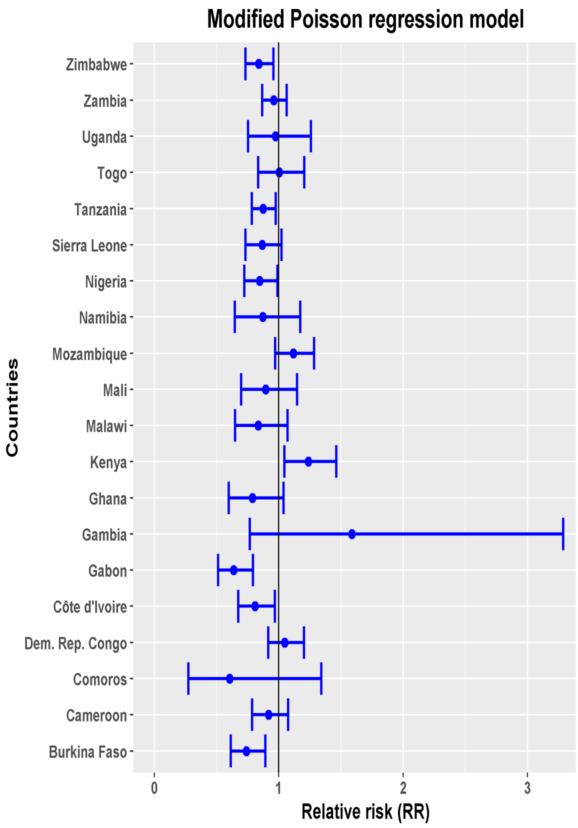


(b)

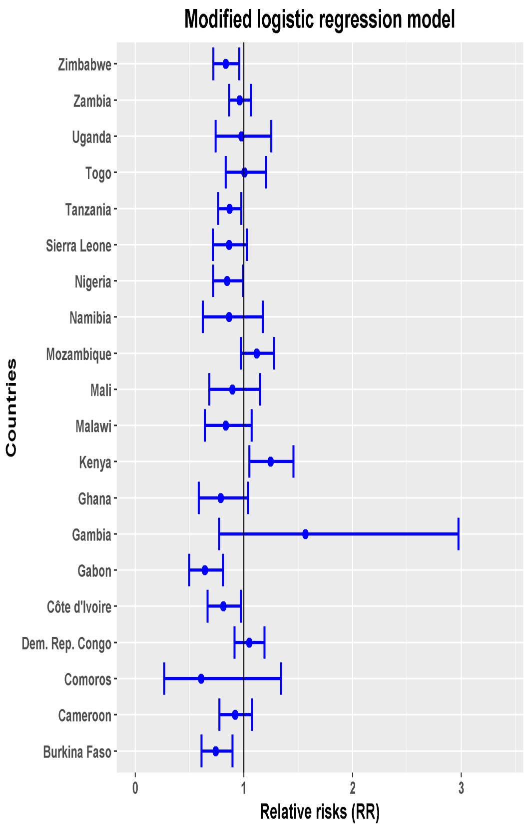


(c)

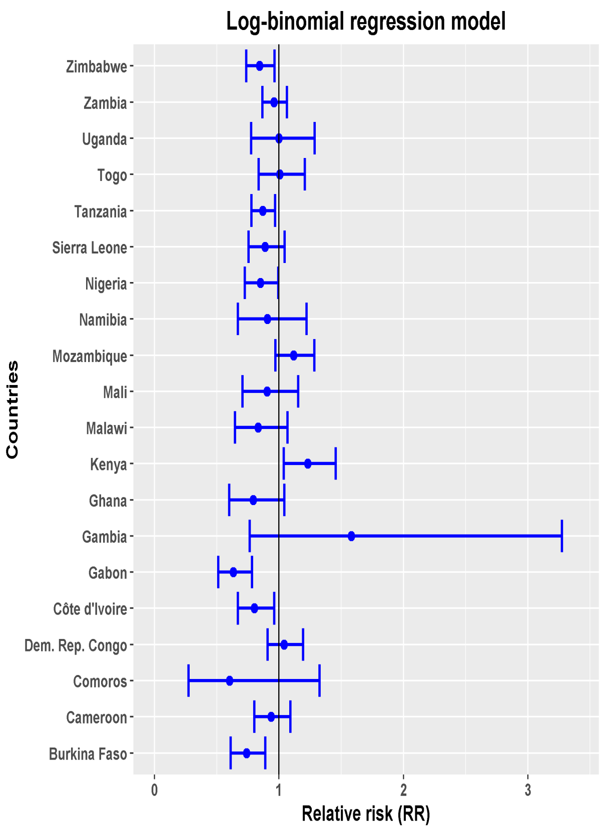
Figure 4.1: Emotional IPV.



(a)

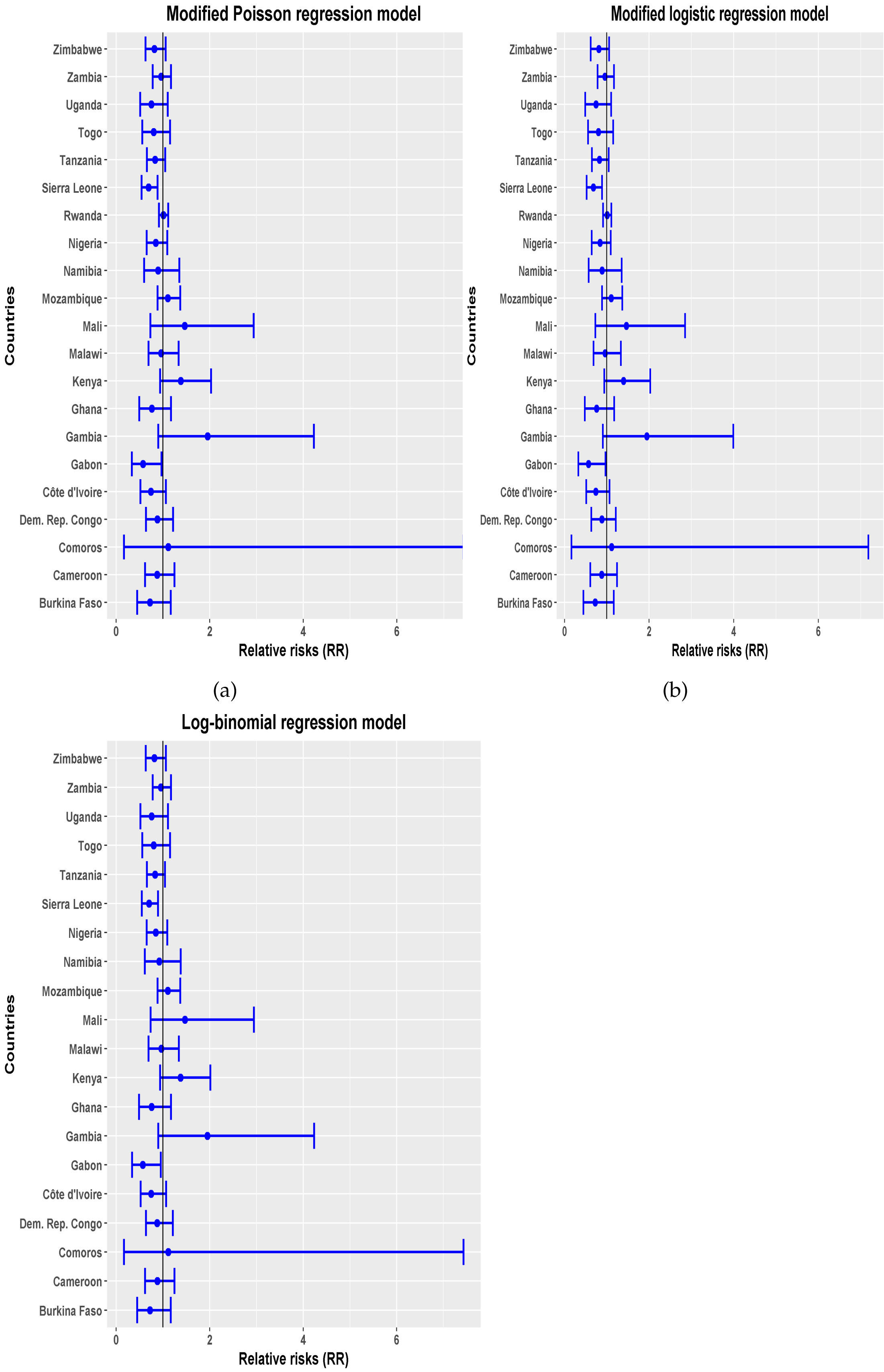


(b)



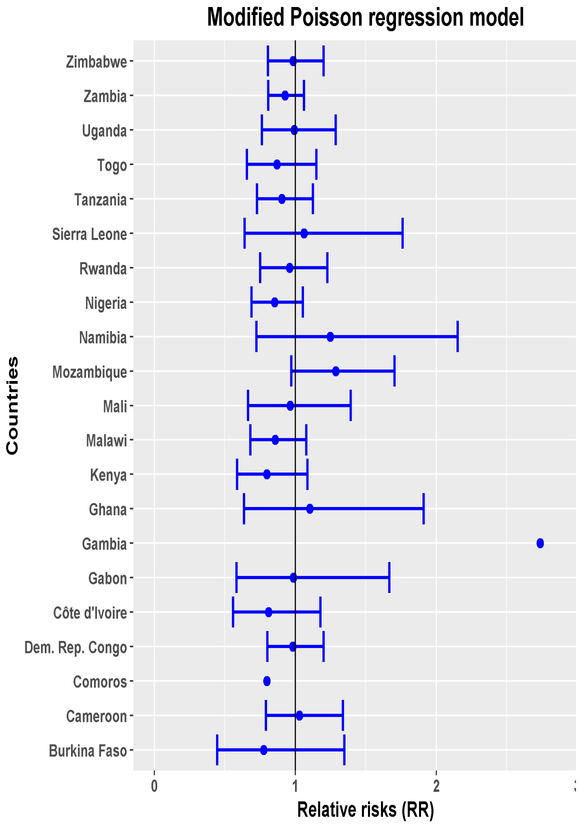
(c)

Figure 4.2: Less severe IPV.

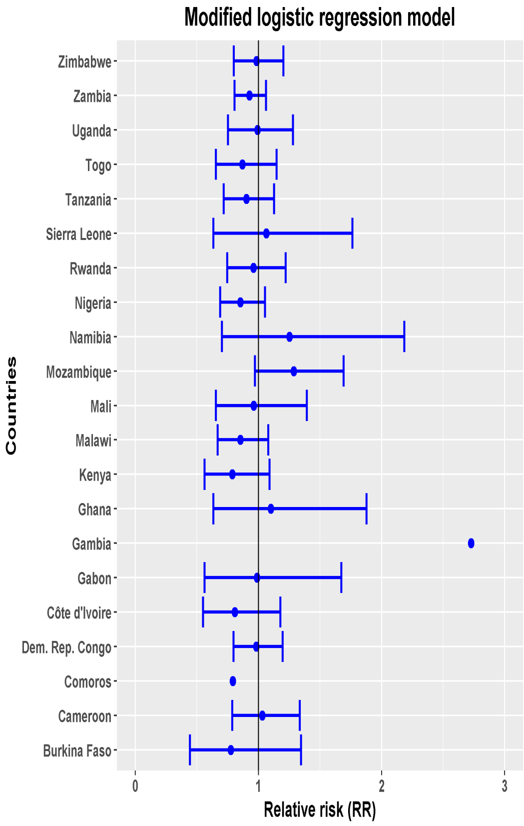


(a) (b) (c)

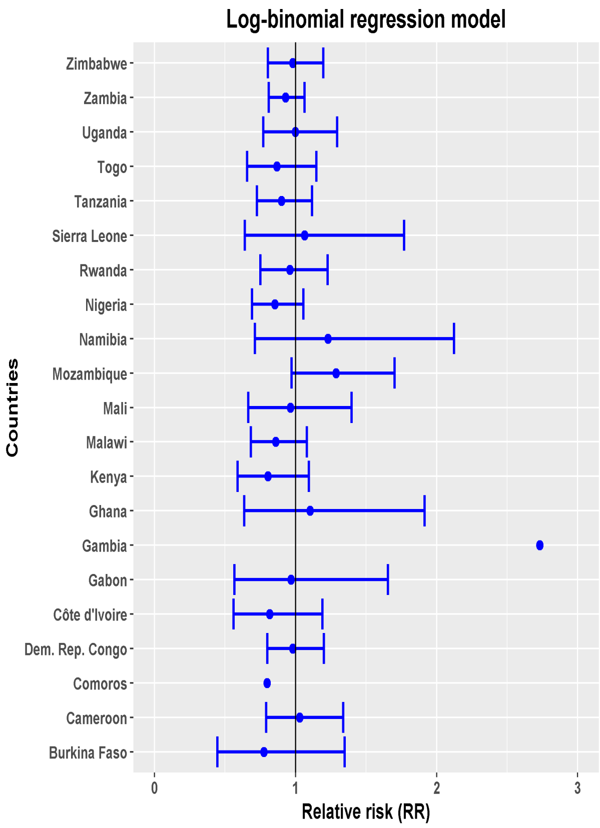
Figure 4.3: Severe IPV.



(a)



(b)



(c)

Figure 4.4: Sexual IPV.

Figures 4.1 to 4.4 show the results from the regression models. The vertical line is the reference line, at RR = 1. The dots are the relative risks (RRs). The horizontal lines through the RRs represent the confidence interval. The RR on the right of the reference line indicates that a woman in a relationship with a man more that five years older is at a higher risk of experiencing IPV. The RRs that are on the left of the reference line show that a woman is at a lower risk of experiencing IPV. In addition, if the confidence interval crosses the reference line, then there is no evidence of association between IPV and age disparity. For instance, figure 4.1 shows that women in Burkina Faso and Sierra Leone are at a lower risk of experiencing emotional IPV, while women in Kenya are at a higher risk of experiencing emotional IPV, with no evidence of association in the rest of the countries.

Table 4.4: Emotional IPV: modified Poisson regression model

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.745	0.110	0.007
2	Cameroon	1.007	0.077	0.930
3	Comoros	1.147	0.306	0.655
4	Dem. Rep. Congo	1.049	0.071	0.505
5	Côte d'Ivoire	0.909	0.099	0.335
6	Gabon	0.874	0.144	0.350
7	Gambia	1.174	0.307	0.601
8	Ghana	0.920	0.094	0.376
9	Kenya	1.304	0.084	0.002
10	Malawi	1.039	0.080	0.633
11	Mali	1.015	0.104	0.884
12	Mozambique	1.058	0.050	0.262
13	Namibia	1.062	0.153	0.692
14	Nigeria	0.970	0.054	0.568
15	Sierra Leone	0.791	0.087	0.007
16	Tanzania	0.980	0.063	0.747
17	Togo	1.063	0.066	0.353
18	Uganda	1.004	0.097	0.971
19	Zambia	0.995	0.061	0.938
20	Zimbabwe	0.938	0.062	0.303

Table 4.5: Emotional IPV: modified logistic regression model

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.744	0.121	0.008
2	Cameroon	1.008	0.126	0.924
3	Comoros	1.145	0.323	0.654
4	Dem. Rep. Congo	1.048	0.103	0.503
5	Côte d'Ivoire	0.908	0.121	0.336
6	Gabon	0.876	0.201	0.353
7	Gambia	1.170	0.342	0.603
8	Ghana	0.918	0.137	0.375
9	Kenya	1.315	0.116	0.002
10	Malawi	1.040	0.105	0.633
11	Mali	1.015	0.143	0.884
12	Mozambique	1.057	0.074	0.266
13	Namibia	1.062	0.195	0.697
14	Nigeria	0.969	0.066	0.566
15	Sierra Leone	0.785	0.116	0.008
16	Tanzania	0.979	0.094	0.753
17	Togo	1.063	0.089	0.349
18	Uganda	1.004	0.155	0.966
19	Zambia	0.995	0.076	0.939
20	Zimbabwe	0.936	0.083	0.299

Table 4.6: Emotional IPV: log-binomial regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.745	0.111	0.008
2	Cameroon	1.015	0.076	0.847
3	Comoros	1.140	0.307	0.669
4	Dem. Rep. Congo	1.044	0.070	0.543
5	Côte d'Ivoire	0.907	0.099	0.329
6	Gabon	0.882	0.140	0.372
7	Gambia	1.185	0.315	0.590
8	Ghana	0.923	0.094	0.397
9	Kenya	1.304	0.084	0.002
10	Malawi	1.035	0.081	0.668
11	Mali	1.013	0.103	0.902
12	Mozambique	1.059	0.050	0.256
13	Namibia	1.054	0.151	0.729
14	Nigeria	0.974	0.054	0.626
15	Sierra Leone	0.801	0.087	0.011
16	Tanzania	0.969	0.062	0.611
17	Togo	1.062	0.066	0.359
18	Uganda	1.013	0.097	0.897
19	Zambia	0.996	0.061	0.947
20	Zimbabwe	0.937	0.062	0.297

Table 4.7: Less severe IPV: modified Poisson regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.740	0.095	0.002
2	Cameroon	0.919	0.080	0.294
3	Comoros	0.606	0.406	0.218
4	Dem. Rep. Congo	1.049	0.070	0.495
5	Côte d'Ivoire	0.809	0.092	0.022
6	Gabon	0.637	0.111	0.000
7	Gambia	1.588	0.371	0.214
8	Ghana	0.787	0.141	0.091
9	Kenya	1.238	0.086	0.013
10	Malawi	0.834	0.128	0.156
11	Mali	0.895	0.126	0.383
12	Mozambique	1.118	0.071	0.119
13	Namibia	0.872	0.152	0.365
14	Nigeria	0.846	0.080	0.038
15	Rwanda	1.024	0.072	0.740
16	Sierra Leone	0.866	0.085	0.092
17	Tanzania	0.874	0.056	0.018
18	Togo	1.003	0.094	0.975
19	Uganda	0.973	0.131	0.835
20	Zambia	0.960	0.053	0.443
21	Zimbabwe	0.839	0.068	0.010

Table 4.8: Less severe IPV: modified logistic regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.740	0.107	0.002
2	Cameroon	0.917	0.127	0.290
3	Comoros	0.605	0.424	0.221
4	Dem. Rep. Congo	1.048	0.107	0.493
5	Côte d'Ivoire	0.809	0.123	0.024
6	Gabon	0.639	0.168	0.000
7	Gambia	1.564	0.393	0.210
8	Ghana	0.785	0.171	0.092
9	Kenya	1.246	0.125	0.013
10	Malawi	0.832	0.151	0.156
11	Mali	0.893	0.167	0.389
12	Mozambique	1.118	0.097	0.118
13	Namibia	0.861	0.194	0.353
14	Nigeria	0.844	0.092	0.039
15	Rwanda	1.024	0.097	0.741
16	Sierra Leone	0.861	0.129	0.098
17	Tanzania	0.866	0.087	0.019
18	Togo	1.003	0.107	0.976
19	Uganda	0.975	0.191	0.852
20	Zambia	0.961	0.071	0.444
21	Zimbabwe	0.831	0.091	0.011

Table 4.9: Less severe IPV: log-binomial regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.739	0.095	0.002
2	Cameroon	0.936	0.079	0.397
3	Comoros	0.602	0.404	0.210
4	Dem. Rep. Congo	1.042	0.070	0.558
5	Côte d'Ivoire	0.803	0.092	0.018
6	Gabon	0.633	0.109	0.000
7	Gambia	1.582	0.371	0.217
8	Ghana	0.792	0.141	0.099
9	Kenya	1.230	0.086	0.017
10	Malawi	0.832	0.128	0.152
11	Mali	0.903	0.125	0.418
12	Mozambique	1.117	0.071	0.122
13	Namibia	0.906	0.153	0.517
14	Nigeria	0.850	0.081	0.045
15	Rwanda	1.027	0.072	0.714
16	Sierra Leone	0.888	0.083	0.156
17	Tanzania	0.869	0.056	0.012
18	Togo	1.006	0.093	0.950
19	Uganda	0.999	0.129	0.996
20	Zambia	0.960	0.052	0.435
21	Zimbabwe	0.843	0.069	0.014

Table 4.10: Severe IPV: modified Poisson regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.723	0.245	0.185
2	Cameroon	0.877	0.179	0.463
3	Comoros	1.114	0.968	0.911
4	Dem. Rep. Congo	0.882	0.164	0.444
5	Côte d'Ivoire	0.743	0.182	0.103
6	Gabon	0.572	0.270	0.039
7	Gambia	1.952	0.394	0.091
8	Ghana	0.760	0.222	0.216
9	Kenya	1.380	0.196	0.101
10	Malawi	0.960	0.169	0.809
11	Mali	1.465	0.355	0.283
12	Mozambique	1.103	0.111	0.380
13	Namibia	0.896	0.208	0.600
14	Nigeria	0.843	0.132	0.194
15	Rwanda	1.009	0.050	0.852
16	Sierra Leone	0.693	0.125	0.004
17	Tanzania	0.830	0.118	0.115
18	Togo	0.803	0.184	0.235
19	Uganda	0.752	0.194	0.144
20	Zambia	0.957	0.103	0.669
21	Zimbabwe	0.814	0.133	0.124

Table 4.11: Severe IPV: modified logistic regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.723	0.249	0.185
2	Cameroon	0.876	0.199	0.463
3	Comoros	1.114	0.980	0.911
4	Dem. Rep. Congo	0.880	0.181	0.442
5	Côte d'Ivoire	0.741	0.194	0.104
6	Gabon	0.568	0.301	0.038
7	Gambia	1.945	0.412	0.089
8	Ghana	0.757	0.242	0.218
9	Kenya	1.393	0.226	0.100
10	Malawi	0.960	0.181	0.808
11	Mali	1.463	0.369	0.281
12	Mozambique	1.102	0.122	0.379
13	Namibia	0.889	0.241	0.589
14	Nigeria	0.841	0.140	0.195
15	Rwanda	1.009	0.096	0.857
16	Sierra Leone	0.684	0.150	0.004
17	Tanzania	0.827	0.133	0.114
18	Togo	0.802	0.192	0.235
19	Uganda	0.744	0.235	0.145
20	Zambia	0.957	0.113	0.669
21	Zimbabwe	0.812	0.144	0.124

Table 4.12: Severe IPV: log-binomial regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.722	0.245	0.184
2	Cameroon	0.877	0.179	0.466
3	Comoros	1.112	0.969	0.913
4	Dem. Rep. Congo	0.877	0.165	0.426
5	Côte d'Ivoire	0.747	0.182	0.109
6	Gabon	0.570	0.263	0.033
7	Gambia	1.952	0.395	0.092
8	Ghana	0.758	0.223	0.215
9	Kenya	1.375	0.195	0.103
10	Malawi	0.963	0.169	0.822
11	Mali	1.471	0.354	0.277
12	Mozambique	1.102	0.111	0.381
13	Namibia	0.919	0.207	0.684
14	Nigeria	0.843	0.132	0.196
15	Rwanda	1.011	0.049	0.829
16	Sierra Leone	0.699	0.125	0.004
17	Tanzania	0.830	0.118	0.114
18	Togo	0.802	0.184	0.232
19	Uganda	0.755	0.194	0.150
20	Zambia	0.956	0.103	0.661
21	Zimbabwe	0.818	0.133	0.131

Table 4.13: Sexual IPV: modified Poisson regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.776	0.282	0.367
2	Cameroon	1.030	0.134	0.826
3	Comoros	0.799	0.700	0.748
4	Dem. Rep. Congo	0.982	0.103	0.862
5	Côte d'Ivoire	0.810	0.191	0.271
6	Gabon	0.986	0.268	0.959
7	Gambia	2.738	0.759	0.186
8	Ghana	1.102	0.281	0.729
9	Kenya	0.798	0.157	0.152
10	Malawi	0.857	0.117	0.188
11	Mali	0.963	0.189	0.841
12	Mozambique	1.288	0.143	0.079
13	Namibia	1.248	0.278	0.426
14	Nigeria	0.853	0.108	0.142
15	Rwanda	0.960	0.125	0.744
16	Sierra Leone	1.062	0.258	0.814
17	Tanzania	0.905	0.111	0.368
18	Togo	0.869	0.142	0.326
19	Uganda	0.992	0.133	0.951
20	Zambia	0.927	0.070	0.277
21	Zimbabwe	0.984	0.102	0.877

Table 4.14: Sexual IPV: modified logistic regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.775	0.286	0.368
2	Cameroon	1.031	0.153	0.824
3	Comoros	0.792	0.728	0.746
4	Dem. Rep. Congo	0.982	0.129	0.863
5	Côte d'Ivoire	0.808	0.203	0.272
6	Gabon	0.989	0.316	0.968
7	Gambia	2.727	0.767	0.182
8	Ghana	1.101	0.296	0.729
9	Kenya	0.787	0.187	0.152
10	Malawi	0.853	0.138	0.189
11	Mali	0.962	0.215	0.841
12	Mozambique	1.286	0.153	0.078
13	Namibia	1.252	0.307	0.442
14	Nigeria	0.854	0.113	0.143
15	Rwanda	0.960	0.145	0.744
16	Sierra Leone	1.063	0.272	0.814
17	Tanzania	0.903	0.129	0.371
18	Togo	0.869	0.151	0.326
19	Uganda	0.992	0.176	0.954
20	Zambia	0.927	0.082	0.278
21	Zimbabwe	0.984	0.120	0.873

Table 4.15: Sexual IPV: log-binomial regression

	Country	Relative risk	Standard error	P.value
1	Burkina Faso	0.775	0.283	0.367
2	Cameroon	1.029	0.134	0.833
3	Comoros	0.798	0.707	0.749
4	Dem. Rep. Congo	0.981	0.103	0.849
5	Côte d'Ivoire	0.817	0.192	0.293
6	Gabon	0.968	0.274	0.906
7	Gambia	2.731	0.757	0.186
8	Ghana	1.103	0.281	0.726
9	Kenya	0.803	0.158	0.167
10	Malawi	0.859	0.117	0.196
11	Mali	0.963	0.190	0.843
12	Mozambique	1.286	0.143	0.079
13	Namibia	1.230	0.279	0.458
14	Nigeria	0.854	0.108	0.145
15	Rwanda	0.959	0.125	0.740
16	Sierra Leone	1.064	0.259	0.810
17	Tanzania	0.901	0.110	0.343
18	Togo	0.867	0.142	0.319
19	Uganda	0.999	0.132	0.991
20	Zambia	0.929	0.070	0.289
21	Zimbabwe	0.981	0.102	0.846

Table 4.4 through 4.15 shows the RRs, their standard error and p-values. The p-values are interpreted relative to a significance level of 0.05. Similar to figure 4.1, table 4.4 indicate that RRs are significant in Burkina Faso (p-value = 0.007), Sierra Leone (p-value = 0.007), and Kenya (p-value = 0.002), with no evidence of significance in the rest of the countries.

Chapter 5

Meta-analysis of relative risks

5.1 Introduction

Meta-analysis refers to the analysis of analyses, or simply a statistical technique for combining and summarising the findings from individual studies (Barendregt *et al.*, 2013). There are two ways to carry out a meta-analysis: firstly using aggregate data (AGD) obtained from publications or study authors, and secondly using individual participant data (IPD) (Tierney *et al.*, 2015). Specifically, AGD meta-analysis involves obtaining effect estimate such as odds ratio and relative risk from publications or authors. The IPD meta-analysis involves using data recorded for each participant in a study (Riley *et al.*, 2010). Meta-analysis of IPD was used in this study due to the fact that individual participant data from 21 countries were available.

Moreover, meta-analysis of IPD has advantages over AGD meta-analysis as given by Riley et al. (Riley *et al.*, 2010):

- Missing data can be accounted for in the meta-analysis of IPD.
- Studies with overlapping participants can be identified.
- Reduction in publication bias since unpublished data can be included in the IPD meta-analysis.
- IPD meta-analysis allows for the assessment of model assumptions in each study.
- IPD meta-analysis allows for the verification of published results.
- Statistical model/method can be standardised across studies.
- IPD meta-analysis allows the analyst to have standard covariates.

Meta-analysis of IPD can be carried out using either a one-step approach or a two-step approach (Jones *et al.*, 2009). The one-step approach involves combining the data from the different studies into one and fitting a single model. The two-step approach involves analysing each study independently by using a statistical model appropriate for the data,which produces aggregate data for each study. The aggregate data is then analysed using a suitable meta-analysis model (Jones *et al.*, 2009).

