Intergenerational effects: child and maternal outcomes related to exposure to intimate partner violence and trauma in a South African community.

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Abstract

Intimate partner violence (IPV) constitutes a major global health problem, affecting one in three women worldwide at some point during their life. IPV is particularly high in low and middle income countries (LMICs) and is associated with a wide range of adverse maternal and child health outcomes. Despite evidence that exposure to IPV affects child development and growth at birth and in infancy, there are limitations to our existing knowledge. First, few studies have considered the impact of maternal emotional IPV separately on child outcomes investigated, focusing primarily on physical and/or sexual IPV. Second, much of the existing data derives from high income countries, rather than from LMIC settings, where the majority of the world's child population lives and where many children are exposed to disproportionately high levels of poverty and violence-related risk factors. Third, there is limited information from well characterized longitudinal studies in these settings and a lack of investigation of associations in very young children, despite the fact that children under 2 years may be particularly at risk for long-term health sequelae relating to IPV exposure. Lastly, few studies have formally investigated potential mediators, inclusive of both behavioral and biological mechanisms underlying associations between IPV and food security and early-life child growth or development. In high-risk settings such as South Africa it is critical to gain improved understanding of pathways by which violence affects child health. This may be especially important given that LMIC contexts often have fewer programs in place to address IPV, and that associated mental health issues and risk factors may be different than in higher income countries.

This thesis aimed to investigate IPV in a South African birth cohort, the Drakenstein Child Health Cohort, to understand better the patterns of IPV amongst pregnant and postpartum women, the impact antenatal and postnatal IPV exposure may have on their child's growth and development, and the pathways by which IPV may impact child health sequelae. Chapter 1 reviews the relevant literature, discusses key gaps and presents thesis aims and structure. Chapter 2 comprises a methods chapter which provides an overview of the study population, measures and ethical considerations. Chapter 3 (Paper 1) presents longitudinal profiles of maternal IPV exposure by sub-type from pregnancy through 24 months post-partum and

associations between maternal childhood maltreatment and longitudinal frequency and severity of IPV. Chapter 4 (Paper 2) investigates the association between maternal childhood trauma as well as IPV and food insecurity among pregnant women, and examines whether maternal depression mediates these relationships. Chapter 5 (Paper 3) investigates associations between IPV sub-types and growth at birth and 12 months. Further, multiple psychosocial (substance use, depression) and clinical factors (number of hospitalizations) are tested to determine whether any of these may be mediators in the relationship between IPV and child growth. Chapter 6 (Paper 4) investigates emotional, physical and sexual IPV and their relationship with child development at 24 months of age, and whether depression or maternal alcohol dependence mediates these relationships. Chapter 7 presents a summary of findings across results chapters and includes recommendations for future policy and research.

Key findings in this population show that: i) a high proportion of mothers are exposed to chronic IPV during and after pregnancy and that maternal childhood abuse or neglect is associated with higher frequency and severity of IPV exposure; ii) maternal IPV and childhood trauma are each associated with food insecurity during pregnancy and that depression partially explains these relationships; iii) emotional and physical IPV are associated with reduced fetal growth and reduced growth through infancy, and maternal substance use (alcohol or tobacco) partially explains these relationships; iv) both emotional and physical IPV are associated with poorer child development at 2 years, and neither maternal current depression nor alcohol dependence explain these relationships.

Overall, the findings highlight that emotional IPV in addition to physical IPV is a key risk factor for child growth and development, and identify potential pathways underlying explored relationships. Maternal depression and substance use emerged as partial explanatory variables for nutritional outcomes, specifically food insecurity during pregnancy and growth outcomes at birth and through infancy. The high prevalence of IPV and its negative impact on child health, together comprise a major public health problem, causing significant hardship and representing a significant burden for families, economies and health systems. Findings presented in this thesis suggest that comprehensive and intersectoral programs are needed to

address IPV and associated adverse child health outcomes, inclusive of efforts to address maternal mental health and substance use. Further, it is also vital to ensure emotional IPV is included in training and intervention efforts. Clinical implications and areas for future research are discussed.

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Declaration

This thesis is presented in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the Department of Psychiatry and Mental Health, Faculty of Health Sciences, University of Cape Town. The work included in this thesis is original research and has not, in whole or in part, been submitted for another degree at this or any other university. The contents of this thesis are entirely my own work or, in the case of multi-authored papers, constitutes work for which I was the lead author. My contribution to multi-authored papers is outlined at the beginning of each results chapter.

I confirm that I have been granted permission by the University of Cape Town's Doctoral Degrees Board to include the following publication(s) in my PhD thesis, and where co-authorships are involved, my co-authors have agreed that I may include the publication(s). The following manuscripts (two published and two submitted) are included in the thesis and are presented as self-contained chapters in the following order:

1. Barnett W, Halligan S, Heron J, Fraser A, Koen N, Zar HJ, Donald KA, Stein DJ. Maltreatment in childhood and intimate partner violence: A latent class growth analysis in a South African pregnancy cohort. *Child Abuse Negl* 2018; **86**: 336-48. doi: 10.1016/j.chiabu.2018.08.020.
2. Barnett W, Pellowski J, Kuo C, Koen N, Donald KA, Zar HJ, Stein DJ. Food-insecure pregnant women in South Africa: a cross-sectional exploration of maternal depression as a mediator of violence and trauma risk factors. *BMJ open* 2019; **9**(3): e018277. doi: 10.1136/bmjopen-2017-018277.
3. Barnett W, Halligan SL, Nhapi R, Pellowski J, Zar HJ, Donald KA, Stein DJ. Intimate Partner Violence and growth outcomes through infancy: a longitudinal investigation of multiple mediators in a South African birth cohort. *Lancet Child Adolesc Health*, submitted.
4. Barnett W, Halligan SL, Wedderburn CJ, Fraser A, MacGinty R, Hoffman N, Zar HJ, Stein DJ, Donald KA. Maternal emotional and physical intimate partner violence and

early child development: investigating mediators in a cross sectional study in a South African birth cohort. *BMJ Open*, submitted.

At the time of examination, not all publications were in their final published form. The versions submitted for examination are included here. Consistent with University of Cape Town guidelines, the text of each paper is presented verbatim within this thesis. As such, there are minor discrepancies in terminology between papers; these have not been changed in order to reflect the publications. Minor changes have been made to spelling, style and to figure and table numbers to ensure consistency throughout this thesis.

My contribution to each manuscript is outlined at the start of each chapter; I was the lead and corresponding author on all manuscripts, prepared the datasets for analysis, conducted all analyses (with statistical advice provided as indicated in each results chapter) and drafted all versions of the manuscripts. All co-authors reviewed and approved the submitted manuscripts. Supervisors have confirmed to the University of Cape Town Doctoral Degrees Board that the included papers all overwhelmingly reflect the candidates own scientific work.

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Abbreviations & Style

Where chapters of this thesis have been previously published, I have made minor adjustments to the spelling, format and referencing of the original manuscripts in order to maintain consistency, connectedness and clarity throughout this body of work.

AIC:	Akaike Information Criterion
ANC:	Antenatal clinic
aOR:	Adjusted Odds Ratio
ASSIST:	Alcohol, Smoking and Substance Involvement Screening Test
BSID-III:	Bayley Scales of Infant and Toddler Development, Third Edition
BDI-II:	Beck Depression Inventory II
CI:	Confidence interval
CTQ:	Childhood Trauma Questionnaire
DALYs:	Disability adjusted life years
DCHS:	Drakenstein Child Health Study
DOH:	Department of Health
ECD:	Early Childhood Development
EPDS:	Edinburgh Postnatal Depression Rating Scale
FI:	Food insecurity
GCP:	Good Clinical Practice
GMM:	Growth Mixture modeling
HC:	Head circumference
HCAZ:	Head-circumference-for-age z-score
HIC:	High income countries
HIV:	Human immunodeficiency virus
HPA:	Hypothalamic-pituitary-adrenal
IPV:	Intimate Partner Violence
IPVQ:	Intimate Partner Violence Questionnaire
LBW:	Low birthweight
LCA:	Latent class analysis
LCGA:	Latent class growth analysis
LFAZ:	Length-for-age z scores
LMIC:	Low-and middle-income countries

LTFU:	Lost to follow-up
MICE:	Multiple imputation with chained equations
MRC:	Medical Research Council
OR:	Odds ratio
PAF:	Population attributable fraction
PTSD:	Post traumatic stress disorder
SASH:	South African Stress and Health Study
SE:	Standard errors
SES:	Socioeconomic status
SEM:	Structural equation model
SRQ-20:	Self reporting questionnaire 20
ssaBIC:	sample size adjusted Bayesian Information Criterion
UNICEF:	United Nations Children's Fund
WFAZ:	Weight-for-age z-score
WHO:	World Health Organization