The models that form the basis of most meta-analyses are: fixed effect and random, and mixed-effects models (Viechtbauer, 2010). The meta-analysis models start with k independent effect size estimates, estimating a corresponding true effect size. It is assumed that

$$y_i = \theta_i + e_i,$$

with the observed effect, y_i, the corresponding unknown true effect, θ_i, and the sampling error, e_i with $e_i \sim N(0, v_i)$

The observed effects are assumed to be unbiased and normally distributed estimates of their corresponding true effects. The sampling variances, v_i, are assumed to be known. Each type of meta-analysis model has different assumptions about the true effect.

5.2 Fixed-effect model

In this model, it is assumed that all studies in the meta-analysis share a common true effect (Borenstein *et al.*, 2009). When using a fixed-effect model, the goal is to make conditional inference only about the k studies included in the meta-analysis (Viechtbauer, 2010). The fixed-effect model answers the question of how large is the average true effect in the set of the k studies included in the meta-analysis? The fixed-effect model does not assume that the true effects are homogeneous.

According to Borenstein et al. (Borenstein *et al.*, 2009), performing a fixed-effect analysis involves estimating the weighted average effect of the studies. The weight assigned to each study is the inverse of the variance expressed as

$$W_i = \frac{1}{V_i}, \tag{5.2.1}$$

where V_i is the within-study variance for the ith study. The weighted average is computed as

$$A = \frac{\sum_{i=1}^{k} W_i y_i}{\sum_{i=1}^{k} W_i}. \tag{5.2.2}$$

The variance of the summary effect is estimated as

$$V_A = \frac{1}{\sum_{i=1}^{k} W_i}, \tag{5.2.3}$$

which is the reciprocal of the sum of the weights from the individual studies. The standard error of the average effect is then estimated as

$$SE_A = \sqrt{V_A}$$

Moreover, the $(1 - \alpha)100\%$ confidence interval is given as

$$A \pm z_{\alpha/2} \times SE_A.$$

5.3 Random-effects model

Most studies used for meta-analysis are not identical in their methods and characteristics of the included samples. These differences may introduce variability/heterogeneity among the true effects. One way to model the variability is to treat it as purely random, which leads to the random-effects model given by

$$\theta_i = \mu + u_i,$$

where $u_i \sim N(0, \tau^2)$. Therefore, the true effect is assumed to be normally distributed with mean μ, the average true effect and τ^2, the total amount of heterogeneity among the true effects. If $\tau^2 = 0$, then this implies homogeneity among the true effects, so that $\mu = 0$ then denotes the true effect (Viechtbauer, 2010).

The random-effects model then addresses the question: how large is the average true effect in this larger population of studies? (Viechtbauer, 2010).

As the fixed-effect, the aim of the random-effects model is to estimate, from the collection of observed effects y_i, the weighted average effect. Each study is also weighted by the inverse of the variance. The study variance under the random-effects model includes both the within-study variance and between-study variance. The between-study variance is computed as

$$V_{bs} = \frac{Q - df}{C}, \tag{5.3.1}$$

where

$$Q = \sum_{i=1}^{k} W_i y_i^2 = \frac{\left(\sum_{i=1}^{k} W_i y_i\right)}{\sum_{i=1}^{k}},$$

$$df = k - 1,$$

and

$$C = \sum_{i=1}^{k} W_i - \frac{\sum_{i=1}^{k} W_i^2}{\sum_{i=1}^{k} W_i}.$$

The weight assigned to each study under the random-effects model is given by

$$W_i^r = \frac{1}{V_i^r}, \tag{5.3.2}$$

where r denotes random-effect version and the V_i^r is the sum of within-study and between-study variances

$$V_i^r = V_i + V_{bs}.$$

The weighted average effect under the random-effect model is obtained as

$$A^r = \frac{\sum_{i=1}^{k} W_i^r y_i}{\sum_{i=1}^{k} W_i^r}'$$

where the variance of the weighted average effect is given by

$$V_{A^r} = \frac{1}{\sum_{i=1}^{k} W_i^r},$$

while the standard error is computed as the square root of the variance

$$SE_{A^r} = \sqrt{V_{A^r}}.$$

Finally the $(1 - \alpha)100\%$ confidence interval is obtained as

$$A^r \pm z_{\alpha/2} \times SE_{A^r}$$

5.4 Mixed-effect model

Including one or more moderators in the model that may account for at least part of the heterogeneity in the true effects leads to the mixed-effect model given by

$$\theta_i = \mu + \beta_0 + \beta_1 x_{i1} + \cdots + \beta_{p'} x_{ip} + u_i,$$

with $\mu_i \sim N(0, \tau^2)$, where x_{ij} is the value of the j-th moderator variable for the i-th study, τ^2 is the amount of residual heterogeneity among true effects that is not accounted for by the moderators included in the model. it is also assume that $u_i \sim N(0, \tau^2)$.

The aim of the mixed-effect model is to examine to what extent the moderators included in the model influence the size of the average true effect.

The random/mixed-effects model provides unconditional inference about a larger set of studies from which the k studies included in the meta-analysis are assumed to be a random sample (Hedges & Vevea, 1998). A hypothetical population of studies is envisioned to consist of studies that have been conducted, or that may be conducted in the future or that could have been conducted in the past.

5.5 Relative risks meta-analysis

The random-effects model was used to carry out relative risks(RR) meta-analysis. The effect of interest was the average relative risk(ARR). The model is therefore given as

$$RR_i = ARR + u_i,$$

where $u_i \sim N(0, \tau^2)$. Therefore, the true effect is assumed to be normally distributed with ARR as the average true effects and τ^2, the total amount of heterogeneity among the true effect.

The *metafor* package in R was used to carry out the meta-analysis (Viechtbauer, 2010). Specifically the *rma* function by setting the *method* argument to restricted maximum-likelihood estimator (REML), (one of the heterogeneity estimators), which is a way of specifying random effect models. The REML estimator was chosen because it is unbiased and efficient (Viechtbauer, 2010).

The inverse-variance weights, which is the default in the *rma* function were used. The inverse-variance weights are often compared to the sample weights when choosing weights to use in a meta-analysis (Marín-Martínez & Sánchez-Meca, 2010). The optimal weight for averaging a set of k independent effect sizes is the inverse variance of each effect size (Hedges & Vevea, 1998).

Chapter 6

Discussion of results

The results of the data analysis are presented in this chapter. Two fundamental goals drove the analysis. These goals were to establish the prevalence of intimate partner violence in sub-Saharan Africa and to describe the association between IPV and age disparity in sub-Saharan Africa. The findings presented in this chapter demonstrate the prevalence of the types of IPV and their specific measures illustrated in prevalence maps. This is followed by meta-analysis of results on the association between types of IPV (as well as the specific measures of types of IPV) and age disparity reported in forest plots.

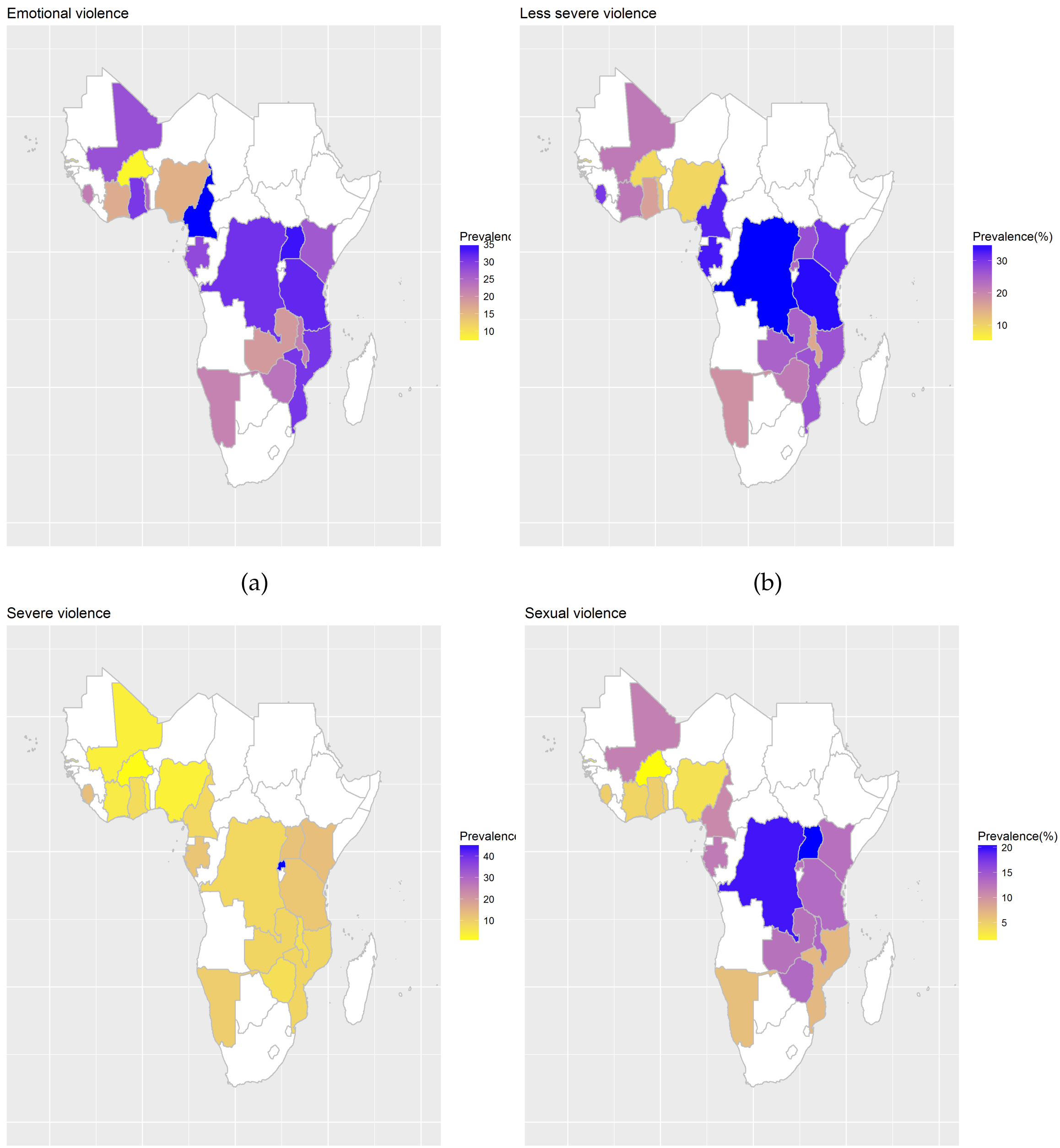
6.1 Prevalence of Intimate Partner Violence in sub-Saharan Africa

This study considered the prevalence of intimate partner violence within twelve months prior to the survey (past year or last year), commonly known as recent violence in the study of IPV. The prevalence presented in this section were calculated as indicated in chapter 3 section 3.2.

6.1.1 Prevalence of types of IPV

Considering the the types of IPV, the results indicate the highest prevalence of emotional violence in Cameroon at 35.0% percent followed by Uganda at 34.0% (figure 6.1a). Other countries that reported relatively high prevalence are Tanzania (32.0%), DRC (31.0%), Mozambique (30.8), and Ghana at 30.7%. The lowest prevalence was reported in Comoros (6.3%). Democratic Republic of Congo (DRC) reported the highest prevalence of less severe violence at 34.8% followed by Tanzania at 34.3% and then Gabon at 33.3%

(figure 6.1b). Cameroon and Kenya follows at 32.6% and 31.0% respectively. The lowest prevalence (4.1%) was reported in Comoros. Most countries reported prevalence of severe violence between 1.0% (Comoros) and 13.3% (Kenya) except Rwanda which reported extreme prevalence at 45.5% (figure 6.1c). Uganda and DRC reported the highest prevalence of sexual violence at 20.5% and 19.7% respectively. Zimbabwe, Zambia, Malawi, Tanzania, Rwanda, Kenya, and Mali reported relatively similar prevalence of sexual violence as shown in figure 6.1d.



(a) (b) (c) (d)

Figure 6.1: Prevalence of types of intimate partner violence.

6.1.2 Prevalence of specific measures of types of IPV

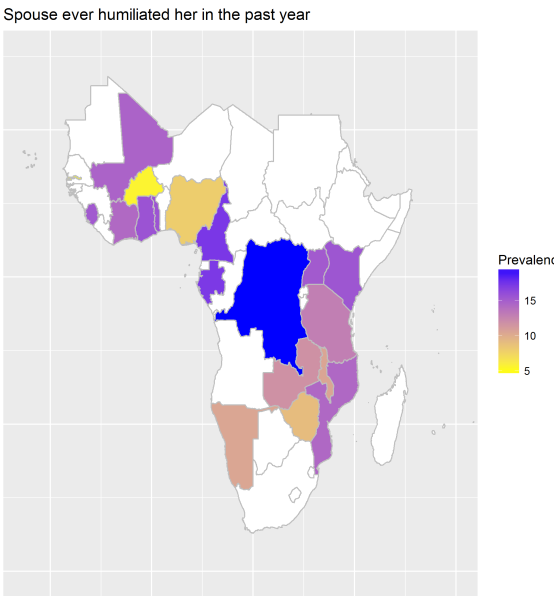
A woman being humiliated by her male partner was most common in Democratic Republic of Congo (DRC) (19.6%) and least common in Comoros (4.8%) (figure 6.2a). A woman having been threatened with harm in the last year was most common in Uganda (15.1%) and least common in Gambia with 2.0% of women being threatened with harm (figure 6.2b). The highest prevalence among the acts of emotional violence was observed in Tanzania where 28.0% of women were insulted in the past year (figure 6.2c).

The highest prevalence of having been pushed, shaken or having something thrown at her by the spouse in the last year was reported in DRC (16.4%) followed by Gabon and Kenya, and the lowest prevalence was reported in Gambia (1.6%) (figure 6.3a). The prevalence of being slapped during the 12 months before the survey was highest in Tanzania (30.9%) and lowest in Comoros (2.8%) (figure 6.3b). Having been punched with fist was highest in Tanzania (14.8%) and lowest in Comoros (0.8%) (figure 6.3c). The highest prevalence of arms having been twisted or hair pulled was reported in Gabon (13.5%) followed by Cameroon at 10% and the lowest prevalence was reported in Comoros (0.8%) (figure 6.3d).

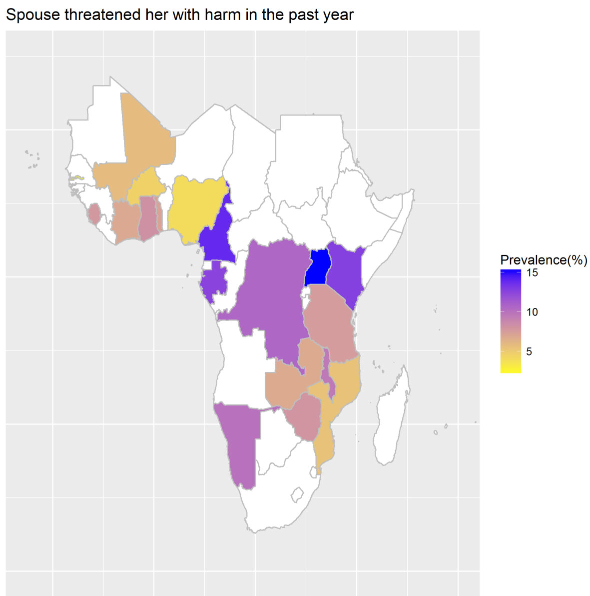
Prevalence of having been kicked or dragged in the past year was highest in Rwanda at 38.9% followed by Kenya at 12.0% (figure 6.4a). Rwanda also reported the highest prevalence (24.7%) for women who were strangled or burnt in the last year (figure 6.4b). Rwanda also reported the highest prevalence (5.0%) for women who were threatened with knife/gun or other weapon (figure 6.4c).

Uganda reported the highest prevalence at 18.9% for women who were forced to have sex by their male intimate partner against their will in the last year followed closely by DRC at 17.9% (figure 6.5a). Countries such as Kenya, Malawi, Rwanda, Zambia and Zimbabwe indicated relatively similar prevalence for women who had sex forced on them by their partners.

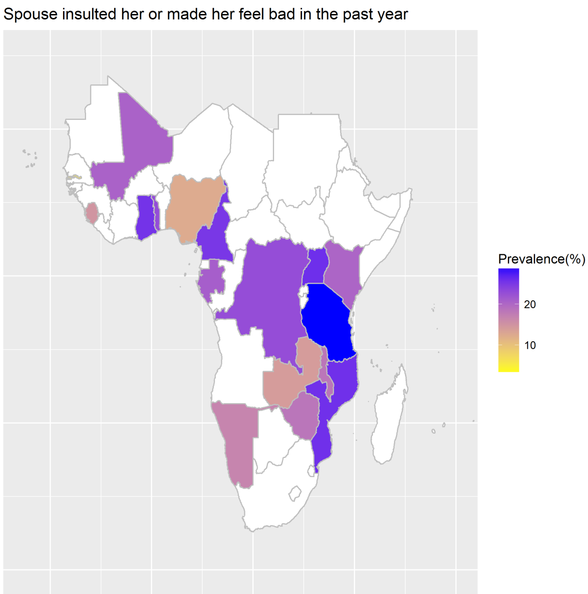
DRC reported the highest prevalence (7.7%) for women who had other sexual acts forced on them followed closely by Zimbabwe at 7.2% as shown in figure 6.5b.



(a)



(b)



(c)

Figure 6.2: Prevalence of specific acts of emotional IPV.

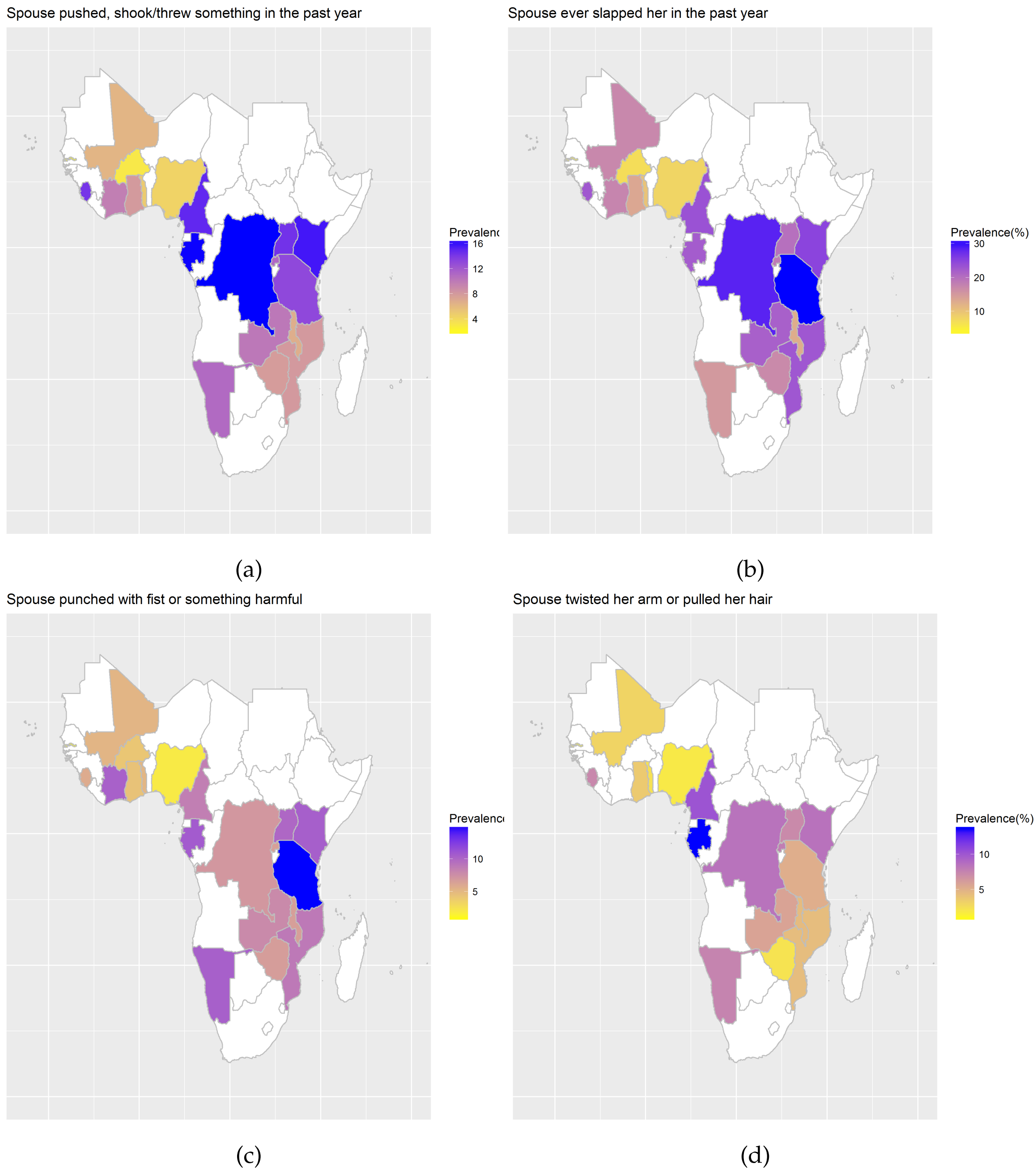
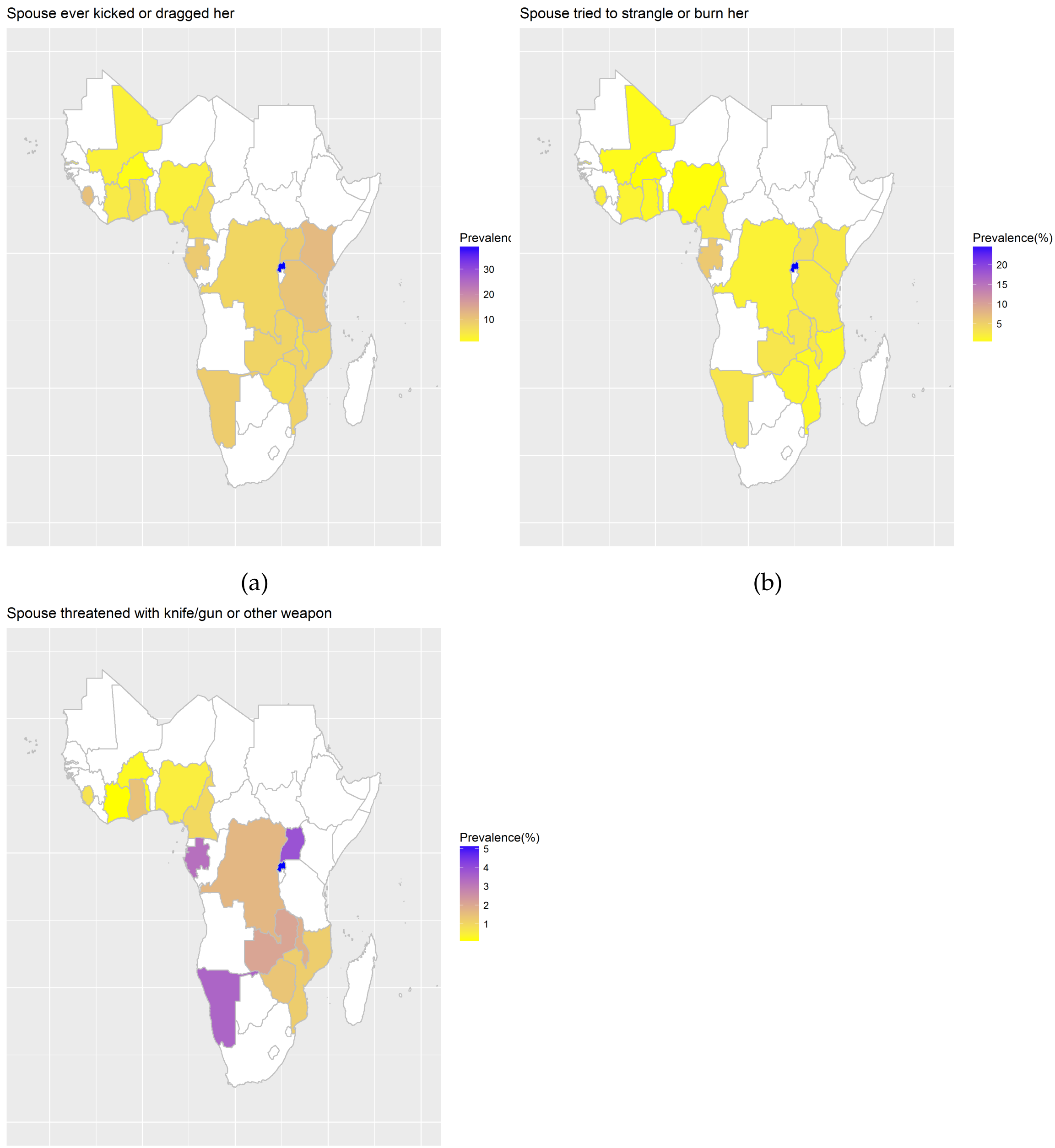
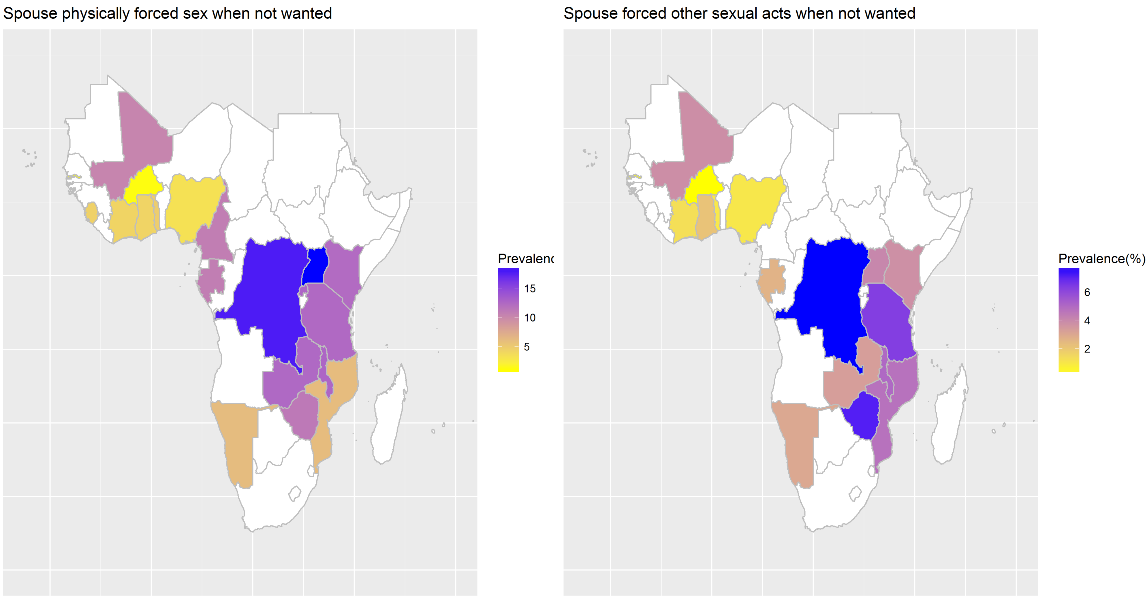


Figure 6.3: Prevalence of specific acts of less severe IPV.



(a) (b) (c)

Figure 6.4: Prevalence of specific acts of severe IPV.



(a) (b)

Figure 6.5: Prevalence of specific acts of sexual IPV.

6.2 Results of the association between IPV and age disparity

Four types of IPV (emotional violence, less severe violence, severe violence and sexual violence) and their specific acts of violence were used as outcome variables in models, with age differences as the independent variable. Specifically, a modified Poisson regression model (4.3.49) was fitted to estimate the relative risk (RR) of a woman experiencing IPV, within 12 months before the survey, if she was at least five years younger than her partner, compared to the reference group in which the age difference was at most four years. This was followed by a meta-analysis across all countries, weighted by inverse variance (5.3.2), to establish the average RR of a woman experiencing each type of IPV. The results of the analyses are as shown in the forest plots whereby the squares show the relative risks from the single studies, wherein the diamond shows the pooled result. The size of the diamond is affected by the width of the confidence interval, the wider the interval the bigger the diamond. The horizontal lines through the squares illustrate the length of the given confidence interval. Having an older partner shows a protective nature when RR falls on the left of the vertical line (RR = 1, the reference line or line of no effect) and shows otherwise when it falls on the right.

6.2.1 Unstratified analysis

The age groups of women, education level of women, education level of the men and employment status of the women were used as covariates in this analysis. The results of the unstratified analysis are shown in figures 6.6 to 6.10.

The association between age disparity and specific acts of emotional violence yielded weighted relative risk averages (WRRAs) that range from 0.93 (95% CI: 0.0.846-1.021) for a woman who was threatened with harm by her intimate partner to 1.012 (95% CI: 0.968-1.058) for a woman who was insulted or made to feel bad, which indicates no evidence of risk. The figures 6.6a, 6.6b and 6.6c illustrate high country variation with most countries showing no evidence of risk of experiencing any act of emotional violence for women in disparate relationships except for Kenya in figures 6.6a, 6.6b and 6.6c. The overall risk of experiencing emotional violence was 0.99 (95% CI:0.942-1.039).

Figure 6.7 indicates that three of the specific acts of less severe violence yielded WRRAs significantly less than 1 (0.845(95% CI: 0.766-0.932) for having been pushed, 0.899(95% CI: 0.836-0.968 for having been slapped, and 0.866(95% CI: 0.785-0.955) for having been punched by spouse), showing a protective nature when a woman is in an age disparate (AD) relationship. However, some countries (Gabon, for instance) showed a mixed picture across all the acts of less severe violence (see figure 6.7). Figure 6.10b illustrates that having an older partner is protective against less severe violence with WRRA of 0.911 (95% CI: 0.851-0.975). The figure 6.10b shows that having an older partner is significantly protective against less severe violence in Burkina Faso (RR: 0.740; 95% CI: 0.614-0.892), Nigeria(RR: 0.846; 95% CI: 0.723-0.990) and Zimbabwe (RR: 0.838; 95% CI: 0.733-0.959).

All the countries considered indicate mixed results for all the specific acts of severe violence as shown in figures 6.8a to 6.8c. The overall risk of experiencing severe violence (figure 6.10c) show that having an older partner is significantly protective with WRRA of 0.896 (95% CI: 0.826-0.972). Finally, figure 6.10d shows the risk of experiencing sexual violence with WRRA of 0.945 (95% CI: 0.890-1.003), with all countries showing varying results.

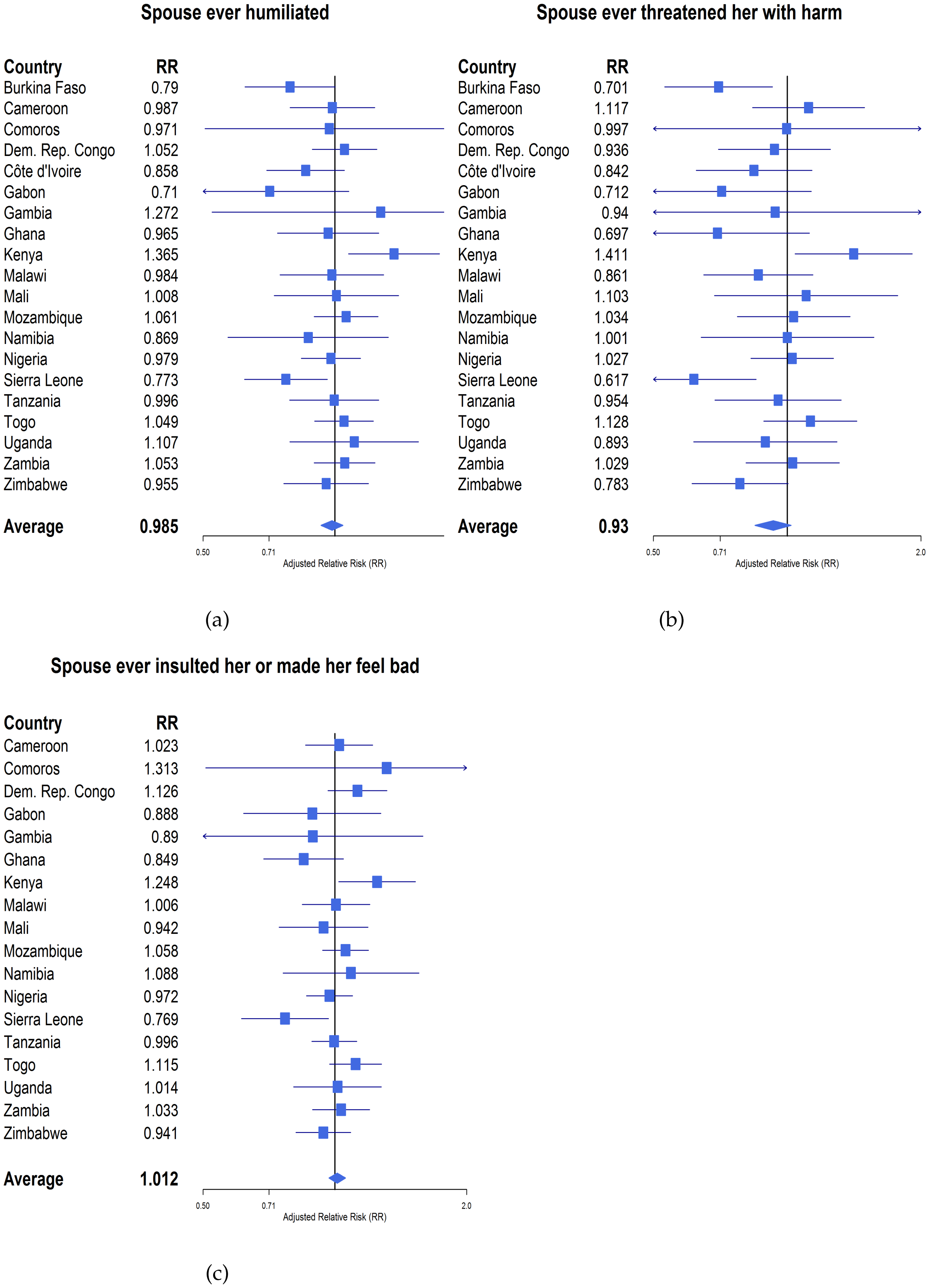


Figure 6.6: Specific acts of emotional violence with adjusted RR.

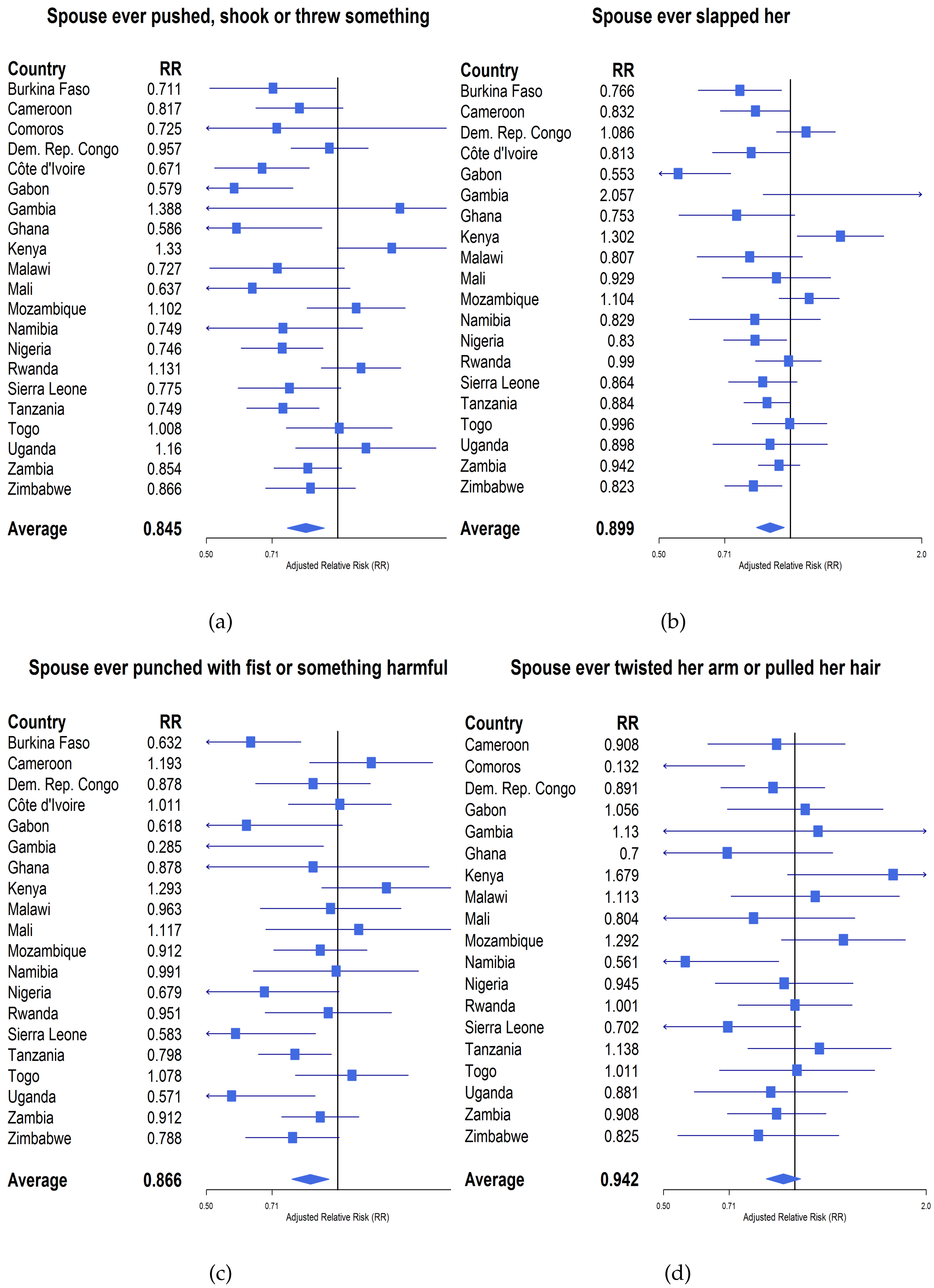
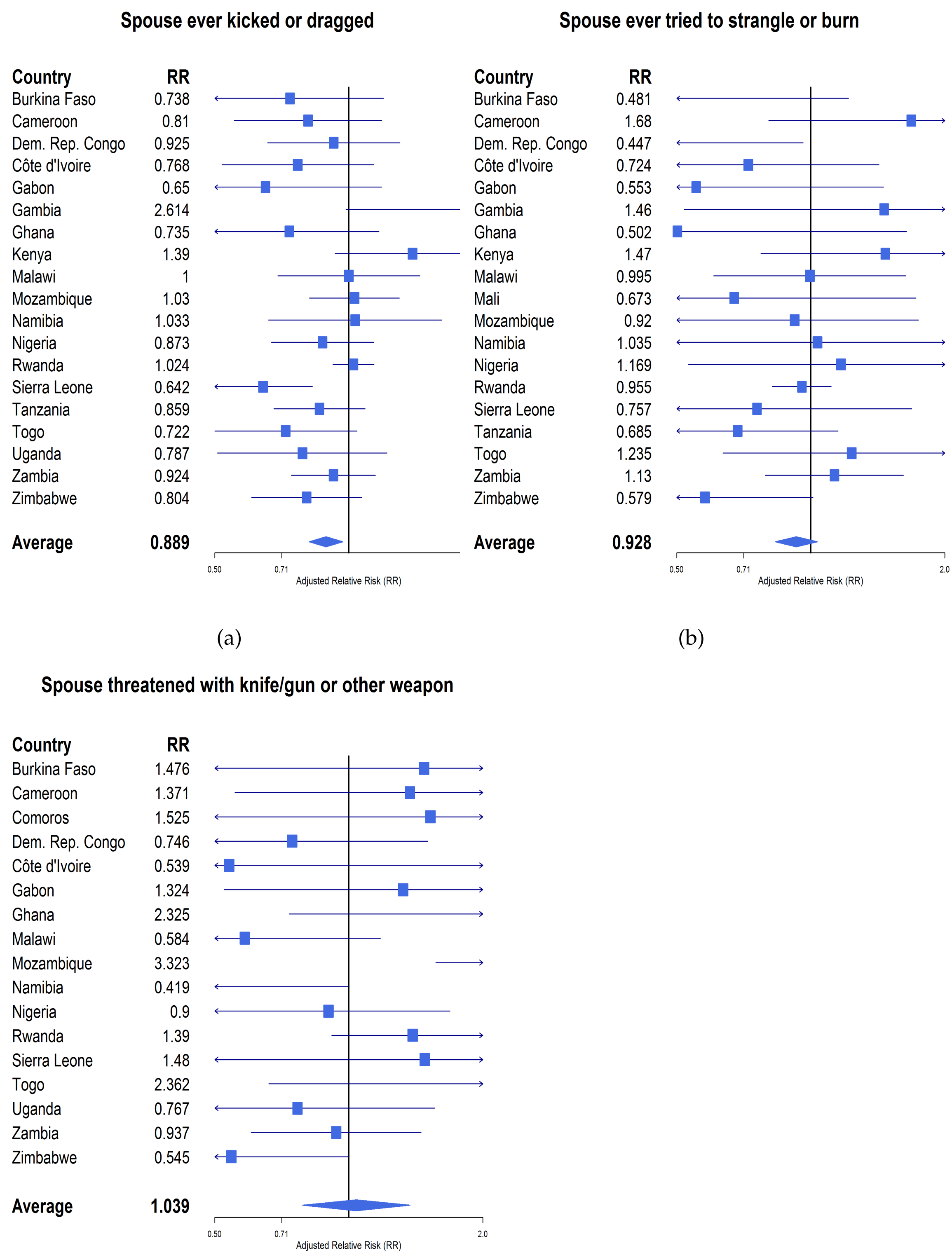
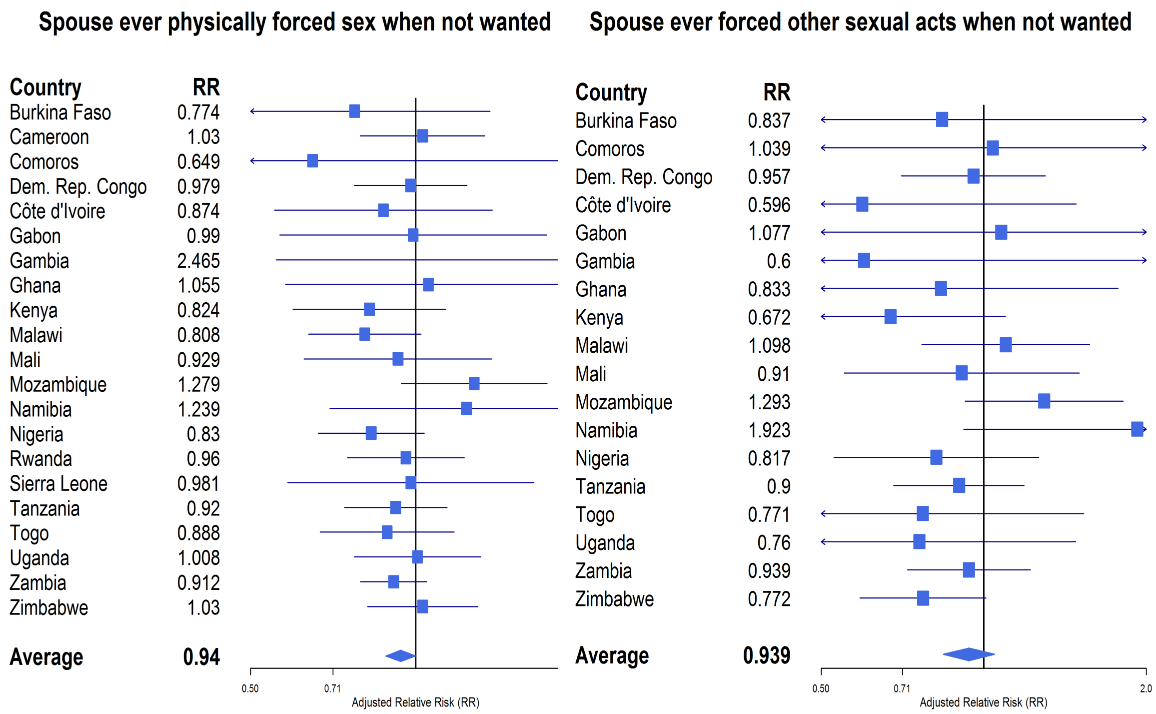


Figure 6.7: Specific acts of less severe violence with adjusted RR.



(a) (b) (c)

Figure 6.8: Specific acts of severe violence with adjusted RR.



(a) (b)

Figure 6.9: Specific acts of sexual violence with adjusted RR.

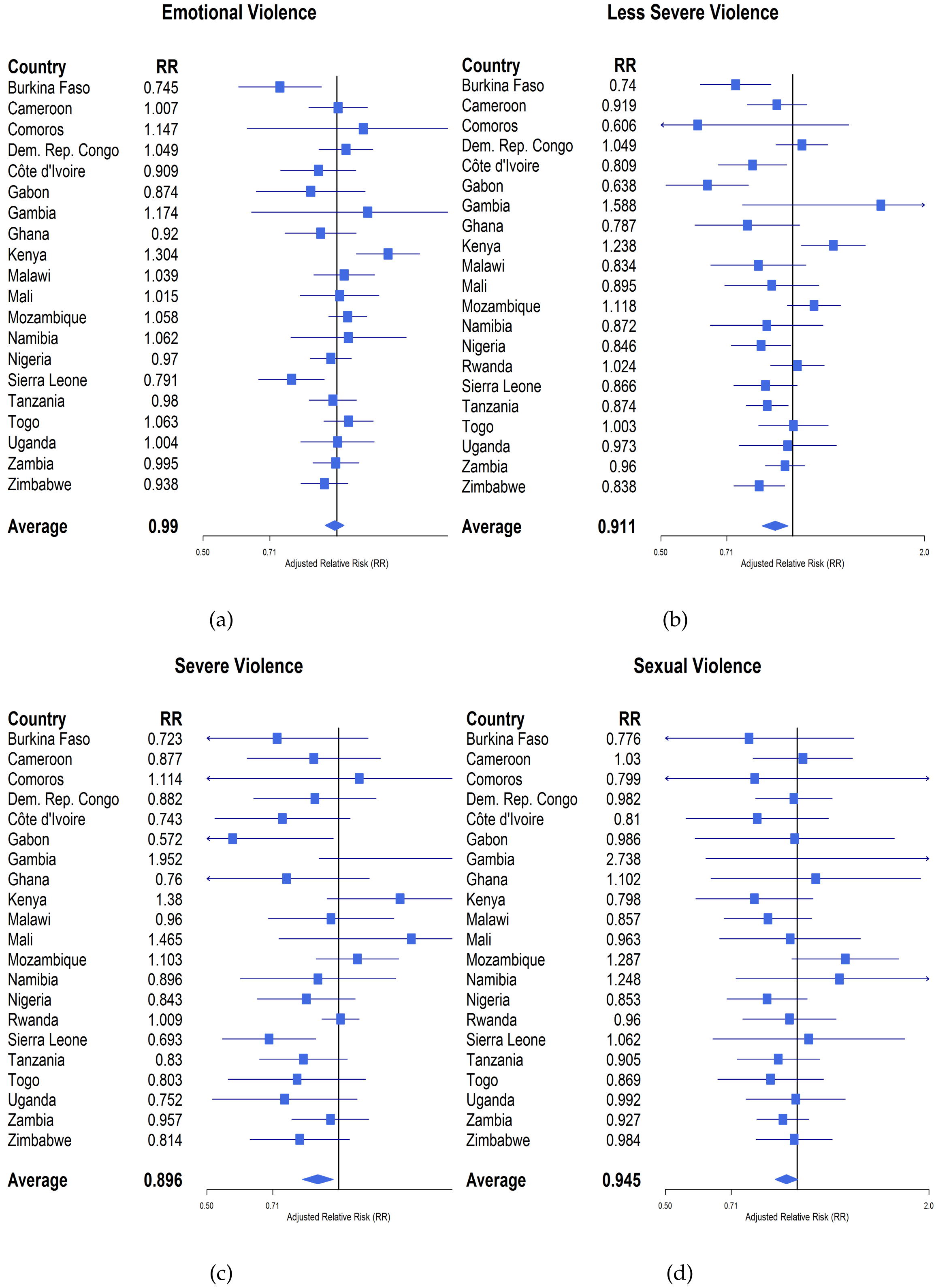


Figure 6.10: IPV types with adjusted RR.

6.2.2 Stratified analysis

This section contains the results of the association between IPV and age disparity stratified by the age of the woman. The education levels of the woman, education level of the man, and employment status of the woman were used as covariates in the stratified analysis.

Figures 6.11 to 6.14 demonstrate the relationship between IPV types and age disparity stratified by the age of the woman. The women were placed in two groups by age. The first group consisted of women at most 25 years of age, referred to as younger women group. The last group consisted of women more than 25 years old, defined as older women group. The results on types of IPV are presented first followed by the specific measures of types of IPV.

6.2.2.1 Types of IPV

Figures 6.11a and 6.11b show WRRAs for the younger women in AD relationship is 0.983 (95% CI: 0.924-1.045) and that for the older women is 0.975 (95% CI: 0.914-1.04) respectively, indicating no evidence of risk. Country variation is evident. For instance, the results indicated a higher RR, (RR: 0.986; 95% CI:0.688-1.441), for the younger women compared to the older women, (RR:0.706; 95% CI : 0.560-0.890) in Burkina Faso. The results from Nigeria revealed a lower RR, (RR: 0.862; 95% CI : 0.726-1.025), for the younger women compared to the older women (RR: 1.024; 95% CI: 0.914-1.147).

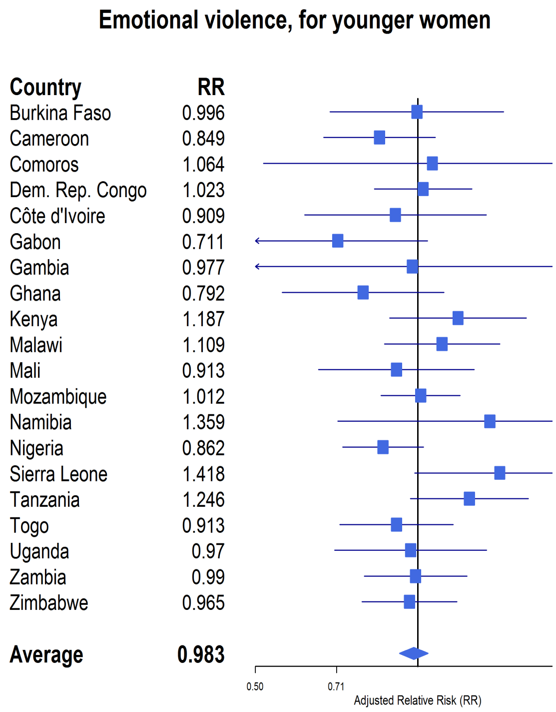
The WRRAs for both younger and older women suggest a significant protection against less severe violence if the women are in AD relationships. The WRRAs are 0.901 (95% CI:0.826-0.984) for younger women and 0.913 (95% CI:0.845-0.983) for older women. Country variation is also notable between younger and older women (figures 6.12a and 6.12b). For instance, the results ahow that in Cameroon and Uganda, being among the younger women and in AD relationship may be protective against less severe violence, (RR:0.0.680; 95% CI:0.560-0.824) and (RR: 0.678;95% CI: 0.460-0.998) respectively.

Considering figure 6.13, the WRRAs for younger and older women are 0.846(95% CI: 0.754-0.950) and 0.920(95% CI:0.842-1.004), respectively, suggesting that younger women may be at a lower risk of experiencing severe physical violence when in AD relationships. There is a high country variation for younger and older women. Younger women in AD relationships may be less likely to experience severe violence in Nigeria with RR of 0.535 (95% CI: 0.327-0.0.877) compared to that of older women (RR: 0.953;95% CI: 0.735-1.237).

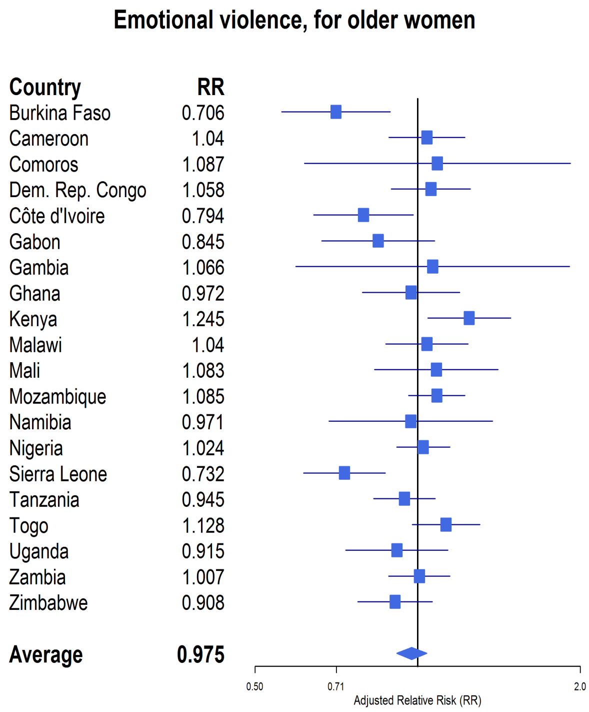
Finally, results of sexual violence yielded WRRA of 0.999(95% CI:0.906-1.101) for younger women and 0.941(95% CI:0.880-1.007) for older women, suggesting no evidence of risk. There is a high variation in country specific RR for sexual violence (figures 6.14a & 6.14b). The results suggest that in Cameroon there is no evidence of risk (RR:0.861; 95% CI: 0.574-1.291) for younger women in AD relationships as well as for older women.

In addition, figures 6.11c, 6.12c, 6.13c and 6.14c show the difference between younger and older women with respect to the effect of age disparity on IPV, or simply the ratio of RR (RRR). The RRRs indicate no significant difference in the effect of age disparity on IPV relative to the age of the woman.

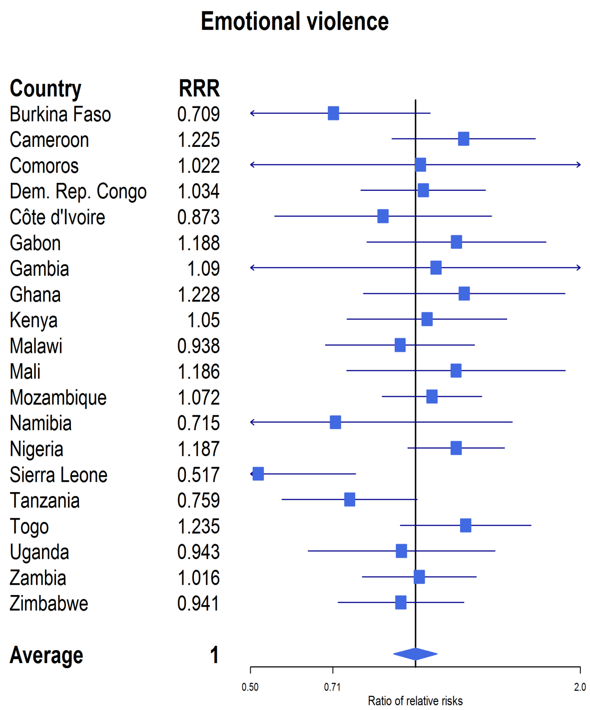
Considering country variability, the results indicate that in Sierra Leone (RRR:0.517; 95%:0.343-0.778) the effect of age disparity on emotional IPV is significantly smaller among the older women compared to the younger women. Moreover, the results suggest that in Burkina Faso (RRR:0.671; 95%: 0.469 - 0.961) and Sierra Leone (RRR: 0.642; 95%: 0.466 -0.885) the effect of age disparity on less severe IPV reduces significantly for older women, while the effect increases in Cameroon (RRR: 1.554; 95%: 1.176-2.053) for older women. The results hint that in Cameroon (RRR:1.966; 95%:1.062-3.640) and Nigeria (RRR: 1.781; 95%: 1.110-2.855) the effect of age disparity on severe IPV increases significantly for the older women compared to the younger women (figure 6.13c). Figure 6.14c shows that the effect of age disparity on IPV does not differ between the younger and older women.



(a)



(b)



(c)

Figure 6.11: Emotional IPV, including relative age.

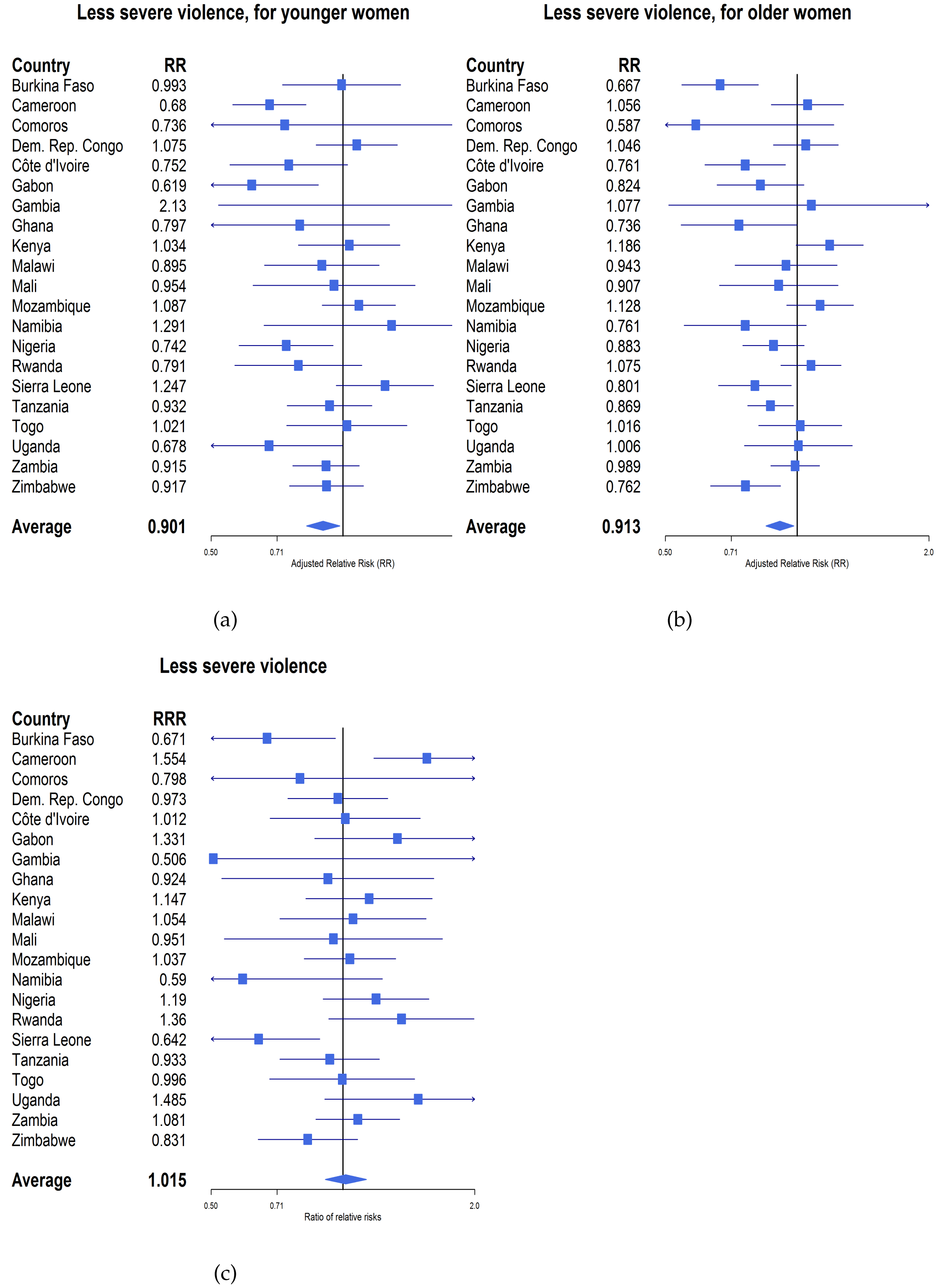
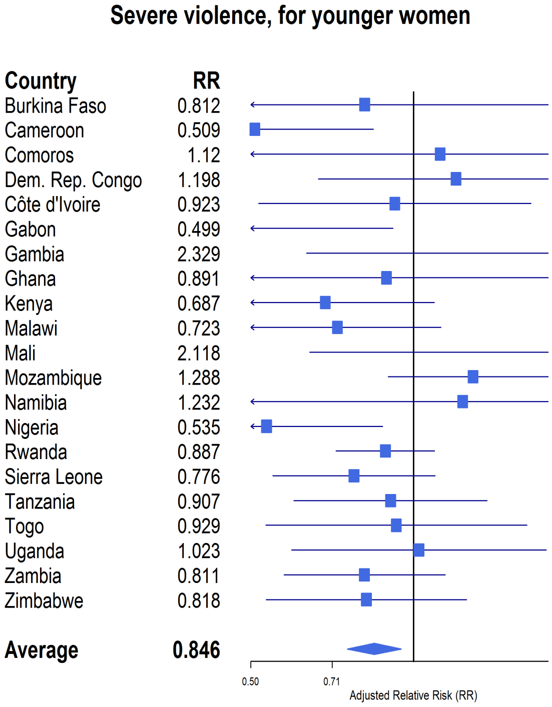
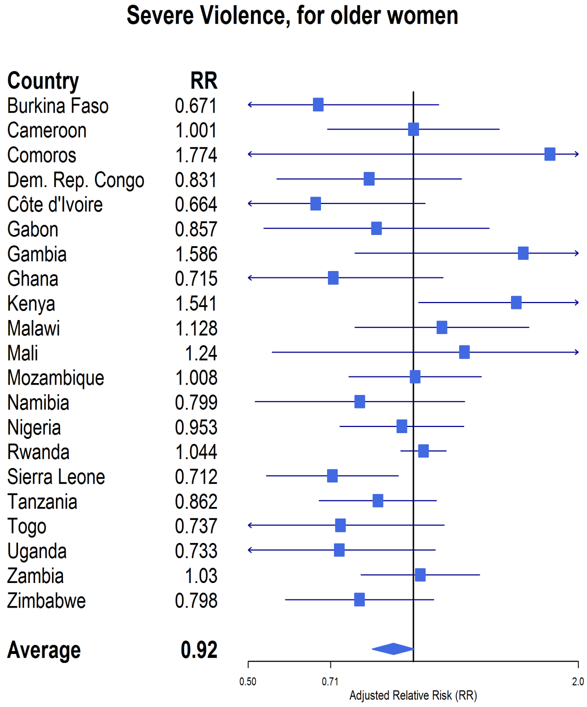


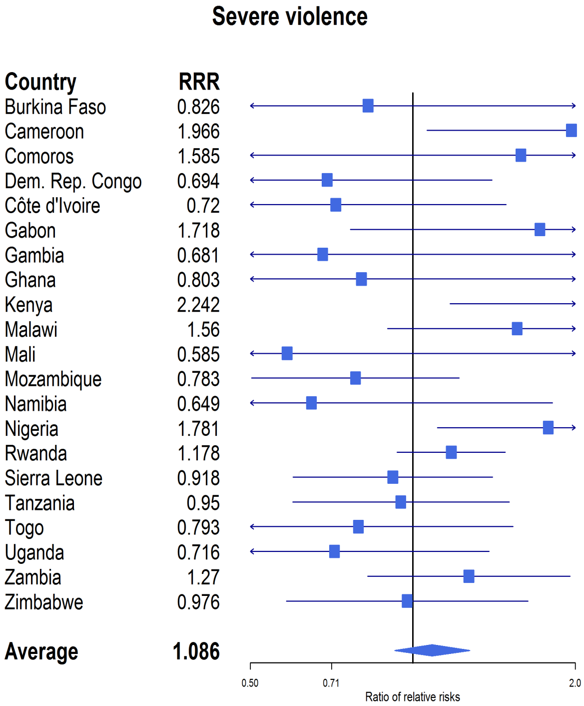
Figure 6.12: Less severe IPV, including relative age.



(a)

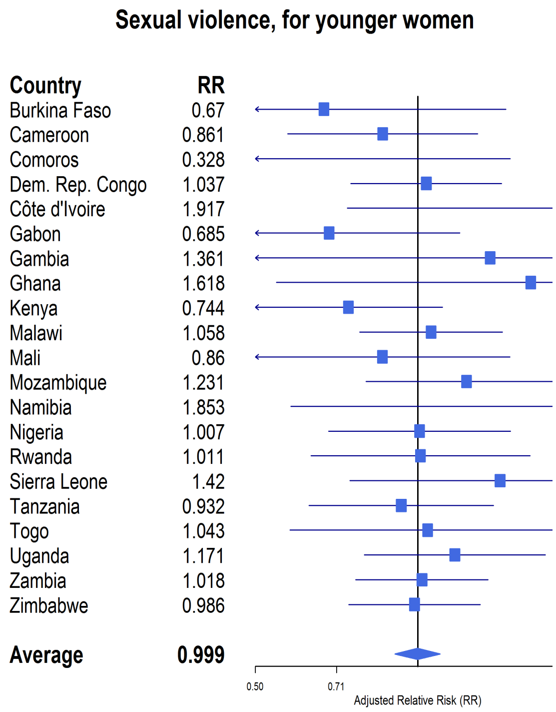


(b)

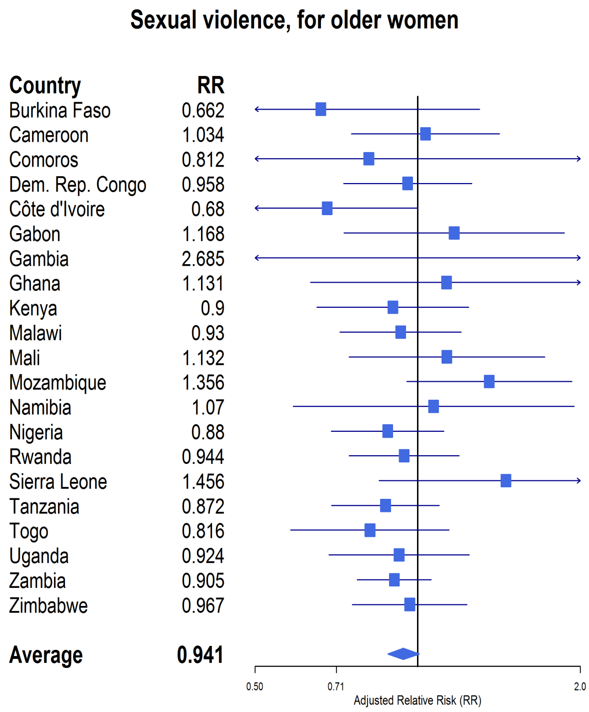


(c)

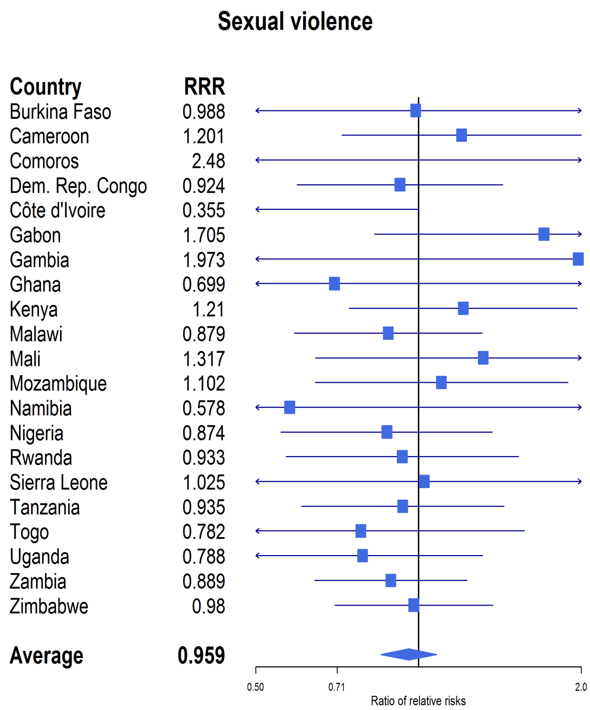
Figure 6.13: Severe IPV, including relative age.



(a)



(b)



(c)

Figure 6.14: Sexual IPV, including relative age.

6.2.2.2 Specific measures of types of IPV

Figure 6.15 shows that the WRRA of younger women having been humiliated by their intimate partners and in an AD relationship is 0.98 (95% CI: 0.894-1.073), while that of older women is 0.967 (95% CI:0.892-1.049). The WRRA for having been threatened with harm in the last year was 0.920 (95% CI: 0.797-1.062) for younger women and 0.925 (95% CI: 0.836-1.023) for older women (figure 6.16). Also, the WRRA for younger women who were insulted or made to feel bad is 0.978 (95% CI: 0.905-1.058) and 1.011 (95% CI: 0.955-1.071) for older women. The country outcome between the younger and older women showed high variability. For instance, the results showed that that there is no evidence of risk of humiliation in Burkina Faso for younger women who are in AD relationships (RR: 1.131; 95% CI: 0.753-1.698). The older women in AD relationships showed protective effect against humiliation in Burkina Faso with RR of 0.737 (95% CI: 0.568-0.956). A similar result was observed in Sierra Leone with RR of 1.33 (95% CI: 0.850-2.081) for the younger women and RR of 0.717 (95% CI: 0.574-0.896) for the older women. Moreover, the results showed a protective effect against humiliation for the Nigerian younger women (RR: 0.76; 95% CI: 0.581-0.994), but no evidence of risk for the older women (RR: 1.051; 95% CI: 0.884-1.250).

Figure 6.18 indicates that being in AD relationship is significantly protective against being pushed, shaken or something thrown at a woman for both younger women (WRRA: 0.809; 95% CI: 0.786-0.944) and older women (WRRA: 0.861; 95% CI: 0.714-0.917), with a ratio of RR (RRR) of 1.063 (95% CI: 0.930-1.216). Furthermore, figure 6.19 illustrates that older women in AD relationship are less likely to be slapped by their spouses with WRRA of 0.899 (95%: 0.829-0.975) compared to the younger women. However, the difference in effect of age disparity on being slapped by the spouse between the older and younger women is not significant as shown by the ratio of RR (RRR: 0.991: 95% CI: 0.858-1.146) (see figure 6.19c). Scenarios with similar explanations are observed in figures 6.20 to 6.26.

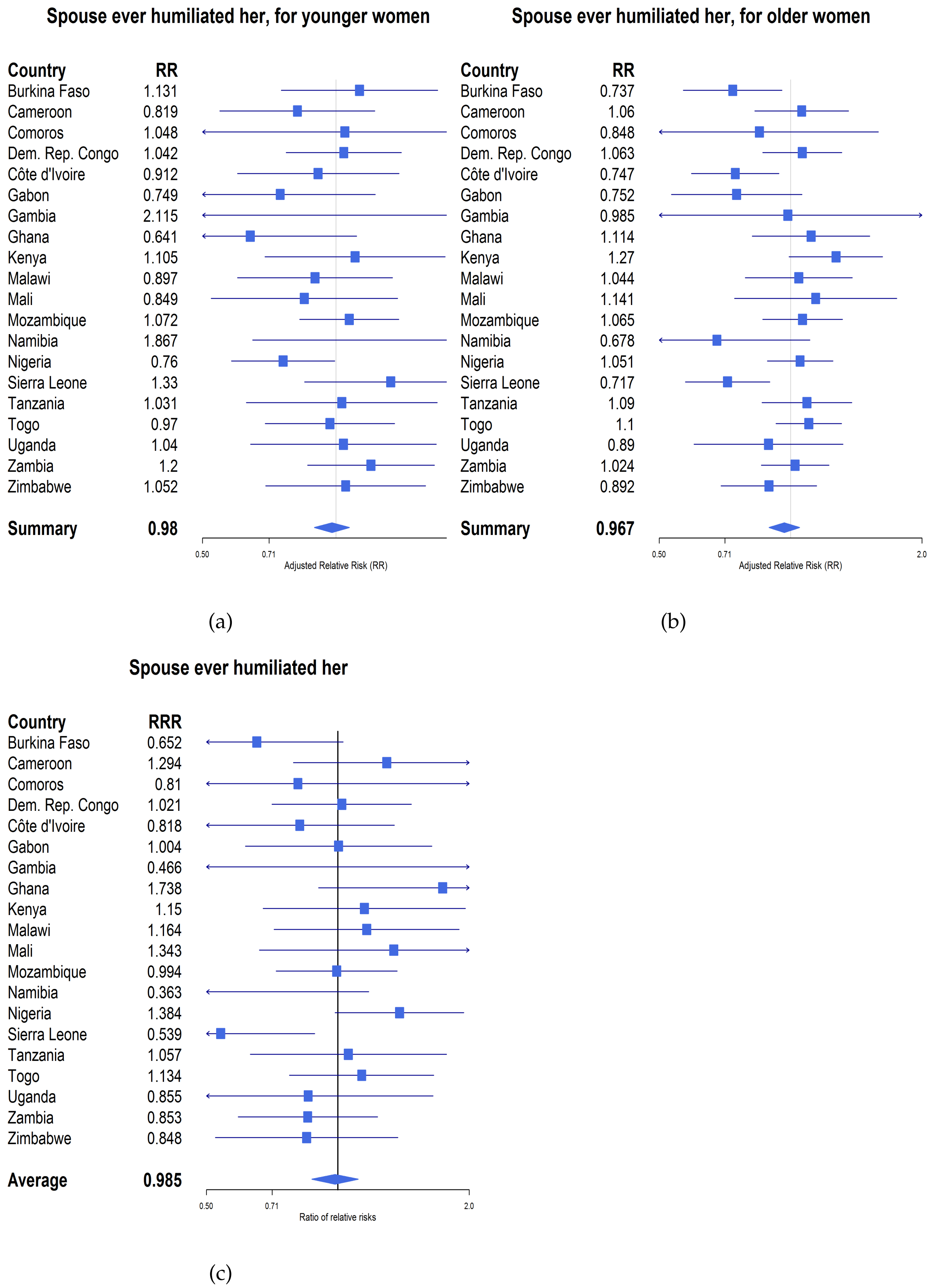
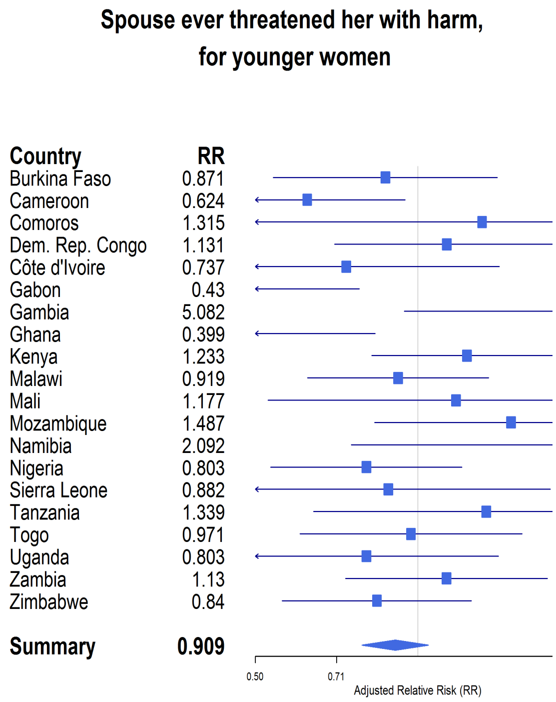
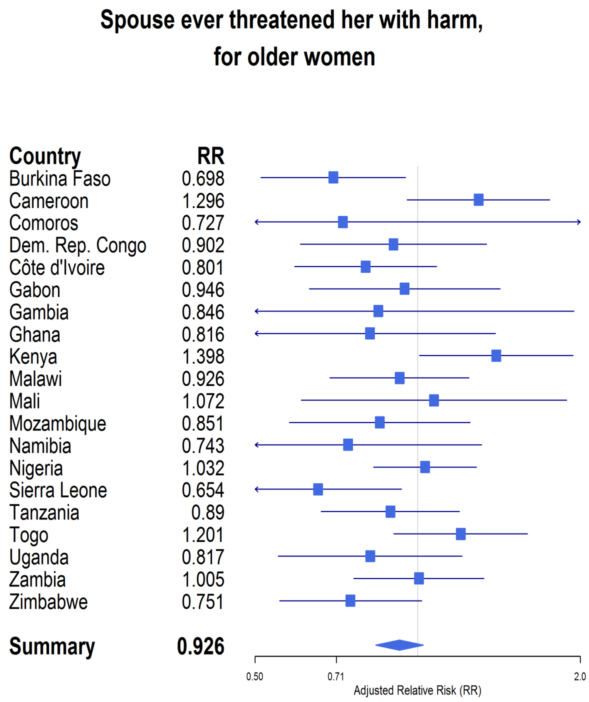


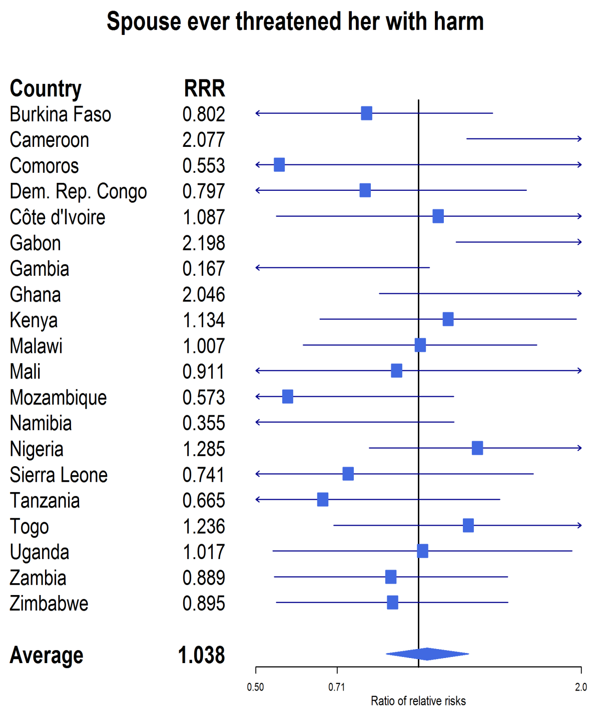
Figure 6.15: Spouse ever humiliated the woman, including relative age.



(a)



(b)



(c)

Figure 6.16: Spouse ever threatened the woman with harm, including relative age.

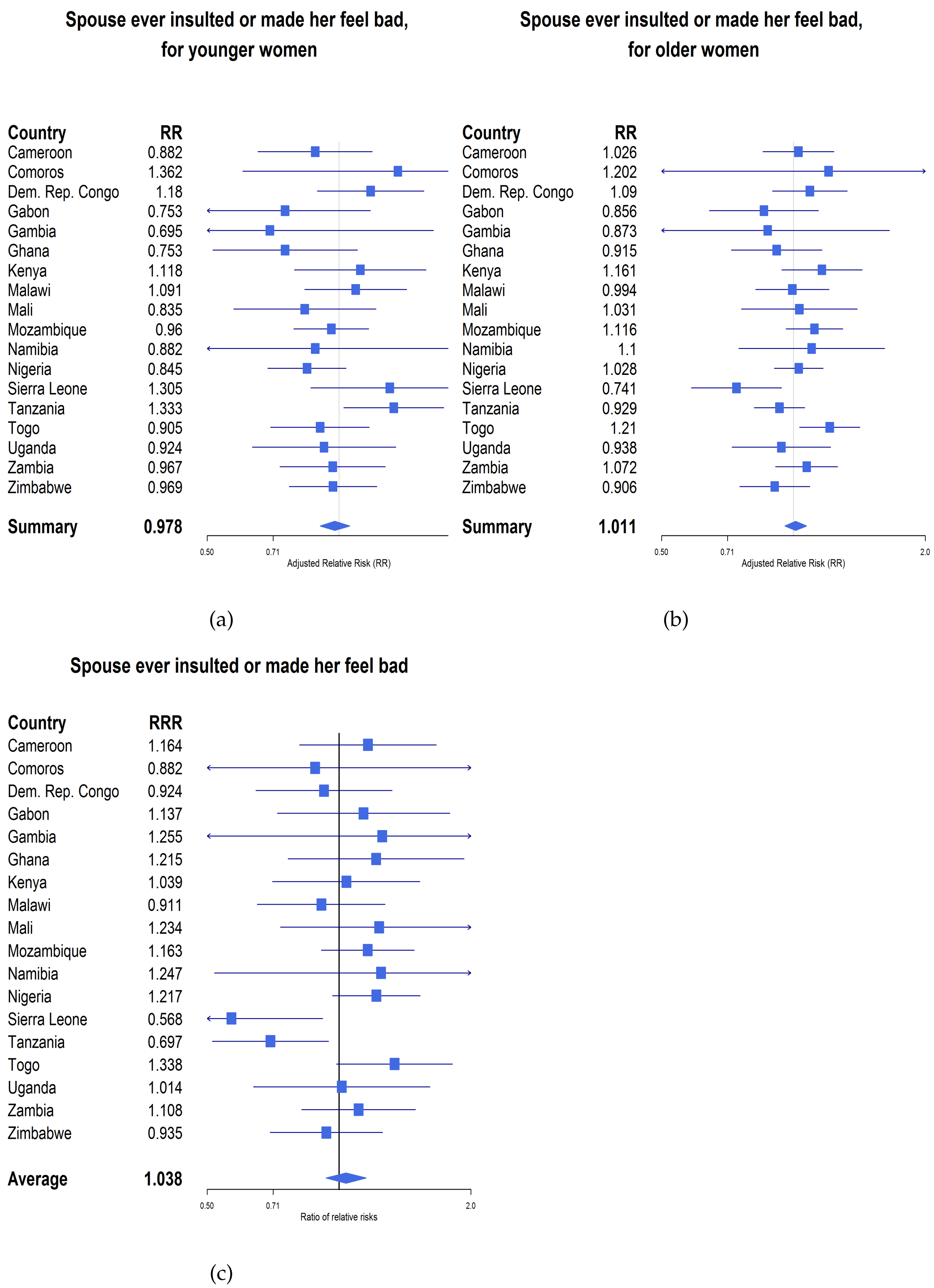
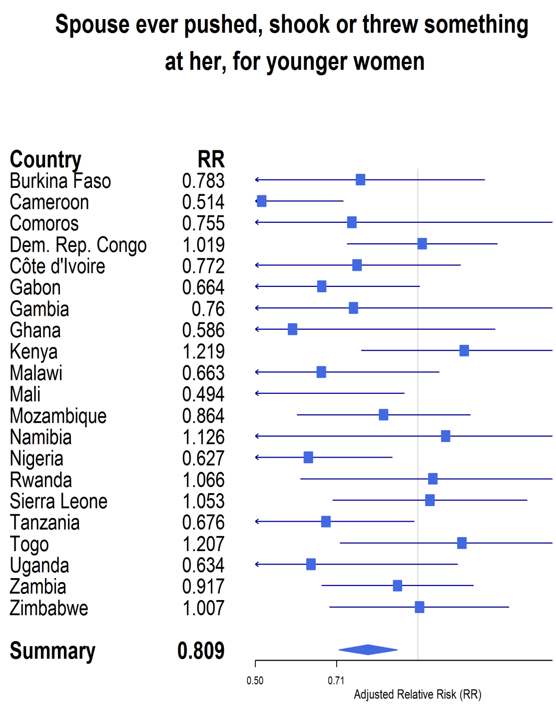
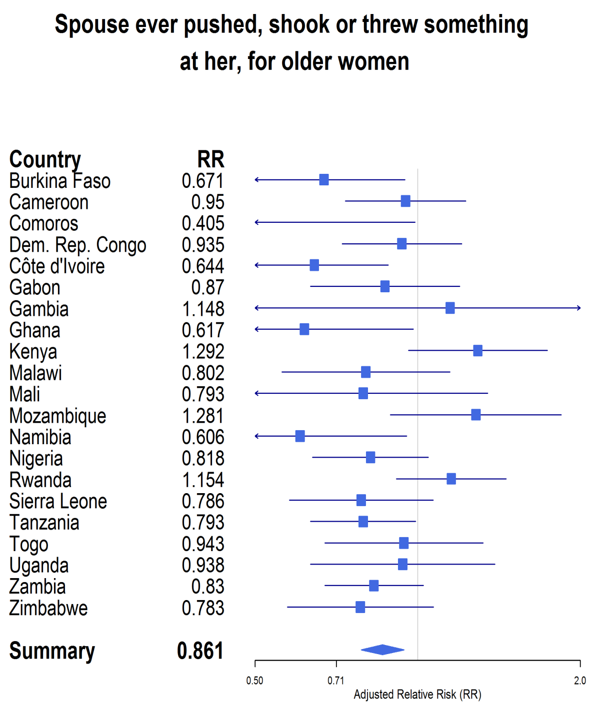


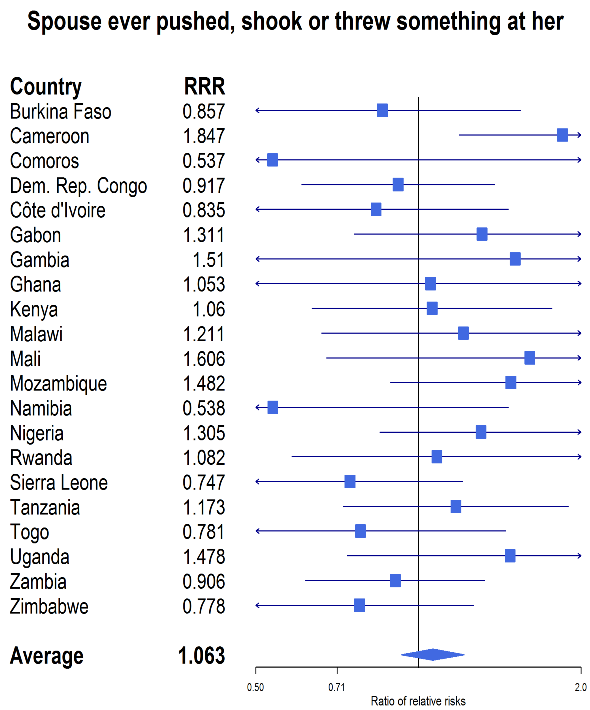
Figure 6.17: Spouse ever insulted or made the woman feel bad, including relative age.



(a)



(b)



(c)

Figure 6.18: Spouse ever pushed, shook or threw something at the woman, including relative age.

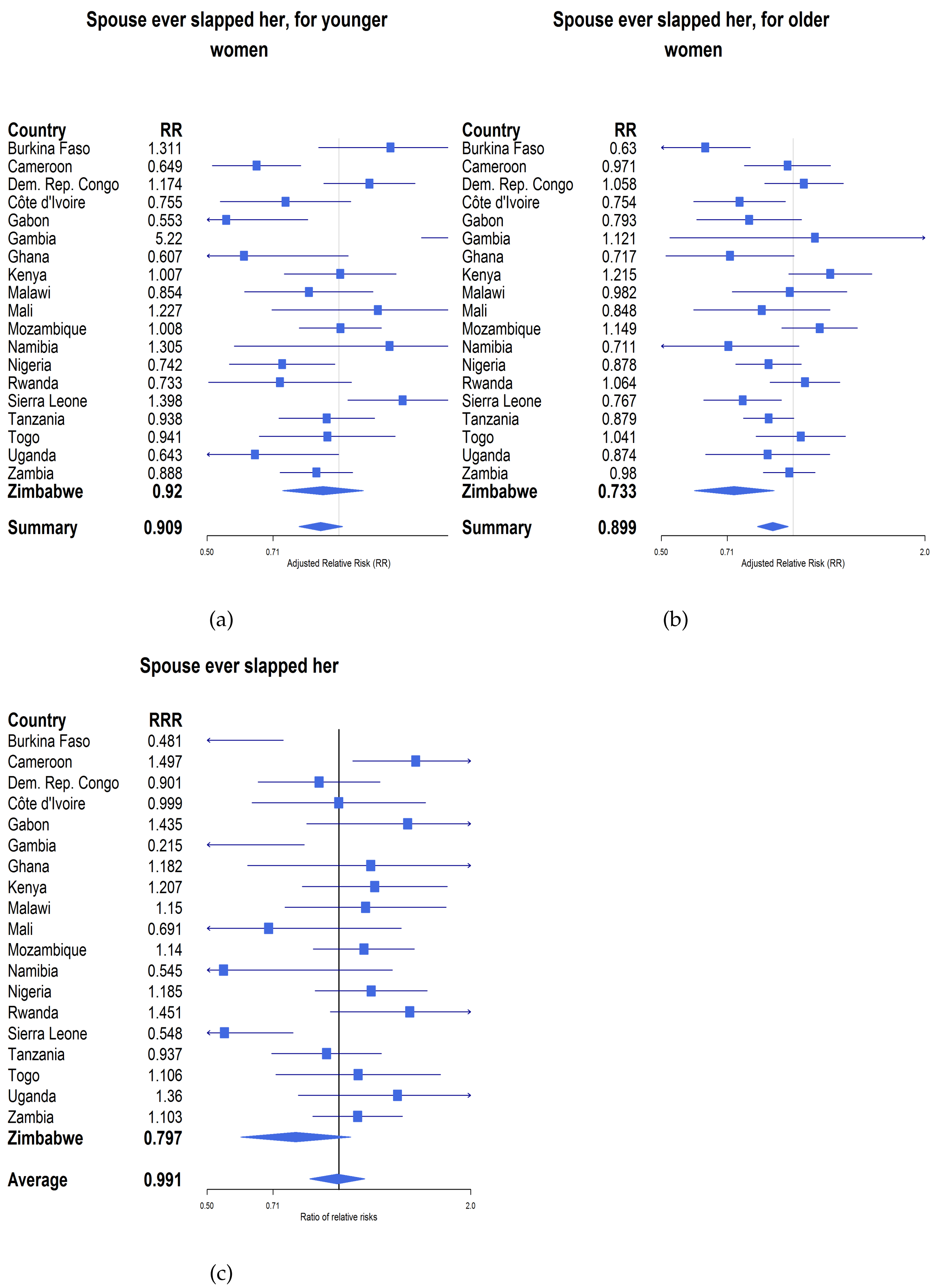
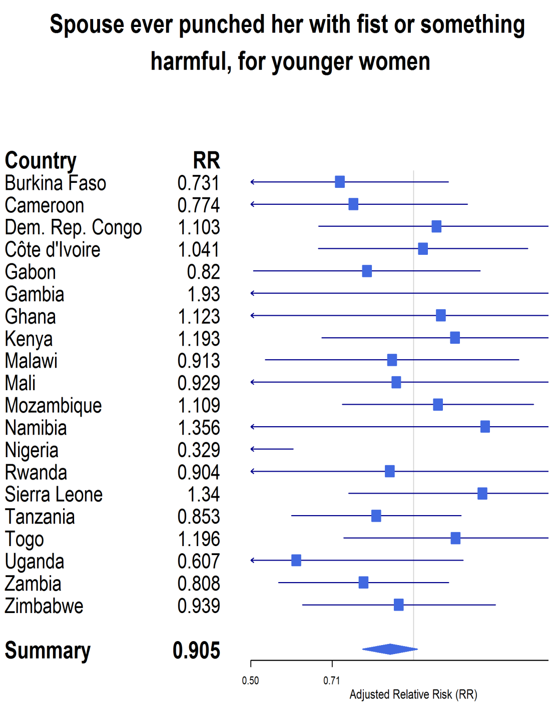
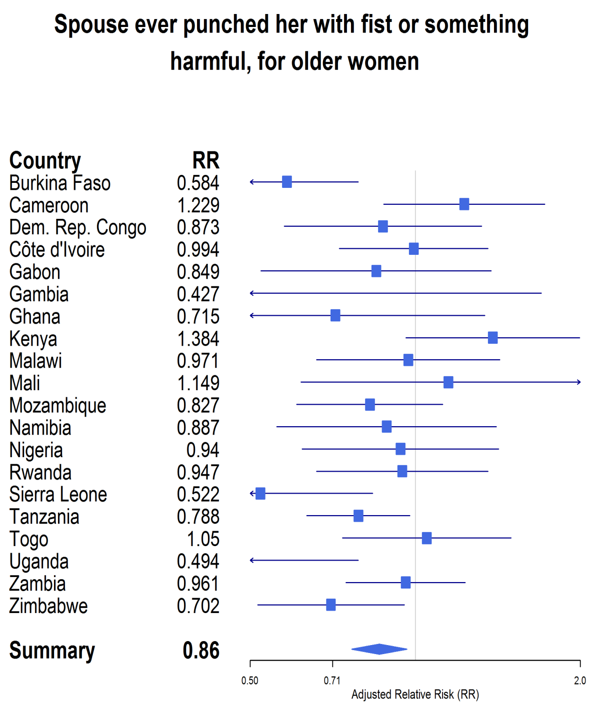


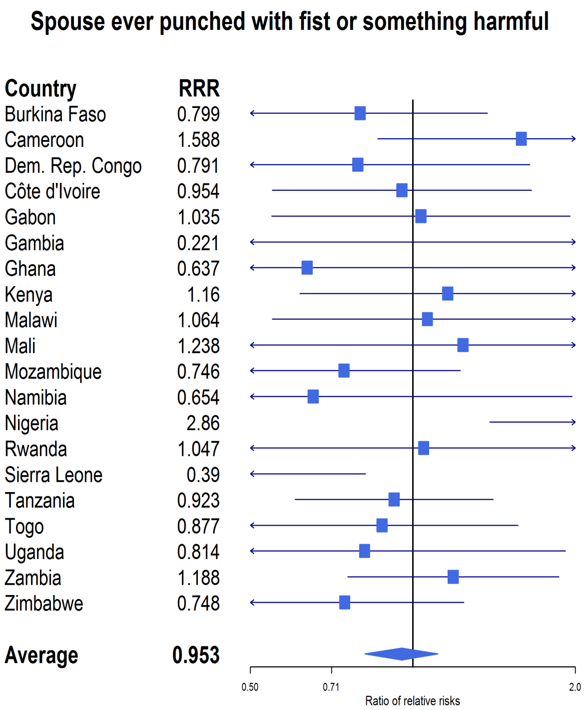
Figure 6.19: Spouse ever slapped the woman, including relative age.



(a)

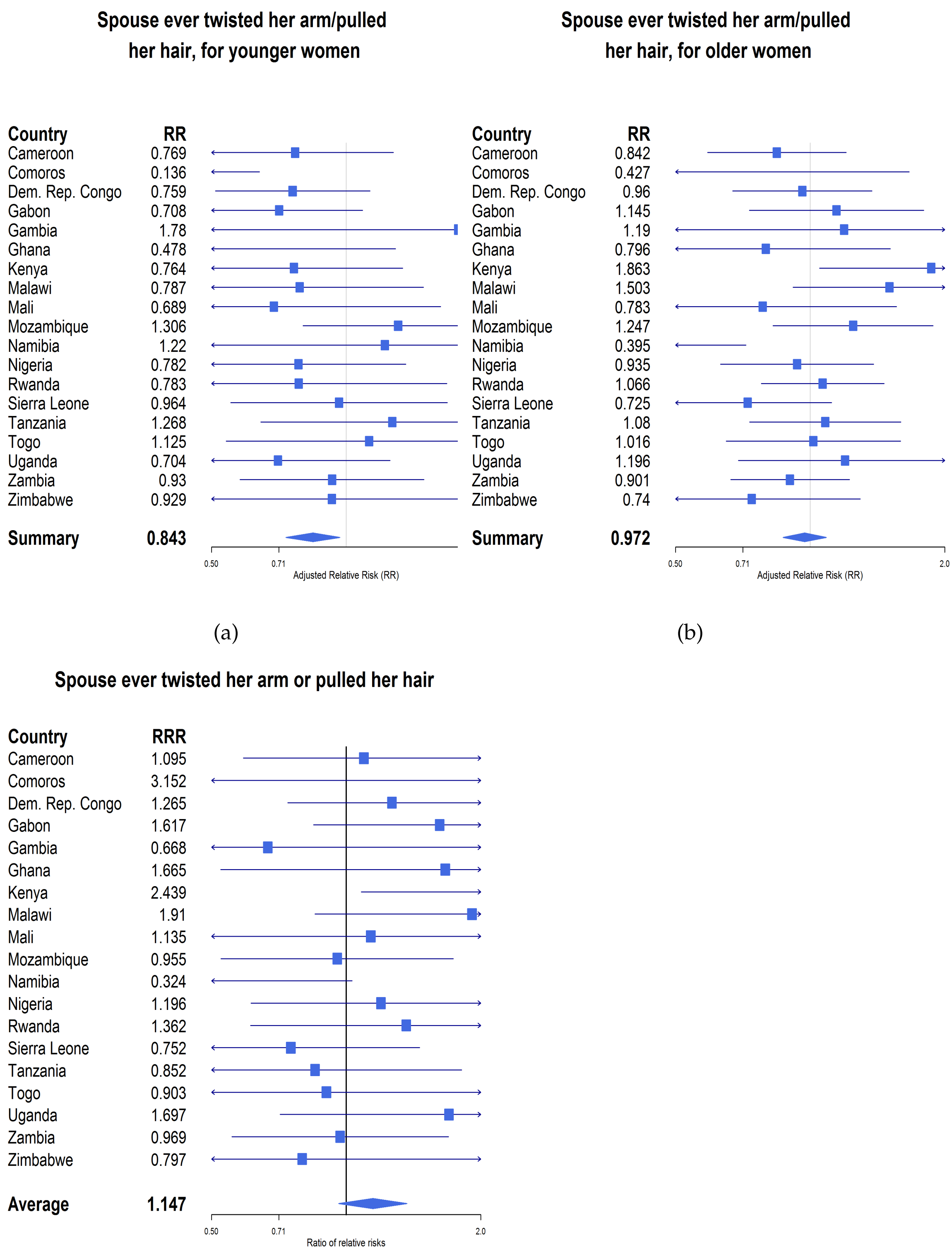


(b)



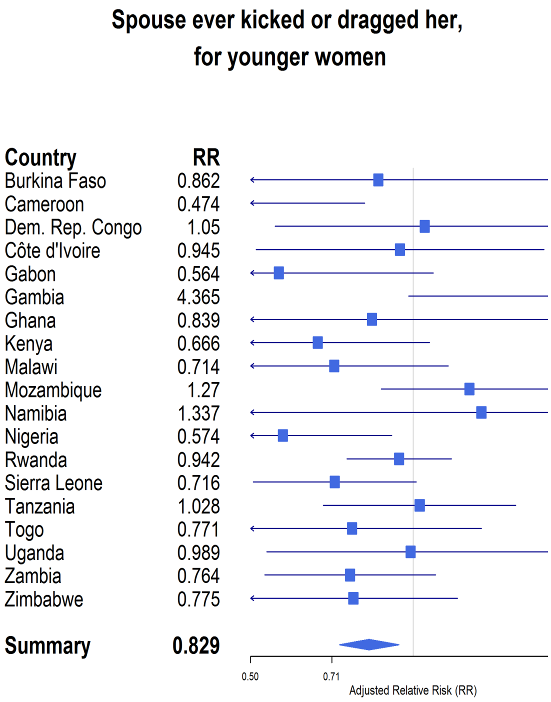
(c)

Figure 6.20: Spouse ever punched the woman with fist or something harmful, including relative age.

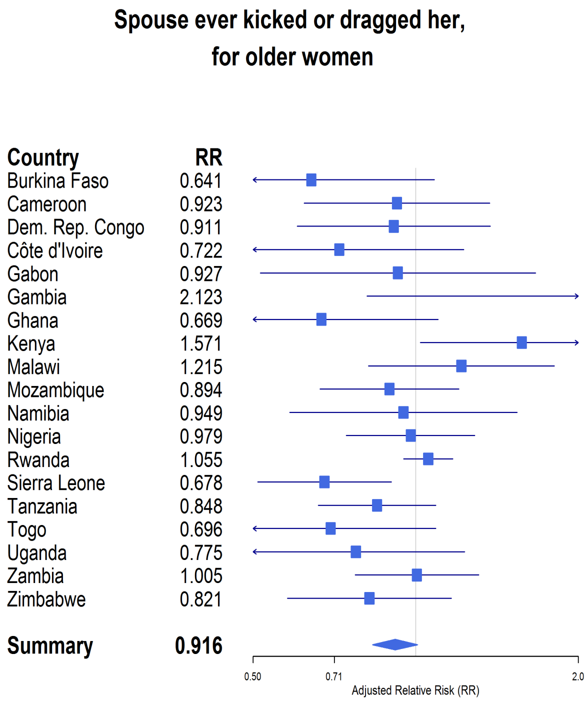


(c)

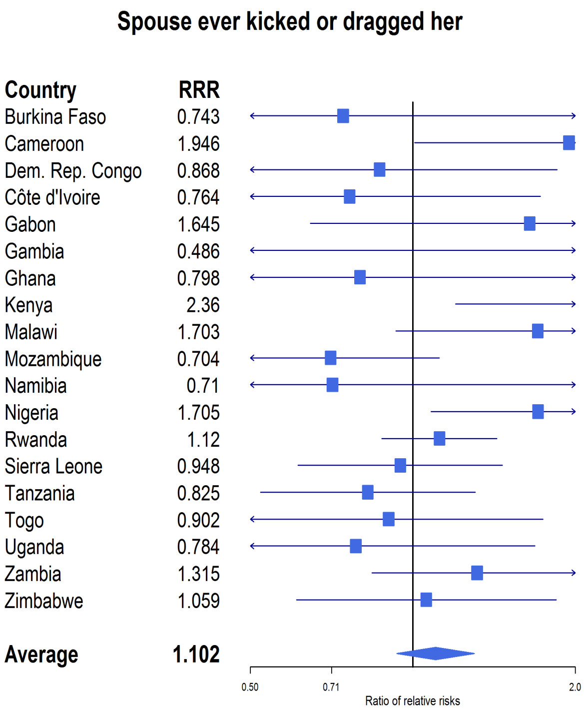
Figure 6.21: Spouse ever twisted her arm or pulled her hair, including relative age.



(a)



(b)



(c)

Figure 6.22: Spouse ever kicked or dragged her, including relative age.

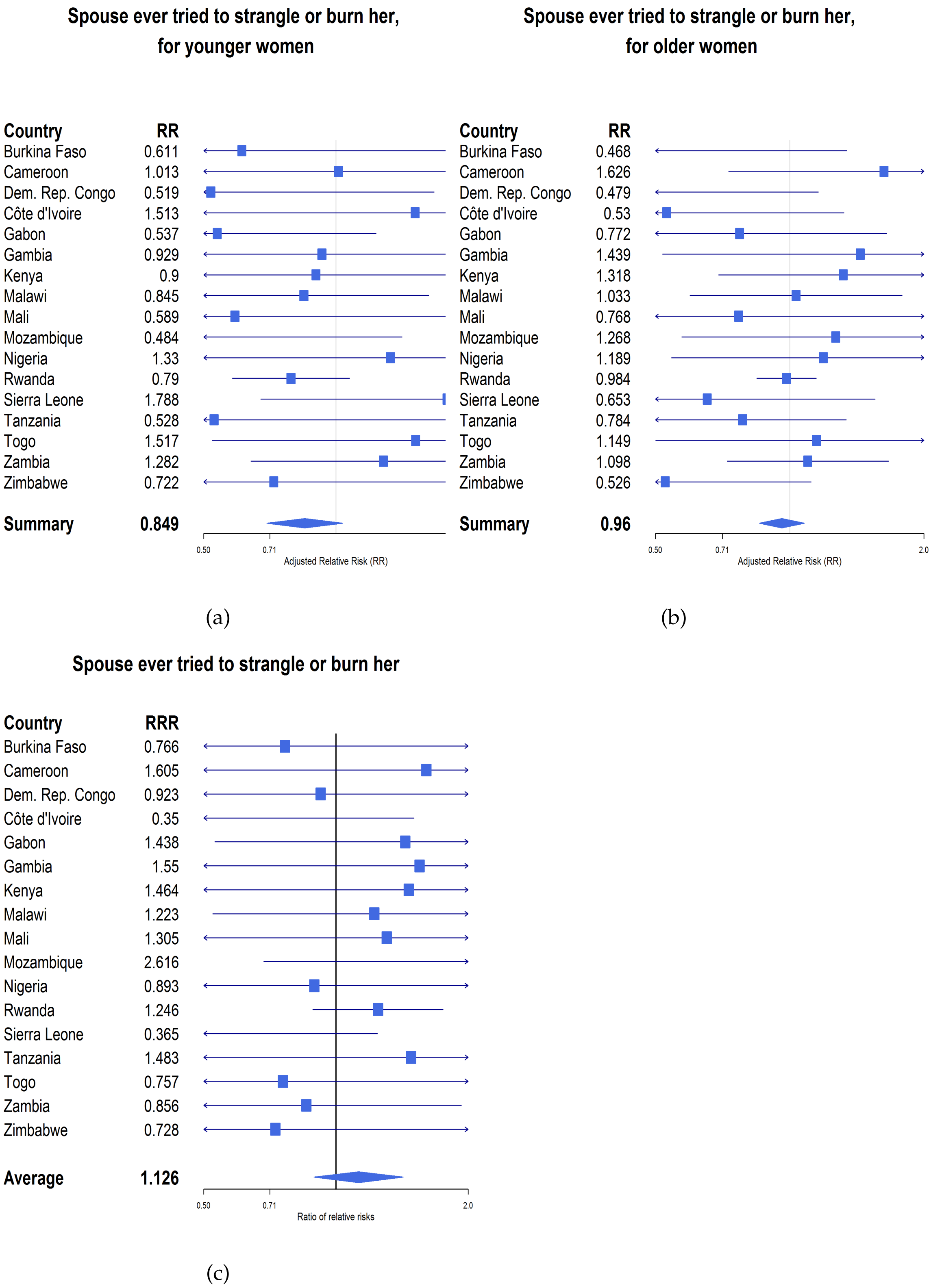
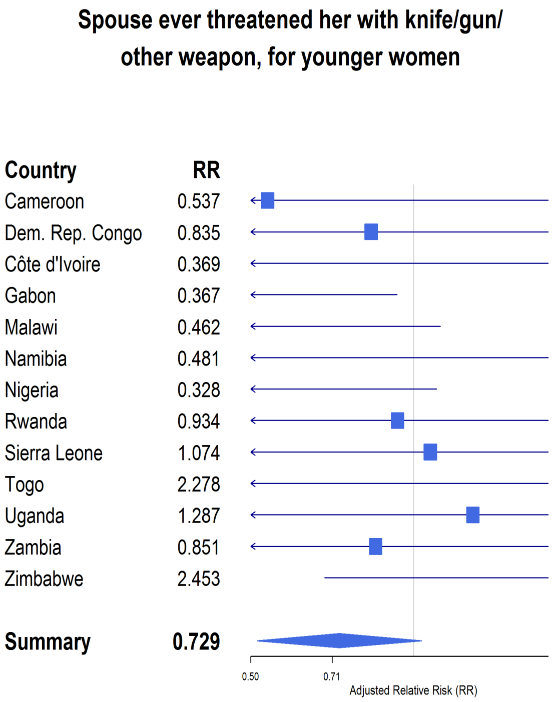
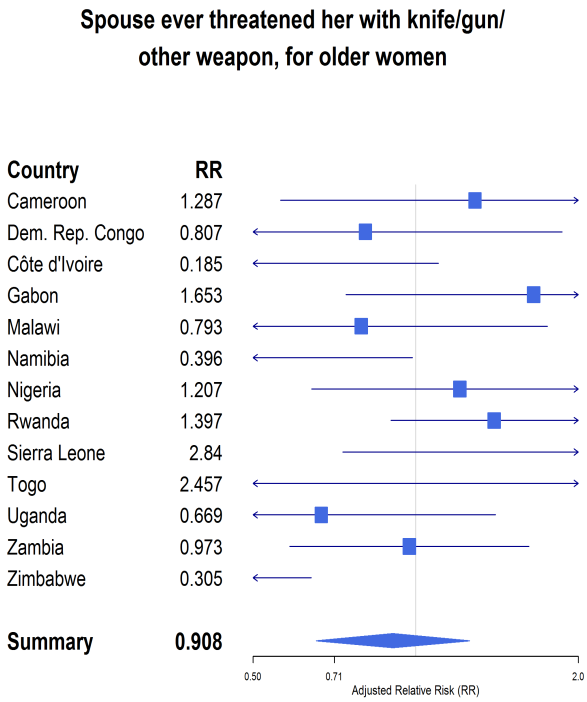


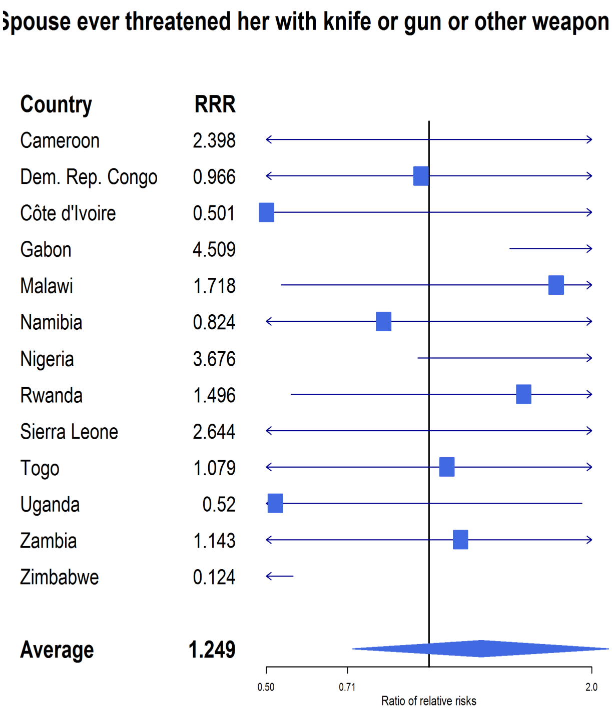
Figure 6.23: Spouse ever tried to strangle or burn the woman, including relative age.



(a)



(b)



(c)

Figure 6.24: Spouse ever threatened the woman with knife or gun or other weapon, including relative age.

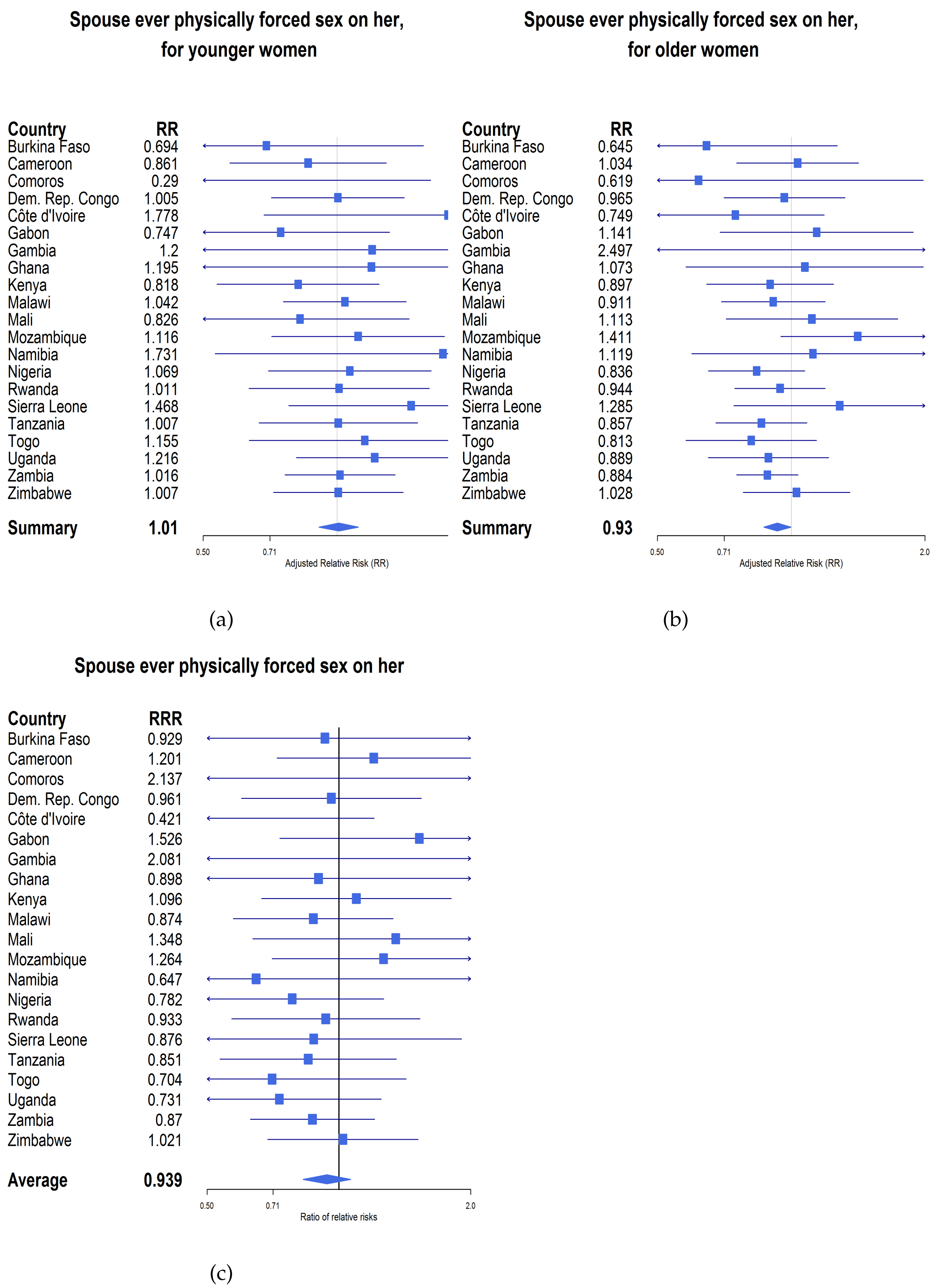
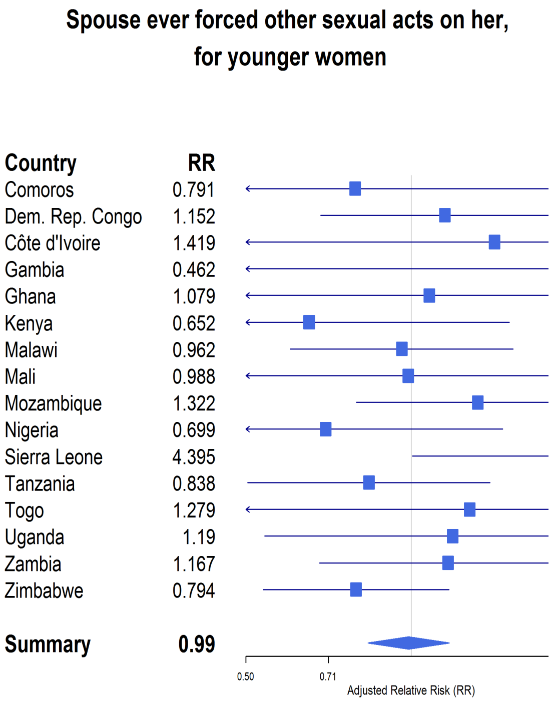
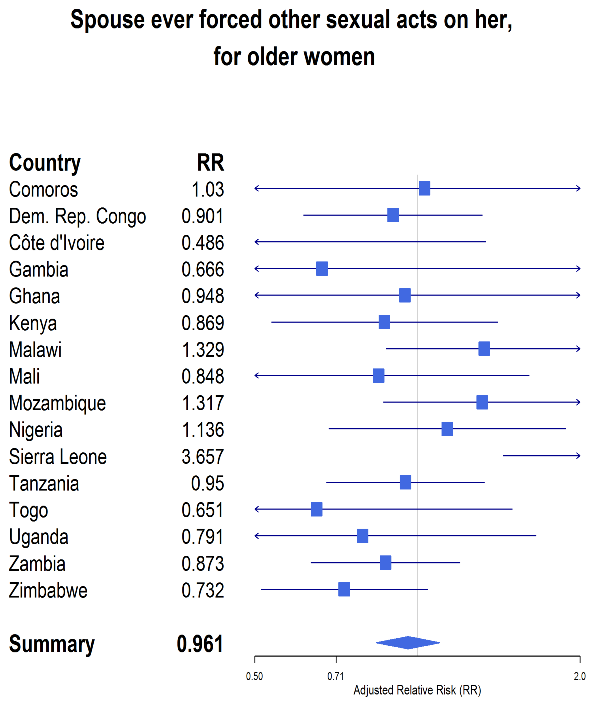


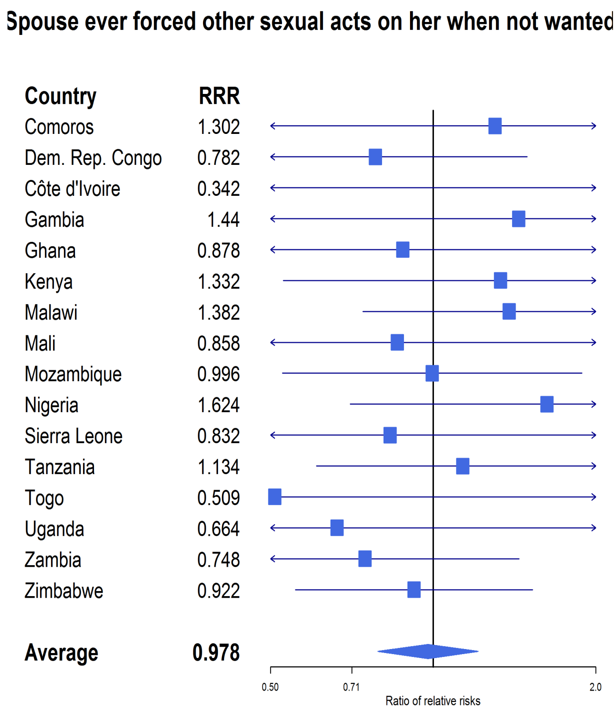
Figure 6.25: Spouse ever physically forced sex on the woman, including relative age.



(a)



(b)



(c)

Figure 6.26: Spouse ever forced other sexual acts on the woman when not wanted, including relative age.

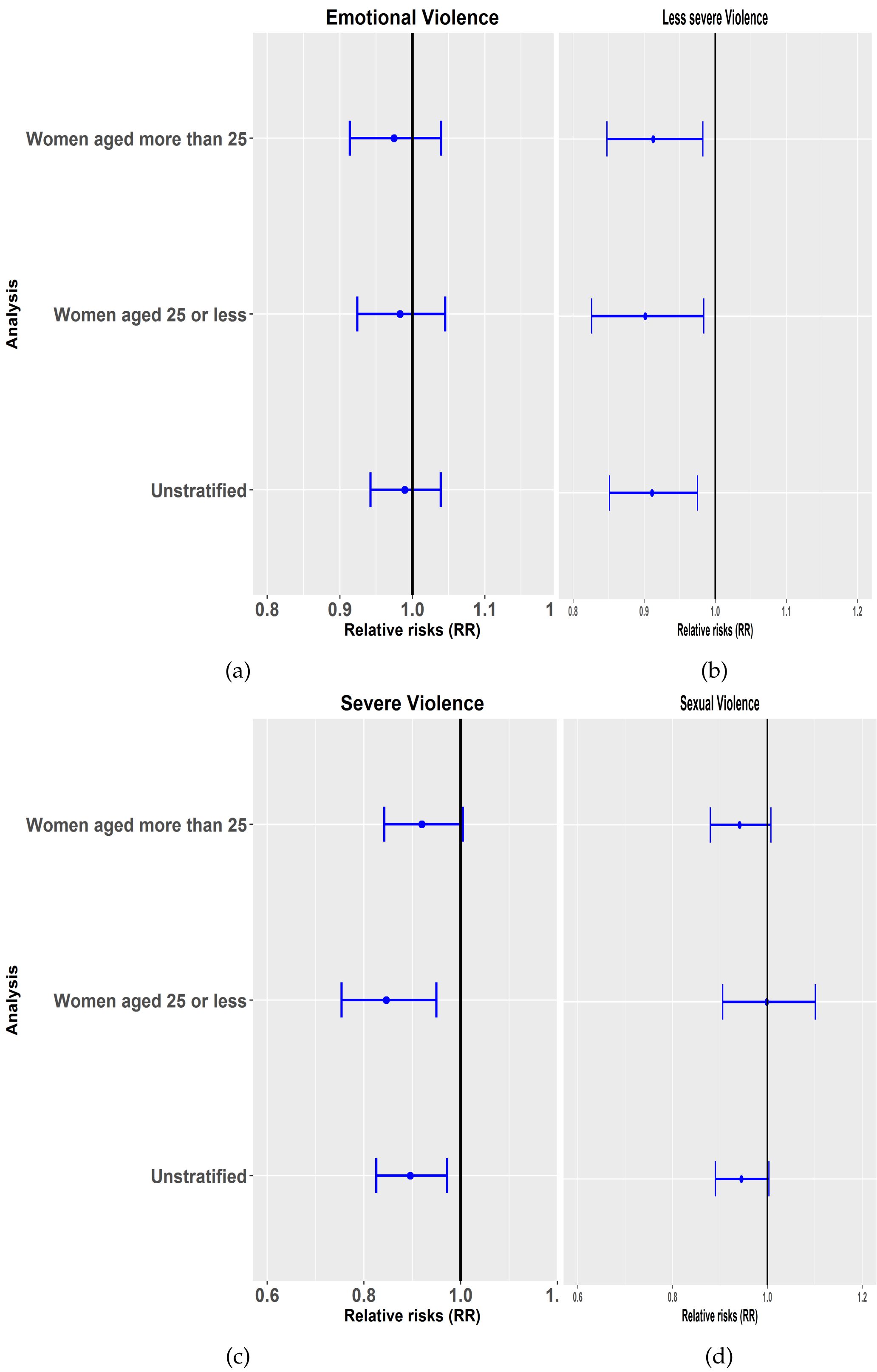


Figure 6.27: Weighted average relative risks put together from the unstratified and stratified analyses.

In conclusion, figure 6.27 is a summary of the WRRAs for unstratified and stratified analyses. The figure shows that there is no meaningful difference in the results from the two sets of analyses. The results show that all WRRAs from the meta-analyses were less than 1 for the types of IPV (see figure 6.27), but estimated average effects are small (0.846-1.00) and only significantly different from 1 for less severe violence for both the unstratified and stratified analyses.

Chapter 7

Final summary and conclusion

7.1 Prevalence of IPV

In this study we aimed to examine the prevalence of intimate partner violence within 12 months preceding the survey and its association with age disparity. IPV was measured in four forms/types: emotional IPV, less severe and severe physical IPV, and sexual IPV.

According to Babalola *et al.* (2014), more than one fifth of women in DRC have experienced humiliation from their intimate male partners . Similar findings are mirrored in this study, which suggest that prevalence of a woman having been humiliated in the last year was highest in DRC, which is higher than other studies carried out in Malawi (Pelser *et al.*, 2005) and Haiti (Gage, 2005). Studies have shown that the conflicts in DRC led to numerous rape cases, which left women devastated and likely to be humiliated by their spouses (Peterman *et al.*, 2011; Tankink & Slegh, 2016). The results also indicated that prevalence of having been pushed, shaken, or having something thrown at them, by their intimate partner, is most common in DRC, which is higher than that of Cambodia (Kishor & Johnson, 2004).

This study indicates that women in Uganda experienced the highest proportion of having been threatened with harm, as well as having been insulted by their intimate partners (see figure 6.2). Uganda is characterised by dominant norms of masculinity and gender inequalities, which helps legitimise the power imbalance, thus resulting in increased cases of acts of IPV, such as being threatened with harm/insulted/made to feel bad (Ogland *et al.*, 2014).

These results add to the existing body of research, which is mainly from Sub-Saharan Africa and confirm that intimate partner violence is a common experience in Sub-Saharan Africa. The highest overall prevalence of emotional IPV was recorded in Cameroon, which is higher than the prevalence (30.7%) documented by Alio *et al.* (2011).

Rwanda reported the highest prevalence of IPV across all the specific acts of severe violence, and even in the overall prevalence of severe violence. These results are not consistent with a review of DHS findings from seven countries, which shows that 30% of women in Rwanda have experienced physical violence compared to Uganda and Zambia, which each reported around 50% (Borwankar *et al.*, 2008). The highest prevalence of severe IPV can be attributed to the gender power imbalance in Rwanda reinforced by cultural norms and tolerance of traditional gender norms by the society (Umubyeyi *et al.*, 2014). It is believed that IPV is purely an issue between couples that is not of societal concern, and it is therefore rarely disclosed outside the household (Umubyeyi *et al.*, 2014). In addition, IPV is considered normal and justified by men's superior position in the society, a view that is echoed by some women (Mannell & Jackson, 2014).

The regional difference in prevalence of IPV in the last year is clear. Countries from West Africa such as Nigeria and Burkina Faso indicated lowest prevalences across all the IPV indicators. This could be due to positive changes in attitudes towards violence against women in these countries. Another reason for the low prevalence of IPV in these regions could be due to under-reporting in the DHS data. In Nigeria, for instance, studies have shown that the rigid culture of patriarchy makes reporting incidences of IPV almost impossible because it is viewed as being disrespectful to the husband and to the elders who arbitrate such matters (Antai, 2008 (accessed December 11, 2016).

The prevalence of IPV in the East African countries such as Uganda, Kenya and Tanzania fluctuates between highest to moderately low rates. Tanzania, for instance, reported highest prevalence of emotional and less severe violence among the east African countries, which is consistent with the study by Garcia-Moreno *et al.* (2006). A study by McCloskey *et al.* (2005) indicated that gender inequality in Tanzania has led to increased cases of IPV. Moreover, Uganda reported the highest prevalence of sexual IPV, which is not consistent with the study carried out in Rakai in Uganda (Kouyoumdjian *et al.*, 2013), but is consistent with the study by Koenig *et al.* (2003). Koenig *et al.* (2003) found that 28% of women justified beating when a woman refused to have sex with her partner.

Finally, particularly striking are the results from DRC which reported highest prevalence of emotional, less severe and sexual IPV. A study carried by Tlapek (2014) in DRC also reported high rates of IPV prevalence . The study reported that more than 80% of women justified wife-beating as acceptable, and women who justify violence against women are likely to experience IPV.

7.1.1 Association between IPV and age disparity

This study shows that all the weighted relative risk averages (WRRAs) that came from the unstratified analysis were less than 1 and significant for less severe violence and severe violence (see figure 6.10), which is consistent with the views of the South African women that having an older partner is protective against IPV (Beauclair & Delva, 2013). These results are also in line with the study by Jewkes *et al.* (2002) that having an intimate partner at least five years older is protective against IPV. A high between-country heterogeneity is evident with most countries showing no evidence of association between IPV and age disparity. In some countries, such as Burkina Faso, Cameroon, and Nigeria, having an older partner is protective against IPV, across all of the IPV indicators, which supports the findings by Jewkes *et al.* (2002). However, results from Kenya indicate that having an older partner may not be protective against emotional, less severe and severe IPV, which is similar to findings by **?**.

Moreover, we assessed the effect of age disparity on IPV, in the two cases when a woman is less than or equal to 25 years old (younger women group), or more than 25 years old (older women group). The WRRAs of the association between IPV and age disparity was less than 1 for younger and older women groups, similar to the unstratified analysis. The WRRAs were significantly smaller than 1 for less severe violence. The younger women group gave WRRA significantly less than 1 for severe IPV, implying that being in the younger women age-group category and in an age-disparate (AD) relationship is protective against severe IPV (Abramsky *et al.*, 2011; Jewkes *et al.*, 2002). The WRRAs also show that there is no evidence of difference in effect of age disparity between younger and older women. However, country Relative risk (RR) gave a mixed picture. Burkina Faso and Sierra Leone show that the effect of age disparity on emotional and less severe IPV is lower for younger women, compared to older women which agree with the findings that older women are protective against IPV (Tang & Lai, 2008; Thompson *et al.*, 2006). Furthermore, in Cameroon and Nigeria, the effect of age disparity on severe IPV increases significantly for the older women group compared to the younger women group.

This study provides measure of effect (RR) that is easy to communicate and comprehensible, in contrast to the odds ratio (OR) used by Kishor & Johnson (2004) and Hindin *et al.* (2008). We also used IPV data reported within 12 months before the survey compared to the lifetime data which is prone to recall bias. Data collected between 2008-2014 were used that only focused on sub-Saharan African countries. Kishor and Johnson and Hindin et al. used data collected before 2008. Furthermore, unlike Kishor & Johnson (2004) and Hindin *et al.* (2008), we used sampling weight in the regression model. Sampling weight accounts for bias due to the difference in selection probability.

Finally, this study agrees with the findings that age disparity is associated with IPV but the direction and strength of association differs per setting (Abramsky *et al.*, 2011; Hindin *et al.*, 2008; Kishor & Johnson, 2004). Also, our ability to give meaningful interpretation of the WRRAs is limited by the high degree of between-country heterogeneity and the need to analyse this heterogeneity. Furthermore, having fitted random-effect models in the meta-analysis, one is tempted to treat the WRRAs as estimates of the true effect of age disparity in Sub-Saharan Africa. However, the countries considered in this analysis are not sufficiently representative of Sub-Saharan Africa to allow for generalisation of the results.

7.2 Strength and limitations of the study and future research

The strength of this study is that the DHS surveys are nationally representative, therefore allowing for the outcome to cover the entire country. Also, the sampling methods and the instruments used adhere to the accepted ethical standards recommended for research on IPV. Another strength is that the data collectors are well trained to adhere to the ethical standards when collecting data on IPV. Further, we used design based approach to inference, which is considered suitable for complex surveys (Lohr, 2010).

Nevertheless, DHS surveys still give lower estimates of the extent of IPV compared to other surveys like those carried out by WHO (Abramsky *et al.*, 2011). Therefore, results from this study may represent underestimation of the true prevalence of IPV, and underestimation or overestimation of the true association between IPV and age disparity. Dividing the age disparity into only two categories can lead to loss of information, that is, we cannot tell if having a male partner 10 years older have a different effect compared to a partner 20 years older. Splitting the women into two groups also lead to loss of information compared to when more than two categories are used. Furthermore, joining responses, "often" and "sometimes", to form yes can also lead to loss of information. For instance, perhaps age disparity is only associated with "often" IPV.

The findings from this analysis help to provide a background for important future research to address the associations between IPV and age disparity among countries in Sub-Saharan Africa. The next step is to attempt to understand the reasons for high heterogeneity between the country effects. Also, to allow for a better meaningful interpretation, more groups would be added to the age difference, such as a man 10 years or less than 15 years older than the woman and a man more than 15 years older than the woman, with the hypothesis that women having a partner at least 15 years older would have a larger protective effect against IPV.

Another extension of the current study would be to stratify data into women less than or equal to 25 years, women 26-35 years and women at least 36 years old. The hypothesis in this case would be that women more than 36 years old and in age disparate relationships are less likely to experience IPV. Further analysis that can be explored is the correlation between the forms of IPV.

In addition, this study only considered heterosexual relationships where women are the victims of IPV. Further research is needed to establish the risk of a man experiencing IPV from the female intimate partner in sub-Saharan Africa relative to the age disparity between them.

7.3 Conclusion

This study has shown that there is high prevalence of IPV in Sub-Saharan Africa, relative to the rest of the world, but the prevalence varies considerably with country and the types of IPV. Prevalence of severe violence, for instance, was highest in Rwanda and the prevalence of emotional violence was highest in Cameroon.

This study also found that there is an association between IPV and age disparity but the association is country dependent. Speculation is that heterogeneities in underlying socio-cultural and economic histories and current realities explain dependence.

An important conclusion for policy makers is that IPV prevention programmes should be country dependent when considering age disparity as a risk factor of intimate partner violence. The programmes should also be tailored towards preventing each form of IPV independently.

Appendix A

The relative risk estimates presented in forest plots in chapter 6 are shown in this appendix in form of tables together with their standard errors and P-values. Section A.1 shows the unstratified analysis, while the results from the stratified analyses are shown section A.2.

A.1 The unstratified analysis

Table A.1: Spouse ever humiliated her

	Country	Relative Risk	Standard error	P-value
1	Burkina Faso	0.813	0.120	0.085
2	Cameroon	0.998	0.102	0.982
3	Comoros	0.915	0.254	0.728
4	Dem. Rep. Congo	1.039	0.086	0.656
5	Côte d'Ivoire	0.777	0.099	0.011
6	Gabon	0.758	0.169	0.103
7	Gambia	1.170	0.395	0.691
8	Ghana	0.977	0.132	0.858
9	Kenya	1.243	0.109	0.047
10	Malawi	0.988	0.118	0.916
11	Mali	1.040	0.150	0.795
12	Mozambique	1.071	0.086	0.422
13	Namibia	0.859	0.213	0.475
14	Nigeria	0.965	0.071	0.614
15	Sierra Leone	0.835	0.102	0.078
16	Tanzania	1.080	0.114	0.503
17	Togo	1.064	0.078	0.428
18	Uganda	0.968	0.156	0.834
19	Zambia	1.060	0.081	0.470
20	Zimbabwe	0.938	0.112	0.572

Table A.2: Spouse ever threatened with harm.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.701	0.143	0.013
2	Cameroon	1.117	0.148	0.453
3	Comoros	0.997	0.509	0.995
4	Dem. Rep. Congo	0.936	0.148	0.655
5	Côte d'Ivoire	0.842	0.153	0.263
6	Gabon	0.712	0.238	0.154
7	Gambia	0.940	0.466	0.895
8	Ghana	0.697	0.243	0.138
9	Kenya	1.411	0.155	0.027
10	Malawi	0.861	0.144	0.301
11	Mali	1.103	0.242	0.687
12	Mozambique	1.034	0.149	0.821
13	Namibia	1.001	0.229	0.996
14	Nigeria	1.027	0.109	0.806
15	Sierra Leone	0.617	0.165	0.004
16	Tanzania	0.954	0.167	0.779
17	Togo	1.128	0.123	0.329
18	Uganda	0.893	0.189	0.549
19	Zambia	1.029	0.123	0.816
20	Zimbabwe	0.783	0.127	0.056

Table A.3: Spouse ever insulted her.

	Country	Relative risk	Standard error	P-value
1	Cameroon	1.023	0.090	0.802
2	Comoros	1.313	0.486	0.575
3	Dem. Rep. Congo	1.126	0.079	0.135
4	Gabon	0.888	0.184	0.518
5	Gambia	0.890	0.295	0.693
6	Ghana	0.849	0.107	0.126
7	Kenya	1.248	0.103	0.032
8	Malawi	1.006	0.091	0.947
9	Mali	0.942	0.119	0.619
10	Mozambique	1.058	0.062	0.363
11	Namibia	1.088	0.182	0.644
12	Nigeria	0.972	0.062	0.650
13	Sierra Leone	0.769	0.117	0.025
14	Tanzania	0.996	0.061	0.953
15	Togo	1.115	0.070	0.123
16	Uganda	1.014	0.118	0.905
17	Zambia	1.033	0.077	0.673
18	Zimbabwe	0.941	0.073	0.410

Table A.4: Spouse ever pushed, shook or threw something.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.711	0.170	0.046
2	Cameroon	0.817	0.118	0.087
3	Comoros	0.725	0.513	0.531
4	Dem. Rep. Congo	0.957	0.104	0.675
5	Côte d'Ivoire	0.671	0.128	0.002
6	Gabon	0.579	0.159	0.001
7	Gambia	1.388	0.621	0.598
8	Ghana	0.586	0.230	0.021
9	Kenya	1.330	0.148	0.054
10	Malawi	0.727	0.181	0.078
11	Mali	0.637	0.263	0.087
12	Mozambique	1.102	0.132	0.463
13	Namibia	0.749	0.215	0.178
14	Nigeria	0.746	0.110	0.008
15	Rwanda	1.131	0.107	0.250
16	Sierra Leone	0.775	0.138	0.067
17	Tanzania	0.749	0.097	0.003
18	Togo	1.008	0.143	0.954
19	Uganda	1.160	0.189	0.432
20	Zambia	0.854	0.091	0.083
21	Zimbabwe	0.866	0.121	0.236

Table A.5: Spouse ever slapped.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.766	0.112	0.018
2	Cameroon	0.832	0.094	0.052
3	Dem. Rep. Congo	1.086	0.079	0.301
4	Côte d'Ivoire	0.813	0.104	0.047
5	Gabon	0.553	0.142	0.000
6	Gambia	2.057	0.441	0.103
7	Ghana	0.753	0.156	0.070
8	Kenya	1.302	0.116	0.024
9	Malawi	0.807	0.142	0.132
10	Mali	0.929	0.146	0.615
11	Mozambique	1.104	0.081	0.222
12	Namibia	0.829	0.176	0.289
13	Nigeria	0.830	0.085	0.029
14	Rwanda	0.990	0.089	0.906
15	Sierra Leone	0.864	0.093	0.116
16	Tanzania	0.884	0.062	0.048
17	Togo	0.996	0.100	0.968
18	Uganda	0.898	0.154	0.487
19	Zambia	0.942	0.056	0.290
20	Zimbabwe	0.823	0.077	0.012

Table A.6: Spouse ever punched with fist or something harmful.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.632	0.135	0.001
2	Cameroon	1.193	0.166	0.289
3	Dem. Rep. Congo	0.878	0.155	0.399
4	Côte d'Ivoire	1.011	0.138	0.936
5	Gabon	0.618	0.259	0.063
6	Gambia	0.285	0.602	0.038
7	Ghana	0.878	0.312	0.678
8	Kenya	1.293	0.175	0.141
9	Malawi	0.963	0.190	0.844
10	Mali	1.117	0.250	0.660
11	Mozambique	0.912	0.126	0.467
12	Namibia	0.991	0.223	0.966
13	Nigeria	0.679	0.201	0.055
14	Rwanda	0.951	0.170	0.769
15	Sierra Leone	0.583	0.216	0.013
16	Tanzania	0.798	0.098	0.022
17	Togo	1.078	0.152	0.622
18	Uganda	0.571	0.226	0.013
19	Zambia	0.912	0.104	0.376
20	Zimbabwe	0.788	0.126	0.060

Table A.7: Spouse ever twisted her arm or pulled her hair.

	Country	Relative risk	Standard error	P-value
1	Cameroon	0.908	0.185	0.601
2	Comoros	0.132	0.898	0.025
3	Dem. Rep. Congo	0.891	0.140	0.409
4	Gabon	1.056	0.210	0.796
5	Gambia	1.130	0.552	0.825
6	Ghana	0.700	0.285	0.210
7	Kenya	1.679	0.284	0.069
8	Malawi	1.113	0.227	0.637
9	Mali	0.804	0.273	0.424
10	Mozambique	1.292	0.167	0.126
11	Namibia	0.561	0.252	0.022
12	Nigeria	0.945	0.185	0.762
13	Rwanda	1.001	0.153	0.993
14	Sierra Leone	0.702	0.197	0.073
15	Tanzania	1.138	0.193	0.503
16	Togo	1.011	0.209	0.958
17	Uganda	0.881	0.207	0.540
18	Zambia	0.908	0.133	0.469
19	Zimbabwe	0.825	0.217	0.375

Table A.8: Spouse ever kicked or dragged.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.738	0.247	0.218
2	Cameroon	0.810	0.194	0.278
3	Dem. Rep. Congo	0.925	0.174	0.657
4	Côte d'Ivoire	0.768	0.200	0.188
5	Gabon	0.650	0.307	0.161
6	Gambia	2.614	0.498	0.055
7	Ghana	0.735	0.237	0.194
8	Kenya	1.390	0.204	0.108
9	Malawi	1.000	0.187	0.999
10	Mozambique	1.030	0.119	0.803
11	Namibia	1.033	0.228	0.888
12	Nigeria	0.873	0.135	0.315
13	Rwanda	1.024	0.054	0.662
14	Sierra Leone	0.642	0.131	0.001
15	Tanzania	0.859	0.121	0.208
16	Togo	0.722	0.188	0.084
17	Uganda	0.787	0.224	0.283
18	Zambia	0.924	0.111	0.476
19	Zimbabwe	0.804	0.145	0.134

Table A.9: Spouse ever tried to strangle or burn.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.481	0.473	0.122
2	Cameroon	1.680	0.376	0.168
3	Dem. Rep. Congo	0.447	0.391	0.040
4	Côte d'Ivoire	0.724	0.345	0.349
5	Gabon	0.553	0.494	0.231
6	Gambia	1.460	0.527	0.473
7	Ghana	0.502	0.605	0.255
8	Kenya	1.470	0.328	0.241
9	Malawi	0.995	0.253	0.984
10	Mali	0.673	0.479	0.410
11	Mozambique	0.920	0.326	0.797
12	Namibia	1.035	0.397	0.930
13	Nigeria	1.169	0.403	0.698
14	Rwanda	0.955	0.078	0.553
15	Sierra Leone	0.757	0.408	0.496
16	Tanzania	0.685	0.265	0.154
17	Togo	1.235	0.340	0.535
18	Zambia	1.130	0.182	0.504
19	Zimbabwe	0.579	0.284	0.055

Table A.10: Spouse ever threatened with knife/gun or other weapon.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	1.476	0.657	0.554
2	Cameroon	1.371	0.461	0.494
3	Comoros	1.525	1.595	0.791
4	Dem. Rep. Congo	0.746	0.358	0.414
5	Côte d'Ivoire	0.539	0.931	0.507
6	Gabon	1.324	0.472	0.553
7	Ghana	2.325	0.588	0.152
8	Malawi	0.584	0.358	0.133
9	Mozambique	3.323	0.383	0.002
10	Namibia	0.419	0.445	0.051
11	Nigeria	0.900	0.321	0.741
12	Rwanda	1.390	0.213	0.124
13	Sierra Leone	1.480	0.608	0.519
14	Togo	2.362	0.650	0.187
15	Uganda	0.767	0.362	0.464
16	Zambia	0.937	0.224	0.770
17	Zimbabwe	0.545	0.311	0.052

Table A.11: Spouse ever physically forced sex when not wanted.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.774	0.290	0.378
2	Cameroon	1.030	0.134	0.826
3	Comoros	0.649	0.719	0.548
4	Dem. Rep. Congo	0.979	0.121	0.862
5	Côte d'Ivoire	0.874	0.234	0.564
6	Gabon	0.990	0.286	0.973
7	Gambia	2.465	0.759	0.236
8	Ghana	1.055	0.306	0.862
9	Kenya	0.824	0.163	0.237
10	Malawi	0.808	0.121	0.078
11	Mali	0.929	0.201	0.714
12	Mozambique	1.279	0.156	0.115
13	Namibia	1.239	0.293	0.464
14	Nigeria	0.830	0.114	0.101
15	Rwanda	0.960	0.125	0.744
16	Sierra Leone	0.981	0.263	0.943
17	Tanzania	0.920	0.110	0.448
18	Togo	0.888	0.144	0.409
19	Uganda	1.008	0.136	0.952
20	Zambia	0.912	0.071	0.194
21	Zimbabwe	1.030	0.118	0.800

Table A.12: Spouse ever forced other sexual acts when not wanted.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.837	0.766	0.816
2	Comoros	1.039	1.076	0.972
3	Dem. Rep. Congo	0.957	0.157	0.781
4	Côte d'Ivoire	0.596	0.465	0.267
5	Gabon	1.077	0.664	0.911
6	Gambia	0.600	0.899	0.570
7	Ghana	0.833	0.385	0.636
8	Kenya	0.672	0.250	0.112
9	Malawi	1.098	0.182	0.610
10	Mali	0.910	0.256	0.714
11	Mozambique	1.293	0.172	0.135
12	Namibia	1.923	0.377	0.084
13	Nigeria	0.817	0.223	0.366
14	Sierra Leone	2.797	0.438	0.019
15	Tanzania	0.900	0.142	0.456
16	Togo	0.771	0.350	0.459
17	Uganda	0.760	0.339	0.420
18	Zambia	0.939	0.134	0.637
19	Zimbabwe	0.772	0.137	0.060

Table A.13: Emotional Violence.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.745	0.110	0.008
2	Cameroon	1.007	0.077	0.930
3	Comoros	1.147	0.306	0.656
4	Dem. Rep. Congo	1.049	0.071	0.505
5	Côte d'Ivoire	0.909	0.099	0.335
6	Gabon	0.874	0.144	0.350
7	Gambia	1.174	0.307	0.601
8	Ghana	0.920	0.094	0.376
9	Kenya	1.304	0.084	0.002
10	Malawi	1.039	0.080	0.633
11	Mali	1.015	0.104	0.884
12	Mozambique	1.058	0.050	0.262
13	Namibia	1.062	0.153	0.692
14	Nigeria	0.970	0.054	0.568
15	Sierra Leone	0.791	0.087	0.007
16	Tanzania	0.980	0.063	0.747
17	Togo	1.063	0.066	0.353
18	Uganda	1.004	0.097	0.971
19	Zambia	0.995	0.061	0.938
20	Zimbabwe	0.938	0.062	0.303

Table A.14: Less severe IPV.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.740	0.095	0.002
2	Cameroon	0.919	0.080	0.294
3	Comoros	0.606	0.406	0.218
4	Dem. Rep. Congo	1.049	0.070	0.495
5	Côte d'Ivoire	0.809	0.092	0.022
6	Gabon	0.638	0.111	0.000
7	Gambia	1.588	0.371	0.214
8	Ghana	0.787	0.141	0.091
9	Kenya	1.238	0.086	0.013
10	Malawi	0.834	0.128	0.157
11	Mali	0.895	0.126	0.383
12	Mozambique	1.118	0.071	0.119
13	Namibia	0.872	0.152	0.365
14	Nigeria	0.846	0.080	0.038
15	Rwanda	1.024	0.072	0.740
16	Sierra Leone	0.866	0.085	0.092
17	Tanzania	0.874	0.056	0.017
18	Togo	1.003	0.094	0.975
19	Uganda	0.973	0.131	0.835
20	Zambia	0.960	0.053	0.443
21	Zimbabwe	0.838	0.068	0.010

Table A.15: Severe IPV.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.723	0.245	0.185
2	Cameroon	0.877	0.179	0.463
3	Comoros	1.114	0.968	0.911
4	Dem. Rep. Congo	0.882	0.164	0.444
5	Côte d'Ivoire	0.743	0.182	0.103
6	Gabon	0.572	0.269	0.039
7	Gambia	1.952	0.394	0.091
8	Ghana	0.760	0.222	0.216
9	Kenya	1.380	0.196	0.100
10	Malawi	0.960	0.169	0.809
11	Mali	1.465	0.355	0.283
12	Mozambique	1.103	0.111	0.380
13	Namibia	0.896	0.209	0.600
14	Nigeria	0.843	0.132	0.194
15	Rwanda	1.009	0.050	0.851
16	Sierra Leone	0.693	0.125	0.004
17	Tanzania	0.830	0.118	0.115
18	Togo	0.803	0.184	0.235
19	Uganda	0.752	0.194	0.144
20	Zambia	0.957	0.103	0.669
21	Zimbabwe	0.814	0.133	0.124

Table A.16: Sexual IPV.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.776	0.282	0.367
2	Cameroon	1.030	0.134	0.826
3	Comoros	0.799	0.700	0.748
4	Dem. Rep. Congo	0.982	0.103	0.862
5	Côte d'Ivoire	0.810	0.191	0.271
6	Gabon	0.986	0.268	0.959
7	Gambia	2.738	0.759	0.186
8	Ghana	1.102	0.281	0.729
9	Kenya	0.798	0.157	0.152
10	Malawi	0.857	0.118	0.188
11	Mali	0.963	0.189	0.841
12	Mozambique	1.287	0.143	0.079
13	Namibia	1.248	0.278	0.426
14	Nigeria	0.853	0.108	0.142
15	Rwanda	0.960	0.125	0.744
16	Sierra Leone	1.062	0.258	0.814
17	Tanzania	0.905	0.111	0.368
18	Togo	0.869	0.142	0.326
19	Uganda	0.992	0.133	0.951
20	Zambia	0.927	0.070	0.277
21	Zimbabwe	0.984	0.102	0.877

A.2 Stratified analysis

Table A.17: Spouse ever humiliated her given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	1.131	0.207	0.554
2	Cameroon	0.819	0.205	0.331
3	Comoros	1.048	0.422	0.912
4	Dem. Rep. Congo	1.042	0.153	0.790
5	Côte d'Ivoire	0.912	0.214	0.669
6	Gabon	0.749	0.252	0.253
7	Gambia	2.115	0.747	0.317
8	Ghana	0.641	0.282	0.116
9	Kenya	1.105	0.239	0.677
10	Malawi	0.897	0.205	0.598
11	Mali	0.849	0.247	0.509
12	Mozambique	1.072	0.131	0.596
13	Namibia	1.867	0.539	0.248
14	Nigeria	0.760	0.137	0.045
15	Sierra Leone	1.330	0.228	0.212
16	Tanzania	1.031	0.253	0.903
17	Togo	0.970	0.171	0.860
18	Uganda	1.040	0.246	0.872
19	Zambia	1.200	0.169	0.279
20	Zimbabwe	1.052	0.212	0.813

Table A.18: Spouse ever humiliated her given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.737	0.133	0.022
2	Cameroon	1.060	0.126	0.645
3	Comoros	0.848	0.320	0.607
4	Dem. Rep. Congo	1.063	0.106	0.565
5	Côte d'Ivoire	0.747	0.117	0.013
6	Gabon	0.752	0.176	0.106
7	Gambia	0.985	0.441	0.973
8	Ghana	1.114	0.158	0.496
9	Kenya	1.270	0.126	0.057
10	Malawi	1.044	0.144	0.764
11	Mali	1.141	0.218	0.546
12	Mozambique	1.065	0.107	0.555
13	Namibia	0.678	0.250	0.121
14	Nigeria	1.051	0.088	0.572
15	Sierra Leone	0.717	0.114	0.003
16	Tanzania	1.090	0.121	0.474
17	Togo	1.100	0.089	0.282
18	Uganda	0.890	0.200	0.560
19	Zambia	1.024	0.091	0.792
20	Zimbabwe	0.892	0.129	0.375

Table A.19: Spouse ever threatened her with harm given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.871	0.244	0.570
2	Cameroon	0.624	0.213	0.027
3	Comoros	1.315	0.534	0.609
4	Dem. Rep. Congo	1.131	0.244	0.614
5	Côte d'Ivoire	0.737	0.333	0.360
6	Gabon	0.430	0.303	0.006
7	Gambia	5.082	0.859	0.060
8	Ghana	0.399	0.376	0.015
9	Kenya	1.233	0.207	0.312
10	Malawi	0.919	0.197	0.670
11	Mali	1.177	0.409	0.691
12	Mozambique	1.487	0.296	0.181
13	Namibia	2.092	0.521	0.157
14	Nigeria	0.803	0.208	0.290
15	Sierra Leone	0.882	0.353	0.721
16	Tanzania	1.339	0.376	0.437
17	Togo	0.971	0.242	0.904
18	Uganda	0.803	0.288	0.446
19	Zambia	1.130	0.220	0.578
20	Zimbabwe	0.840	0.206	0.396

Table A.20: Spouse ever threatened her with harm given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.698	0.157	0.022
2	Cameroon	1.296	0.155	0.095
3	Comoros	0.727	0.593	0.591
4	Dem. Rep. Congo	0.902	0.202	0.611
5	Côte d'Ivoire	0.801	0.154	0.151
6	Gabon	0.946	0.208	0.788
7	Gambia	0.846	0.425	0.694
8	Ghana	0.816	0.273	0.456
9	Kenya	1.398	0.167	0.045
10	Malawi	0.926	0.151	0.609
11	Mali	1.072	0.288	0.810
12	Mozambique	0.851	0.196	0.412
13	Namibia	0.743	0.290	0.306
14	Nigeria	1.032	0.111	0.779
15	Sierra Leone	0.654	0.181	0.019
16	Tanzania	0.890	0.150	0.438
17	Togo	1.201	0.145	0.208
18	Uganda	0.817	0.200	0.310
19	Zambia	1.005	0.142	0.972
20	Zimbabwe	0.751	0.155	0.064

Table A.21: Spouse ever insulted her or made her feel bad given she is younger.

	Country	Relative risk	Standard error	P-value
1	Cameroon	0.882	0.153	0.413
2	Comoros	1.362	0.416	0.458
3	Dem. Rep. Congo	1.180	0.143	0.247
4	Gabon	0.753	0.229	0.215
5	Gambia	0.695	0.439	0.408
6	Ghana	0.753	0.194	0.146
7	Kenya	1.118	0.177	0.529
8	Malawi	1.091	0.137	0.522
9	Mali	0.835	0.191	0.345
10	Mozambique	0.960	0.101	0.685
11	Namibia	0.882	0.402	0.756
12	Nigeria	0.845	0.105	0.108
13	Sierra Leone	1.305	0.212	0.210
14	Tanzania	1.333	0.134	0.033
15	Togo	0.905	0.132	0.449
16	Uganda	0.924	0.192	0.683
17	Zambia	0.967	0.141	0.813
18	Zimbabwe	0.969	0.118	0.790

Table A.22: Spouse ever insulted her or made her feel bad given she is older.

	Country	Relative risk	Standard error	P-value
1	Cameroon	1.026	0.095	0.785
2	Comoros	1.202	0.451	0.683
3	Dem. Rep. Congo	1.090	0.100	0.391
4	Gabon	0.856	0.146	0.288
5	Gambia	0.873	0.327	0.677
6	Ghana	0.915	0.122	0.467
7	Kenya	1.161	0.108	0.167
8	Malawi	0.994	0.098	0.950
9	Mali	1.031	0.156	0.846
10	Mozambique	1.116	0.076	0.148
11	Namibia	1.100	0.196	0.625
12	Nigeria	1.028	0.065	0.672
13	Sierra Leone	0.741	0.121	0.013
14	Tanzania	0.929	0.067	0.278
15	Togo	1.210	0.081	0.018
16	Uganda	0.938	0.132	0.626
17	Zambia	1.072	0.083	0.405
18	Zimbabwe	0.906	0.094	0.297

Table A.23: Spouse ever pushed, shook or threw something given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.783	0.270	0.365
2	Cameroon	0.514	0.177	0.000
3	Comoros	0.755	0.568	0.622
4	Dem. Rep. Congo	1.019	0.163	0.908
5	Côte d'Ivoire	0.772	0.225	0.250
6	Gabon	0.664	0.213	0.055
7	Gambia	0.760	0.764	0.720
8	Ghana	0.586	0.441	0.226
9	Kenya	1.219	0.224	0.377
10	Malawi	0.663	0.256	0.109
11	Mali	0.494	0.331	0.033
12	Mozambique	0.864	0.188	0.439
13	Namibia	1.126	0.476	0.803
14	Nigeria	0.627	0.183	0.011
15	Rwanda	1.066	0.287	0.823
16	Sierra Leone	1.053	0.211	0.808
17	Tanzania	0.676	0.191	0.041
18	Togo	1.207	0.265	0.478
19	Uganda	0.634	0.318	0.154
20	Zambia	0.917	0.165	0.599
21	Zimbabwe	1.007	0.195	0.972

Table A.24: Spouse ever pushed, shook or threw something given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.671	0.176	0.023
2	Cameroon	0.950	0.131	0.695
3	Comoros	0.405	0.455	0.047
4	Dem. Rep. Congo	0.935	0.130	0.603
5	Côte d'Ivoire	0.644	0.160	0.006
6	Gabon	0.870	0.163	0.393
7	Gambia	1.148	0.572	0.809
8	Ghana	0.617	0.237	0.042
9	Kenya	1.292	0.151	0.090
10	Malawi	0.802	0.183	0.229
11	Mali	0.793	0.271	0.392
12	Mozambique	1.281	0.186	0.182
13	Namibia	0.606	0.232	0.031
14	Nigeria	0.818	0.126	0.111
15	Rwanda	1.154	0.120	0.232
16	Sierra Leone	0.786	0.156	0.124
17	Tanzania	0.793	0.115	0.043
18	Togo	0.943	0.172	0.734
19	Uganda	0.938	0.201	0.750
20	Zambia	0.830	0.107	0.084
21	Zimbabwe	0.783	0.159	0.125

Table A.25: Spouse ever slapped her given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	1.311	0.193	0.161
2	Cameroon	0.649	0.119	0.000
3	Dem. Rep. Congo	1.174	0.123	0.191
4	Cote d'Ivoire	0.755	0.175	0.109
5	Gabon	0.553	0.219	0.007
6	Gambia	5.220	0.622	0.008
7	Ghana	0.607	0.280	0.075
8	Kenya	1.007	0.150	0.965
9	Malawi	0.854	0.172	0.358
10	Mali	1.227	0.285	0.472
11	Mozambique	1.008	0.110	0.943
12	Namibia	1.305	0.416	0.523
13	Nigeria	0.742	0.142	0.035
14	Rwanda	0.733	0.192	0.107
15	Sierra Leone	1.398	0.147	0.023
16	Tanzania	0.938	0.129	0.620
17	Togo	0.941	0.182	0.737
18	Uganda	0.643	0.225	0.050
19	Zambia	0.888	0.097	0.224
20	Zimbabwe	0.920	0.108	0.442

Table A.26: Spouse ever slapped her given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.630	0.121	0.000
2	Cameroon	0.971	0.115	0.795
3	Dem. Rep. Congo	1.058	0.106	0.591
4	Côte d'Ivoire	0.754	0.123	0.022
5	Gabon	0.793	0.140	0.099
6	Gambia	1.121	0.389	0.769
7	Ghana	0.717	0.172	0.054
8	Kenya	1.215	0.111	0.080
9	Malawi	0.982	0.154	0.904
10	Mali	0.848	0.183	0.368
11	Mozambique	1.149	0.101	0.170
12	Namibia	0.711	0.190	0.072
13	Nigeria	0.878	0.088	0.140
14	Rwanda	1.064	0.094	0.506
15	Sierra Leone	0.767	0.104	0.011
16	Tanzania	0.879	0.068	0.057
17	Togo	1.041	0.120	0.739
18	Uganda	0.874	0.167	0.420
19	Zambia	0.980	0.069	0.769
20	Zimbabwe	0.733	0.107	0.004

Table A.27: Spouse ever punched with fist or something harmful given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.731	0.235	0.184
2	Cameroon	0.774	0.248	0.302
3	Dem. Rep. Congo	1.103	0.256	0.701
4	Côte d'Ivoire	1.041	0.227	0.859
5	Gabon	0.820	0.246	0.420
6	Gambia	1.930	1.122	0.558
7	Ghana	1.123	0.631	0.854
8	Kenya	1.193	0.289	0.542
9	Malawi	0.913	0.275	0.741
10	Mali	0.929	0.413	0.858
11	Mozambique	1.109	0.208	0.620
12	Namibia	1.356	0.525	0.563
13	Nigeria	0.329	0.307	0.000
14	Rwanda	0.904	0.435	0.817
15	Sierra Leone	1.340	0.290	0.313
16	Tanzania	0.853	0.184	0.389
17	Togo	1.196	0.243	0.462
18	Uganda	0.607	0.362	0.170
19	Zambia	0.808	0.185	0.250
20	Zimbabwe	0.939	0.210	0.766

Table A.28: Spouse ever punched with fist or something harmful given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.584	0.152	0.000
2	Cameroon	1.229	0.173	0.233
3	Dem. Rep. Congo	0.873	0.212	0.521
4	Côte d'Ivoire	0.994	0.159	0.968
5	Gabon	0.849	0.247	0.506
6	Gambia	0.427	0.704	0.227
7	Ghana	0.715	0.320	0.295
8	Kenya	1.384	0.186	0.081
9	Malawi	0.971	0.196	0.881
10	Mali	1.149	0.315	0.659
11	Mozambique	0.827	0.157	0.224
12	Namibia	0.887	0.235	0.609
13	Nigeria	0.940	0.210	0.768
14	Rwanda	0.947	0.183	0.766
15	Sierra Leone	0.522	0.241	0.007
16	Tanzania	0.788	0.111	0.031
17	Togo	1.050	0.181	0.789
18	Uganda	0.494	0.237	0.003
19	Zambia	0.961	0.127	0.753
20	Zimbabwe	0.702	0.158	0.025

Table A.29: Spouse ever twisted her arm or pulled her hair given she is younger.

	Country	Relative risk	Standard error	P-value
1	Cameroon	0.769	0.258	0.309
2	Comoros	0.136	0.792	0.012
3	Dem. Rep. Congo	0.759	0.203	0.175
4	Gabon	0.708	0.219	0.116
5	Gambia	1.780	0.912	0.528
6	Ghana	0.478	0.506	0.146
7	Kenya	0.764	0.286	0.347
8	Malawi	0.787	0.325	0.461
9	Mali	0.689	0.438	0.396
10	Mozambique	1.306	0.250	0.285
11	Namibia	1.220	0.489	0.684
12	Nigeria	0.782	0.282	0.384
13	Rwanda	0.783	0.390	0.530
14	Sierra Leone	0.964	0.285	0.897
15	Tanzania	1.268	0.346	0.492
16	Togo	1.125	0.376	0.753
17	Uganda	0.704	0.294	0.234
18	Zambia	0.930	0.242	0.763
19	Zimbabwe	0.929	0.357	0.836

Table A.30: Spouse ever twisted her arm or pulled her hair given she is older.

	Country	Relative risk	Standard error	P-value
1	Cameroon	0.842	0.182	0.345
2	Comoros	0.427	0.694	0.220
3	Dem. Rep. Congo	0.960	0.183	0.825
4	Gabon	1.145	0.229	0.555
5	Gambia	1.190	0.657	0.792
6	Ghana	0.796	0.327	0.486
7	Kenya	1.863	0.293	0.034
8	Malawi	1.503	0.253	0.108
9	Mali	0.783	0.352	0.486
10	Mozambique	1.247	0.210	0.294
11	Namibia	0.395	0.306	0.002
12	Nigeria	0.935	0.201	0.739
13	Rwanda	1.066	0.162	0.692
14	Sierra Leone	0.725	0.221	0.145
15	Tanzania	1.080	0.199	0.697
16	Togo	1.016	0.229	0.944
17	Uganda	1.196	0.280	0.523
18	Zambia	0.901	0.156	0.505
19	Zimbabwe	0.740	0.285	0.292

Table A.31: Spouse ever kicked or dragged her given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.862	0.489	0.762
2	Cameroon	0.474	0.275	0.007
3	Dem. Rep. Congo	1.050	0.326	0.881
4	Côte d'Ivoire	0.945	0.313	0.857
5	Gabon	0.564	0.336	0.089
6	Gambia	4.365	0.762	0.054
7	Ghana	0.839	0.476	0.712
8	Kenya	0.666	0.243	0.096
9	Malawi	0.714	0.248	0.174
10	Mozambique	1.270	0.191	0.212
11	Namibia	1.337	0.508	0.568
12	Nigeria	0.574	0.237	0.019
13	Rwanda	0.942	0.114	0.601
14	Sierra Leone	0.716	0.177	0.060
15	Tanzania	1.028	0.209	0.895
16	Togo	0.771	0.280	0.356
17	Uganda	0.989	0.312	0.971
18	Zambia	0.764	0.186	0.149
19	Zimbabwe	0.775	0.227	0.261

Table A.32: Spouse ever kicked or dragged her given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.641	0.268	0.097
2	Cameroon	0.923	0.202	0.692
3	Dem. Rep. Congo	0.911	0.210	0.658
4	Côte d'Ivoire	0.722	0.271	0.228
5	Gabon	0.927	0.299	0.800
6	Gambia	2.123	0.489	0.124
7	Ghana	0.669	0.254	0.113
8	Kenya	1.571	0.220	0.040
9	Malawi	1.215	0.202	0.334
10	Mozambique	0.894	0.151	0.460
11	Namibia	0.949	0.247	0.833
12	Nigeria	0.979	0.140	0.879
13	Rwanda	1.055	0.054	0.319
14	Sierra Leone	0.678	0.145	0.008
15	Tanzania	0.848	0.128	0.198
16	Togo	0.696	0.229	0.113
17	Uganda	0.775	0.237	0.281
18	Zambia	1.005	0.134	0.968
19	Zimbabwe	0.821	0.178	0.269

Table A.33: Spouse ever tried to strangle or burn her given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.611	0.722	0.495
2	Cameroon	1.013	0.559	0.981
3	Dem. Rep. Congo	0.519	0.597	0.272
4	Côte d'Ivoire	1.513	0.589	0.483
5	Gabon	0.537	0.425	0.144
6	Gambia	0.929	1.159	0.949
7	Kenya	0.900	0.440	0.811
8	Malawi	0.845	0.334	0.614
9	Mali	0.589	0.872	0.544
10	Mozambique	0.484	0.546	0.185
11	Nigeria	1.330	1.081	0.792
12	Rwanda	0.790	0.157	0.133
13	Sierra Leone	1.788	0.498	0.244
14	Tanzania	0.528	0.685	0.352
15	Togo	1.517	0.543	0.443
16	Zambia	1.282	0.355	0.484
17	Zimbabwe	0.722	0.690	0.637

Table A.34: Spouse ever tried to strangle or burn her given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.468	0.538	0.158
2	Cameroon	1.626	0.408	0.234
3	Dem. Rep. Congo	0.479	0.451	0.103
4	Côte d'Ivoire	0.530	0.467	0.174
5	Gabon	0.772	0.387	0.504
6	Gambia	1.439	0.520	0.484
7	Kenya	1.318	0.328	0.400
8	Malawi	1.033	0.279	0.907
9	Mali	0.768	0.618	0.669
10	Mozambique	1.268	0.405	0.558
11	Nigeria	1.189	0.400	0.665
12	Rwanda	0.984	0.078	0.835
13	Sierra Leone	0.653	0.443	0.335
14	Tanzania	0.784	0.274	0.373
15	Togo	1.149	0.424	0.744
16	Zambia	1.098	0.212	0.660
17	Zimbabwe	0.526	0.384	0.094

Table A.35: Spouse ever threatened her with knife/gun or other weapon given she is younger.

	Country	Relative risk	Standard error	P-value
1	Cameroon	0.537	0.991	0.530
2	Dem. Rep. Congo	0.835	0.692	0.795
3	Côte d'Ivoire	0.369	1.117	0.372
4	Gabon	0.367	0.476	0.036
5	Malawi	0.462	0.452	0.088
6	Namibia	0.481	0.724	0.312
7	Nigeria	0.328	0.618	0.072
8	Rwanda	0.934	0.445	0.878
9	Sierra Leone	1.074	0.806	0.929
10	Togo	2.278	0.896	0.359
11	Uganda	1.287	0.566	0.656
12	Zambia	0.851	0.499	0.747
13	Zimbabwe	2.453	0.651	0.169

Table A.36: Spouse ever threatened her with knife/gun or other weapon given she is older.

	Country	Relative risk	Standard error	P-value
1	Cameroon	1.287	0.423	0.551
2	Dem. Rep. Congo	0.807	0.427	0.616
3	Côte d'Ivoire	0.185	0.911	0.064
4	Gabon	1.653	0.408	0.218
5	Malawi	0.793	0.405	0.567
6	Namibia	0.396	0.466	0.047
7	Nigeria	1.207	0.322	0.559
8	Rwanda	1.397	0.225	0.137
9	Sierra Leone	2.840	0.691	0.131
10	Togo	2.457	0.850	0.290
11	Uganda	0.669	0.378	0.289
12	Zambia	0.973	0.260	0.916
13	Zimbabwe	0.305	0.380	0.002

Table A.37: Spouse ever physically forced sex when not wanted given she is younger.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.694	0.415	0.379
2	Cameroon	0.861	0.207	0.469
3	Comoros	0.290	0.880	0.161
4	Dem. Rep. Congo	1.005	0.176	0.979
5	Côte d'Ivoire	1.778	0.487	0.238
6	Gabon	0.747	0.287	0.312
7	Gambia	1.200	0.922	0.844
8	Ghana	1.195	0.657	0.787
9	Kenya	0.818	0.214	0.348
10	Malawi	1.042	0.162	0.799
11	Mali	0.826	0.289	0.509
12	Mozambique	1.116	0.228	0.631
13	Namibia	1.731	0.602	0.363
14	Nigeria	1.069	0.215	0.757
15	Rwanda	1.011	0.239	0.962
16	Sierra Leone	1.468	0.323	0.236
17	Tanzania	1.007	0.210	0.972
18	Togo	1.155	0.306	0.637
19	Uganda	1.216	0.207	0.344
20	Zambia	1.016	0.146	0.912
21	Zimbabwe	1.007	0.171	0.967

Table A.38: Spouse ever physically forced sex when not wanted given she is older.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.645	0.346	0.204
2	Cameroon	1.034	0.161	0.838
3	Comoros	0.619	0.594	0.419
4	Dem. Rep. Congo	0.965	0.160	0.826
5	Côte d'Ivoire	0.749	0.235	0.217
6	Gabon	1.141	0.255	0.606
7	Gambia	2.497	0.889	0.303
8	Ghana	1.073	0.313	0.823
9	Kenya	0.897	0.167	0.515
10	Malawi	0.911	0.137	0.497
11	Mali	1.113	0.227	0.636
12	Mozambique	1.411	0.203	0.089
13	Namibia	1.119	0.320	0.725
14	Nigeria	0.836	0.127	0.159
15	Rwanda	0.944	0.120	0.630
16	Sierra Leone	1.285	0.279	0.369
17	Tanzania	0.857	0.120	0.199
18	Togo	0.813	0.172	0.231
19	Uganda	0.889	0.159	0.461
20	Zambia	0.884	0.081	0.128
21	Zimbabwe	1.028	0.141	0.843

Table A.39: Spouse ever forced other sexual acts when not wanted given she is younger.

	Country	Relative risk	Standard error	P-value
1	Comoros	0.791	1.181	0.843
2	Dem. Rep. Congo	1.152	0.266	0.594
3	Côte d'Ivoire	1.419	0.804	0.663
4	Gambia	0.462	1.463	0.598
5	Ghana	1.079	0.842	0.928
6	Kenya	0.652	0.428	0.319
7	Malawi	0.962	0.238	0.870
8	Mali	0.988	0.458	0.980
9	Mozambique	1.322	0.259	0.283
10	Nigeria	0.699	0.379	0.345
11	Sierra Leone	4.395	0.753	0.050
12	Tanzania	0.838	0.259	0.496
13	Togo	1.279	0.598	0.681
14	Uganda	1.190	0.402	0.665
15	Zambia	1.167	0.275	0.574
16	Zimbabwe	0.794	0.199	0.248

Table A.40: Spouse ever forced other sexual acts when not wanted given she is older.

	Country	Relative risk	Standard error	P-value
1	Comoros	1.030	0.961	0.976
2	Dem. Rep. Congo	0.901	0.194	0.592
3	Côte d'Ivoire	0.486	0.517	0.162
4	Gambia	0.666	1.255	0.746
5	Ghana	0.948	0.420	0.898
6	Kenya	0.869	0.246	0.568
7	Malawi	1.329	0.213	0.181
8	Mali	0.848	0.326	0.614
9	Mozambique	1.317	0.214	0.199
10	Nigeria	1.136	0.257	0.621
11	Sierra Leone	3.657	0.475	0.006
12	Tanzania	0.950	0.171	0.766
13	Togo	0.651	0.425	0.312
14	Uganda	0.791	0.378	0.534
15	Zambia	0.873	0.162	0.399
16	Zimbabwe	0.732	0.181	0.085

Table A.41: Emotional IPV, for younger women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.996	0.189	0.982
2	Cameroon	0.849	0.122	0.179
3	Comoros	1.064	0.367	0.867
4	Dem. Rep. Congo	1.023	0.106	0.828
5	Côte d'Ivoire	0.909	0.198	0.630
6	Gabon	0.711	0.195	0.082
7	Gambia	0.977	0.403	0.955
8	Ghana	0.792	0.176	0.186
9	Kenya	1.187	0.149	0.251
10	Malawi	1.109	0.126	0.411
11	Mali	0.913	0.169	0.591
12	Mozambique	1.012	0.086	0.890
13	Namibia	1.359	0.331	0.354
14	Nigeria	0.862	0.088	0.094
15	Sierra Leone	1.418	0.185	0.059
16	Tanzania	1.246	0.128	0.087
17	Togo	0.913	0.123	0.463
18	Uganda	0.970	0.165	0.854
19	Zambia	0.990	0.112	0.932
20	Zimbabwe	0.965	0.103	0.730

Table A.42: Emotional IPV, for older women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.706	0.118	0.003
2	Cameroon	1.040	0.083	0.639
3	Comoros	1.087	0.289	0.772
4	Dem. Rep. Congo	1.058	0.086	0.515
5	Côte d'Ivoire	0.794	0.109	0.033
6	Gabon	0.845	0.123	0.171
7	Gambia	1.066	0.297	0.831
8	Ghana	0.972	0.106	0.792
9	Kenya	1.245	0.090	0.015
10	Malawi	1.040	0.089	0.661
11	Mali	1.083	0.135	0.556
12	Mozambique	1.085	0.061	0.184
13	Namibia	0.971	0.178	0.868
14	Nigeria	1.024	0.058	0.684
15	Sierra Leone	0.732	0.089	0.000
16	Tanzania	0.945	0.067	0.400
17	Togo	1.128	0.073	0.100
18	Uganda	0.915	0.111	0.422
19	Zambia	1.007	0.067	0.920
20	Zimbabwe	0.908	0.081	0.235

Table A.43: Less severe IPV, for younger women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.993	0.158	0.967
2	Cameroon	0.680	0.098	0.000
3	Comoros	0.736	0.451	0.497
4	Dem. Rep. Congo	1.075	0.109	0.508
5	Côte d'Ivoire	0.752	0.158	0.072
6	Gabon	0.619	0.179	0.008
7	Gambia	2.130	0.720	0.294
8	Ghana	0.797	0.241	0.348
9	Kenya	1.034	0.136	0.809
10	Malawi	0.895	0.154	0.469
11	Mali	0.954	0.217	0.828
12	Mozambique	1.087	0.099	0.398
13	Namibia	1.291	0.342	0.456
14	Nigeria	0.742	0.126	0.018
15	Rwanda	0.791	0.170	0.169
16	Sierra Leone	1.247	0.131	0.092
17	Tanzania	0.932	0.114	0.538
18	Togo	1.021	0.161	0.899
19	Uganda	0.678	0.197	0.049
20	Zambia	0.915	0.089	0.321
21	Zimbabwe	0.917	0.099	0.385

Table A.44: Less severe IPV, for older women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.667	0.103	0.000
2	Cameroon	1.056	0.097	0.575
3	Comoros	0.587	0.369	0.150
4	Dem. Rep. Congo	1.046	0.087	0.605
5	Côte d'Ivoire	0.761	0.108	0.012
6	Gabon	0.824	0.117	0.097
7	Gambia	1.077	0.382	0.846
8	Ghana	0.736	0.156	0.049
9	Kenya	1.186	0.090	0.059
10	Malawi	0.943	0.137	0.670
11	Mali	0.907	0.159	0.541
12	Mozambique	1.128	0.090	0.181
13	Namibia	0.761	0.164	0.096
14	Nigeria	0.883	0.083	0.131
15	Rwanda	1.075	0.081	0.367
16	Sierra Leone	0.801	0.098	0.023
17	Tanzania	0.869	0.061	0.022
18	Togo	1.016	0.111	0.884
19	Uganda	1.006	0.145	0.967
20	Zambia	0.989	0.066	0.867
21	Zimbabwe	0.762	0.094	0.004

Table A.45: Severe IPV, for younger women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.812	0.455	0.647
2	Cameroon	0.509	0.258	0.009
3	Comoros	1.120	0.918	0.902
4	Dem. Rep. Congo	1.198	0.299	0.545
5	Côte d'Ivoire	0.923	0.296	0.788
6	Gabon	0.499	0.310	0.026
7	Gambia	2.329	0.664	0.204
8	Ghana	0.891	0.469	0.806
9	Kenya	0.687	0.237	0.114
10	Malawi	0.723	0.225	0.150
11	Mali	2.118	0.608	0.218
12	Mozambique	1.288	0.184	0.170
13	Namibia	1.232	0.480	0.664
14	Nigeria	0.535	0.252	0.013
15	Rwanda	0.887	0.107	0.262
16	Sierra Leone	0.776	0.176	0.151
17	Tanzania	0.907	0.210	0.642
18	Togo	0.929	0.283	0.796
19	Uganda	1.023	0.277	0.934
20	Zambia	0.811	0.175	0.233
21	Zimbabwe	0.818	0.218	0.356

Table A.46: Severe IPV, for older women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.671	0.258	0.122
2	Cameroon	1.001	0.184	0.998
3	Comoros	1.774	0.780	0.462
4	Dem. Rep. Congo	0.831	0.198	0.350
5	Côte d'Ivoire	0.664	0.234	0.080
6	Gabon	0.857	0.241	0.523
7	Gambia	1.586	0.360	0.200
8	Ghana	0.715	0.235	0.154
9	Kenya	1.541	0.209	0.038
10	Malawi	1.128	0.187	0.518
11	Mali	1.240	0.412	0.602
12	Mozambique	1.008	0.142	0.956
13	Namibia	0.799	0.224	0.318
14	Nigeria	0.953	0.133	0.720
15	Rwanda	1.044	0.049	0.376
16	Sierra Leone	0.712	0.142	0.017
17	Tanzania	0.862	0.125	0.236
18	Togo	0.737	0.222	0.169
19	Uganda	0.733	0.206	0.131
20	Zambia	1.030	0.127	0.815
21	Zimbabwe	0.798	0.159	0.156

Table A.47: Sexual IPV, for younger women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.670	0.396	0.313
2	Cameroon	0.861	0.207	0.469
3	Comoros	0.328	0.771	0.149
4	Dem. Rep. Congo	1.037	0.164	0.827
5	Côte d'Ivoire	1.917	0.485	0.181
6	Gabon	0.685	0.285	0.185
7	Gambia	1.361	0.908	0.735
8	Ghana	1.618	0.553	0.385
9	Kenya	0.744	0.204	0.149
10	Malawi	1.058	0.155	0.718
11	Mali	0.860	0.277	0.586
12	Mozambique	1.231	0.219	0.343
13	Namibia	1.853	0.591	0.297
14	Nigeria	1.007	0.198	0.972
15	Rwanda	1.011	0.239	0.962
16	Sierra Leone	1.420	0.327	0.284
17	Tanzania	0.932	0.201	0.726
18	Togo	1.043	0.299	0.889
19	Uganda	1.171	0.197	0.422
20	Zambia	1.018	0.144	0.903
21	Zimbabwe	0.986	0.143	0.923

Table A.48: Sexual IPV, for older women.

	Country	Relative risk	Standard error	P-value
1	Burkina Faso	0.662	0.345	0.232
2	Cameroon	1.034	0.161	0.838
3	Comoros	0.812	0.577	0.718
4	Dem. Rep. Congo	0.958	0.140	0.757
5	Côte d'Ivoire	0.680	0.197	0.050
6	Gabon	1.168	0.240	0.518
7	Gambia	2.685	0.885	0.265
8	Ghana	1.131	0.296	0.677
9	Kenya	0.900	0.165	0.523
10	Malawi	0.930	0.132	0.581
11	Mali	1.132	0.213	0.559
12	Mozambique	1.356	0.179	0.089
13	Namibia	1.070	0.305	0.824
14	Nigeria	0.880	0.122	0.294
15	Rwanda	0.944	0.120	0.630
16	Sierra Leone	1.456	0.276	0.173
17	Tanzania	0.872	0.117	0.242
18	Togo	0.816	0.172	0.236
19	Uganda	0.924	0.153	0.603
20	Zambia	0.905	0.080	0.212
21	Zimbabwe	0.967	0.124	0.786

List of references

Abramsky, T., Watts, C.H., Garcia-Moreno, C., Devries, K., Kiss, L., Ellsberg, M., Jansen, H.A. & Heise, L. 2011. What factors are associated with recent intimate partner violence? findings from the who multi-country study on women's health and domestic violence. *BMC public health*, 11(1):109.

Agresti, A. 1996. *Categorical data analysis*, volume 990. New York: John Wiley & Sons.

Alio, A.P., Salihu, H.M., Nana, P.N., Clayton, H.B., Mbah, A.K. & Marty, P.J. 2011. Association between intimate partner violence and induced abortion in Cameroon. *International Journal of Gynecology & Obstetrics*, 112(2):83–87.

Andersson, N., Ho-Foster, A., Mitchell, S., Scheepers, E. & Goldstein, S. 2007. Risk factors for domestic physical violence: national cross-sectional household surveys in eight Southern African countries. *BMC Women's Health*, 7(1):1.

Antai. 2008 (accessed December 11, 2016). Attitudes of women toward intimate partner violence: a study of rural women in Nigeria . http://www.rrh.org.au/articles/subviewnew.asp?articleid=996.

Antai, D. 2011. Traumatic physical health consequences of intimate partner violence against women: what is the role of community-level factors? *BMC women's health*, 11(1):1.

Babalola, S., Gill-Bailey, A. & Dodo, M. 2014. Prevalence and correlates of experience of physical and sexual intimate partner violence among men and women in Eastern DRC. *Universal Journal of Public Health*, 2(1):25–33.

Barendregt, J.J., Doi, S.A., Lee, Y.Y., Norman, R.E. & Vos, T. 2013. Meta-analysis of prevalence. *Journal of epidemiology and community health*, 67(11):974–978.

Barnawi, F.H. 2015. Prevalence and risk factors of domestic violence against women attending a primary care center in Riyadh, Saudi Arabia. *Journal of interpersonal violence*, page 0886260515587669.

Bazargan-Hejazi, S., Medeiros, S., Mohammadi, R., Lin, J. & Dalal, K. 2012. Patterns of intimate partner violence: a study of female victims in Malawi. *Journal of Injury and Violence Research*, 5(1):38–50.

Beauclair, R. & Delva, W. 2013. Is younger really safer? a qualitative study of perceived risks and benefits of age-disparate relationships among women in cape town, south africa. *PloS one*, 8(11):e81748.

Bland, J.M. & Altman, D.G. 2000. The odds ratio. *British Medical Journal*, 320(7247):1468.

Blizzard, L. & Hosmer, W. 2006. Parameter estimation and goodness-of-fit in log binomial regression. *Biometrical Journal*, 48(1):5–22.

Bonomi, A.E., Thompson, R.S., Anderson, M., Reid, R.J., Carrell, D., Dimer, J.A. & Rivara, F.P. 2006. Intimate partner violence and women's physical, mental, and social functioning. *American journal of preventive medicine*, 30(6):458–466.

Borenstein, M., Hedges, L., Higgins, J. & Rothstein, H. 2009. *Introduction to Meta-Analysis*. Statistics in practice. Wiley. ISBN 9780470743379.
Available at: https://books.google.co.za/books?id=jr0ivWoZwr8C

Borwankar, R., Diallo, R. & Sommerfelt, A.E. 2008. Gender-based violence in Sub-Saharan Africa: a review of Demographic and Health Survey findings and their use in national planning. *Academy for Educational Development [AED], Africa's Health in 2010*.

Breiding, M.J., Black, M.C. & Ryan, G.W. 2008. Prevalence and risk factors of intimate partner violence in eighteen US states/territories, 2005. *American journal of preventive medicine*, 34(2):112–118.

Campbell, J.C. 2002. Health consequences of intimate partner violence. *The Lancet*, 359(9314):1331–1336.

Campbell, J.C. & Soeken, K.L. 1999. Forced sex and intimate partner violence effects on women's risk and women's health. *Violence against women*, 5(9):1017–1035.

Coker, A.L., Smith, P.H., McKeown, R.E. & King, M.J. 2000. Frequency and correlates of intimate partner violence by type: physical, sexual, and psychological battering. *American journal of public health*, 90(4):553.

Cronholm, P.F., Fogarty, C.T., Ambuel, B. & Harrison, S.L. 2011. Intimate partner violence. *American family physician*, 83(10):1165–1172.

Crowell, N.A., Burgess, A.W. *et al.*. 1996. *Understanding violence against women*. National Academies Press.

Davies, H.T.O., Crombie, I.K. & Tavakoli, M. 1998. When can odds ratios mislead? *British Medical Journal*, 316(7136):989–991.

DHS. 2001 (accessed December 7, 2016). Ethical and Safety Guidelines for Implementing the DHS Domestic Violence Module. http://dhsprogram.com/topics/gender-Corner/upload/DHS_Domestic_Violence_Module_Ethical_Guidelines.pdf.

DHS. 2012 (accessed December 3, 2016). Sampling and Household Listing Manual. https://dhsprogram.com/pubs/pdf/DHSM4/DHS6_Sampling_Manual_Sept2012_DHSM4.pdf.

DHS. 2013 (accessed December 7, 2016). Standard Recode Manual. http://www.dhsprogram.com/pubs/pdf/DHSG4/Recode6_DHS_22March2013_DHSG4.pdf.

Diaz-Quijano, F.A. 2012. A simple method for estimating relative risk using logistic regression. *BMC medical research methodology*, 12(1):14.

Emenike, E., Lawoko, S. & Dalal, K. 2008. Intimate partner violence and reproductive health of women in Kenya. *International nursing review*, 55(1):97–102.

Fageeh, W.M. 2014. Factors associated with domestic violence: a cross-sectional survey among women in Jeddah, Saudi Arabia. *British Medical Journal open*, 4(2):e004242.

Gage, A.J. 2005. Women's experience of intimate partner violence in Haiti. *Social science & medicine*, 61(2):343–364.

García-Moreno, C. 2013. *Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence*. World Health Organization.

Garcia-Moreno, C., Jansen, H.A., Ellsberg, M., Heise, L., Watts, C.H. *et al.*. 2006. Prevalence of intimate partner violence: findings from the who multi-country study on women's health and domestic violence. *The Lancet*, 368(9543):1260–1269.

Greenland, S. 1987. Interpretation and choice of effect measures in epidemiologic analyses. *American journal of epidemiology*, 125(5):761–768.

Gregson, S., Nyamukapa, C.A., Garnett, G.P., Mason, P.R., Zhuwau, T., Caraël, M., Chandiwana, S.K. & Anderson, R.M. 2002. Sexual mixing patterns and sex-differentials in teenage exposure to HIV infection in rural Zimbabwe. *The Lancet*, 359(9321):1896–1903.

Hardin, J., Hilbe, J. & Hilbe, J. 2007. *Generalized Linear Models and Extensions, Second Edition*. A Stata Press publication. Taylor & Francis. ISBN 9781597180146. Available at: https://books.google.co.za/books?id=tOeqO6Hs-6gC

Hedges, L.V. & Vevea, J.L. 1998. Fixed-and random-effects models in meta-analysis. *Psychological methods*, 3(4):486.

Heise, L., Ellsberg, M. & Gottemoeller, M. 1999. Ending violence against women. *Population Reports*, 27(4):1–1.

Heise, L. & Garcia-Moreno, C. 2002. Violence by intimate partners. *World Health Organization*.

Hindin, M.J., Kishor, S. & Ansara, D.L. 2008. Intimate partner violence among couples in 10 dhs countries: predictors and health outcomes. *Demographic and Health Surveys report*.

Hosmer, D. & Lemeshow, S. 2000. *Applied Logistic Regression*. A Wiley-Interscience publication. Wiley. ISBN 9780471356325. Available at: https://books.google.co.za/books?id=zW9sngEACAAJ

Janani, L., Mansournia, M.A., Nourijeylani, K., Mahmoodi, M. & Mohammad, K. 2015. Statistical issues in estimation of adjusted risk ratio in prospective studies. *Archives of Iranian Medicine (AIM)*, 18(10).

Jewkes, R. 2002. Intimate partner violence: causes and prevention. *The Lancet*, 359(9315):1423–1429.

Jewkes, R., Levin, J. & Penn-Kekana, L. 2002. Risk factors for domestic violence: findings from a South African cross-sectional study. *Social science & medicine*, 55(9):1603–1617.

Jones, A.P., Riley, R.D., Williamson, P.R. & Whitehead, A. 2009. Meta-analysis of individual patient data versus aggregate data from longitudinal clinical trials. *Clinical Trials*, 6(1):16–27.

Jones, J.H. & Ferguson, B. 2009. Demographic and social predictors of intimate partner violence in Colombia. *Human Nature*, 20(2):184–203.

Karamagi, C.A., Tumwine, J.K., Tylleskar, T. & Heggenhougen, K. 2006. Intimate partner violence against women in eastern Uganda: implications for HIV prevention. *BMC public health*, 6(1):1.

Katz, K.A. 2006. The (relative) risks of using odds ratios. *Archives of dermatology*, 142(6):761–764.

Kelly, R.J., Gray, R.H., Sewankambo, N.K., Serwadda, D., Wabwire-Mangen, F., Lutalo, T. & Wawer, M.J. 2003. Age differences in sexual partners and risk of HIV-1 infection in rural Uganda. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 32(4):446–451.

Kishor, S. 2005 (accessed December 7, 2016). Violence against women: a statistical overview, challenges and gaps in data collection and methodology and approaches for overcoming them. http://www.un.org/womenwatch/daw/egm/vaw-stat-2005/docs/expert-papers/Kishor.pdf.

Kishor, S. & Johnson, K. 2004. Profiling domestic violence: a multi-country study. *Demographic and Health Survey report*.

Klomegah, R.Y. 2008. Intimate partner violence (IPV) in Zambia: An examination of risk factors and gender perceptions. *Journal of Comparative Family Studies*, pages 557–569.

Koenig, M.A., Lutalo, T., Zhao, F., Nalugoda, F., Kiwanuka, N., Wabwire-Mangen, F., Kigozi, G., Sewankambo, N., Wagman, J., Serwadda, D. *et al.*. 2004. Coercive sex in rural Uganda: prevalence and associated risk factors. *Social Science & Medicine*, 58(4):787–798.

Koenig, M.A., Lutalo, T., Zhao, F., Nalugoda, F., Wabwire-Mangen, F., Kiwanuka, N., Wagman, J., Serwadda, D., Wawer, M. & Gray, R. 2003. Domestic violence in rural Uganda: evidence from a community-based study. *Bulletin of the World Health Organization*, 81(1):53–60.

Kouyoumdjian, F.G., Calzavara, L.M., Bondy, S.J., OâĂŹCampo, P., Serwadda, D., Nalugoda, F., Kagaayi, J., Kigozi, G., Wawer, M. & Gray, R. 2013. Risk factors for intimate partner violence in women in the Rakai Community Cohort Study, Uganda, from 2000 to 2009. *BMC Public Health*, 13(1):1.

Lawoko, S., Dalal, K., Jiayou, L. & Jansson, B. 2007. Social inequalities in intimate partner violence: a study of women in Kenya. *Violence and victims*, 22(6):773–784.

Lee, J. 1994. Odds ratio or relative risk for cross-sectional data? *International Journal of Epidemiology*, 23(1):201–203.

Lindsey, J. 2008. *Applying Generalized Linear Models*. Springer Texts in Statistics. Springer New York. ISBN 9780387227306.
Available at: https://books.google.co.za/books?id=QBnoBwAAQBAJ

Lohr, S.L. 2010. *Sampling: design and analysis*. Boston, Mass.

Luke, N., Schuler, S.R., Mai, B.T.T., Thien, P.V. & Minh, T.H. 2007. Exploring couple attributes and attitudes and marital violence in Vietnam. *Violence Against Women*, 13(1):5–27.

Lumley, T. 2011. *Complex surveys: a guide to analysis using R*, volume 565. John Wiley & Sons.

Lumley, T., Kronmal, R. & Ma, S. 2006. Relative risk regression in medical research: models, contrasts, estimators, and algorithms. *UW Biostatistics Working Paper Series*.

Mannell, J. & Jackson, S. 2014. Intimate partner violence in Rwanda: Women's voices. *Health, Community and Development Group, Department of Social Psychology, London School of Economics and Political Science*.

Marín-Martínez, F. & Sánchez-Meca, J. 2010. Weighting by inverse variance or by sample size in random-effects meta-analysis. *Educational and Psychological Measurement*, 70(1):56–73.

Mayhew, S., Watts, C. & Lee, K. 2002. Global rhetoric and individual realities: linking violence against women and reproductive health. *Health policy in a globalising world*, pages 159–180.

Mazza, D., Dennerstein, L. & Ryan, V. 1996. Physical, sexual and emotional violence against women: a general practice-based prevalence study. *Medical journal of Australia*, 164(1):14–16.

McCloskey, L.A., Williams, C. & Larsen, U. 2005. Gender inequality and intimate partner violence among women in Moshi, Tanzania. *International family planning perspectives*, pages 124–130.

McCullagh, P. & Nelder, J. 1989. *Generalized Linear Models, Second Edition*. Chapman & Hall/CRC Monographs on Statistics & Applied Probability. Taylor & Francis. ISBN

9780412317606.
Available at: https://books.google.co.za/books?id=h9kFH2_FfBkC

McNutt, L.-A., Hafner, J.-P. & Xue, X. 1999. Correcting the odds ratio in cohort studies of common outcomes. *The JAMA Network*, 282(6):529–529.

Nathanson, B.H. & Higgins, T.L. 2008. An introduction to statistical methods used in binary outcome modeling. In *Seminars in cardiothoracic and vascular anesthesia*, volume 12, pages 153–166. SAGE Publications Sage CA: Los Angeles, CA.

Novick, G. 2008. Is there a bias against telephone interviews in qualitative research? *Research in nursing & health*, 31(4):391–398.

Ogland, E.G., Xu, X., Bartkowski, J.P. & Ogland, C.P. 2014. Intimate Partner Violence against married women in Uganda. *Journal of Family Violence*, 29(8):869–879.

Parish, W.L., Wang, T., Laumann, E.O., Pan, S. & Luo, Y. 2004. Intimate partner violence in china: national prevalence, risk factors and associated health problems. *International family planning perspectives*, pages 174–181.

Pelser, E., Gondwe, L., Mayamba, C., Mhango, T., Phiri, W. & Burton, P. 2005. Intimate partner violence. *The Institute for Security Studies*.

Peterman, A., Palermo, T. & Bredenkamp, C. 2011. Estimates and determinants of sexual violence against women in the Democratic Republic of Congo. *American Journal of Public Health*, 101(6):1060–1067.

Pfeffermann, D. 1993. The role of sampling weights when modeling survey data. *International Statistical Review/Revue Internationale de Statistique*, pages 317–337.

Riley, R.D., Lambert, P.C. & Abo-Zaid, G. 2010. Meta-analysis of individual participant data: rationale, conduct, and reporting. *British Medical Journal*, 340:c221.

Roman, N.V. & Frantz, J.M. 2013. The prevalence of intimate partner violence in the family: a systematic review of the implications for adolescents in Africa. *Family Practice*, 30(3):256–265.

Saltzman, L.E., Fanslow, J.L., McMahon, P.M. & Shelley, G.A. 1999. Intimate partner violence surveillance: Uniform definitions and recommended data elements, version 1.0. *National Criminal Justice Reference Services*.

Schmidt, C.O. & Kohlmann, T. 2008. When to use the odds ratio or the relative risk? *International journal of public health*, 53(3):165–167.

Schulman, K.A., Berlin, J.A., Harless, W., Kerner, J.F., Sistrunk, S., Gersh, B.J., Dube, R., Taleghani, C.K., Burke, J.E., Williams, S. *et al.*. 1999. The effect of race and sex on physicians' recommendations for cardiac catheterization. *New England Journal of Medicine*, 340(8):618–626.

Seber, G. & Lee, A. 2012. *Linear Regression Analysis*. Wiley Series in Probability and Statistics. Wiley. ISBN 9781118274422.
Available at: https://books.google.co.za/books?id=X2Y6OkXl8ysC

Shamu, S., Abrahams, N., Temmerman, M., Musekiwa, A. & Zarowsky, C. 2011. A systematic review of African studies on intimate partner violence against pregnant women: prevalence and risk factors. *PloS One*, 6(3):e17591.

Straus, M.A., Hamby, S.L., Boney-McCoy, S. & Sugarman, D.B. 1996. The revised Conflict Tactics Scales (CTS2) development and preliminary psychometric data. *Journal of family issues*, 17(3):283–316.

Tang, C.S.-k. 1999. Wife abuse in Hong Kong Chinese families: A community survey. *Journal of Family Violence*, 14(2):173–191.

Tang, C.S.-K. & Lai, B.P.-Y. 2008. A review of empirical literature on the prevalence and risk markers of male-on-female intimate partner violence in contemporary china, 1987–2006. *Aggression and Violent Behavior*, 13(1):10–28.

Tankink, M.T. & Slegh, H. 2016. Living Peace in Democratic Republic of the Congo: An Intervention With Male Partners of Women Survivors of Conflict-Related Rape and Intimate Partner Violence. *PromundoâĂŞUS*.

Thompson, R.S., Bonomi, A.E., Anderson, M., Reid, R.J., Dimer, J.A., Carrell, D. & Rivara, F.P. 2006. Intimate partner violence: prevalence, types, and chronicity in adult women. *American journal of preventive medicine*, 30(6):447–457.

Tierney, J.F., Pignon, J.-P., Gueffyier, F., Clarke, M., Askie, L., Vale, C.L., Burdett, S. & Group, C.I.M.-a.M. 2015. How individual participant data meta-analyses have influenced trial design, conduct, and analysis. *Journal of clinical epidemiology*, 68(11):1325–1335.

Tlapek, S.M. 2014. WomenâĂŹs status and intimate partner violence in the Democratic Republic of Congo. *Journal of interpersonal violence*, page 0886260514553118.

Tumwesigye, N.M., Kyomuhendo, G.B., Greenfield, T.K. & Wanyenze, R.K. 2012. Problem drinking and physical intimate partner violence against women: evidence from a national survey in Uganda. *BMC Public Health*, 12(1):1.

Umubyeyi, A., Mogren, I., Ntaganira, J. & Krantz, G. 2014. Women are considerably more exposed to intimate partner violence than men in Rwanda: results from a population-based, cross-sectional study. *BMC women's health*, 14(1):1.

Viechtbauer, W. 2010. Conducting meta-analyses in r with the metafor package. *Journal of Statistical Software*, 36(3):1–48.

Walton-Moss, B.J., Manganello, J., Frye, V. & Campbell, J.C. 2005. Risk factors for intimate partner violence and associated injury among urban women. *Journal of community health*, 30(5):377–389.

Watts, C., Keogh, E., Ndlovu, M. & Kwaramba, R. 1998. Withholding of sex and forced sex: dimensions of violence against Zimbabwean women. *Reproductive Health Matters*, 6(12):57–65.

Watts, C. & Mayhew, S. 2004. Reproductive health services and intimate partner violence: shaping a pragmatic response in Sub-Saharan Africa. *International Family Planning Perspectives*, 30(4):207–213.

Wedderburn, R. 1976. On the existence and uniqueness of the maximum likelihood estimates for certain generalized linear models. *Biometrika*, pages 27–32.

WHO. 2012. Understanding and addressing violence against women: Intimate partner violence. *World Health Organization*.

Williamson, T., Eliasziw, M. & Fick, G.H. 2013. Log-binomial models: exploring failed convergence. *Emerging themes in epidemiology*, 10(1):14.

Xu, X., Zhu, F., O'Campo, P., Koenig, M.A., Mock, V. & Campbell, J. 2005. Prevalence of and risk factors for intimate partner violence in china. *American journal of public health*, 95(1):78–85.

Yelland, L.N., Salter, A.B. & Ryan, P. 2011. Performance of the modified poisson regression approach for estimating relative risks from clustered prospective data. *American journal of epidemiology*, page kwr183.

Zablotska, I.B., Gray, R.H., Koenig, M.A., Serwadda, D., Nalugoda, F., Kigozi, G., Sewankambo, N., Lutalo, T., Mangen, F.W. & Wawer, M. 2009. Alcohol use, intimate partner violence, sexual coercion and hiv among women aged 15–24 in rakai, uganda. *AIDS and Behavior*, 13(2):225–233.

Zhang, J. & Kai, F.Y. 1998. What's the relative risk?: A method of correcting the odds ratio in cohort studies of common outcomes. *The Jama Network*, 280(19):1690–1691.

Zou, G. 2004. A modified poisson regression approach to prospective studies with binary data. *American journal of epidemiology*, 159(7):702–706.