Table of Contents

List of tables

List of figures

List of supplemental materials

Chapter 1: Background and introduction

This introductory chapter presents prevalence data on IPV globally as well as in South Africa, contextualising the unique sociocultural and historical factors underlying violence in the South African setting. Definitions of IPV and assumptions relating to the measurement of IPV in this thesis are discussed. A conceptual framework underpinning this thesis is presented, highlighting the complexity of interrelated factors explored and introducing potential underlying mechanisms in the relationships between IPV and child health outcomes. Further, this chapter summarizes existing literature investigating maternal IPV and food insecurity in pregnancy, growth at birth and through infancy and early-life child development, highlighting gaps in the literature. Finally, aims and structure of this thesis are presented.

1.1 Introduction

Intimate partner violence (IPV) includes "any behavior within an intimate relationship that causes physical, psychological or sexual harm to those in the relationship".[1] Globally, prevalence of IPV is high, representing a significant human rights issue as well as a threat to

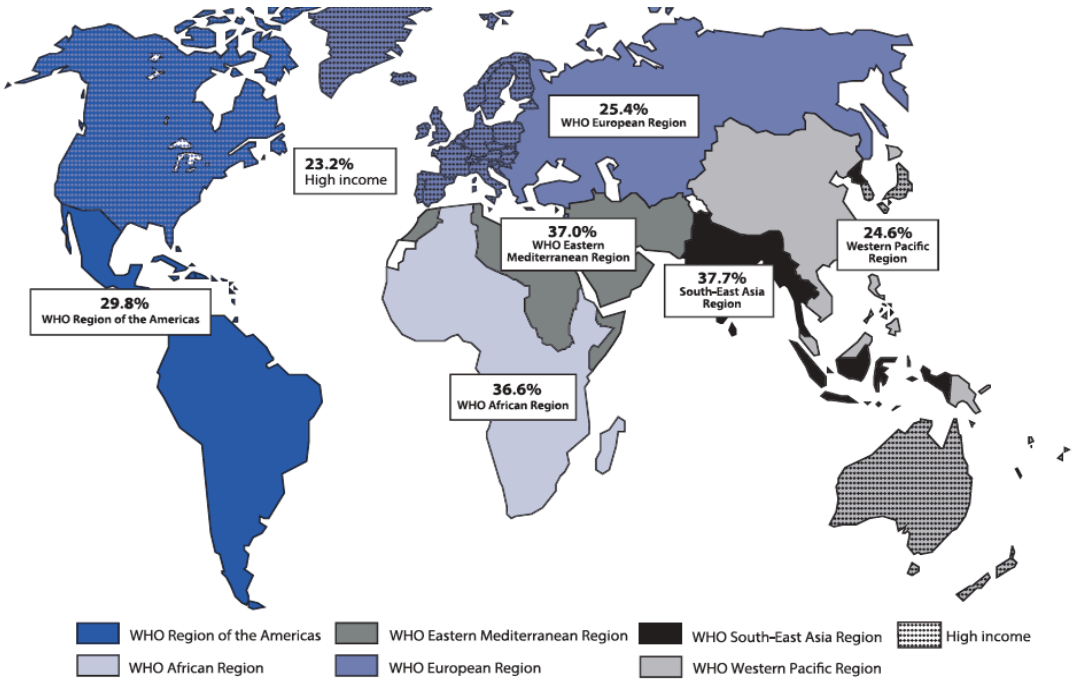

Figure 1.1 Regional estimates of intimate partner violence against women[2]

public health, affecting not only women's health and safety but the physical and mental health of their children. On average, 30% of women globally have experienced physical and/or sexual IPV at some point in their lifetime (data from 79 countries).[2] Regionally, the highest prevalence was found in Africa (36.6%), South East Asia (37.7%) and the Eastern Mediterranean (37%), Figure 1.1.

1.1.1 Intimate partner violence in pregnancy: patterns and prevalence

The prevalence of IPV against pregnant women differs across the globe. Separate reviews from 1996[3] and 2010[4] found prevalence rates between 1-20% or 1-36%, respectively. However, the majority of studies included were from high-income country (HIC) settings. A more recent review of African studies found higher rates of IPV during pregnancy, ranging from 2% (Nigeria) to 57% (Uganda).[5] There is limited information regarding longitudinal patterns of IPV before, during and/or after pregnancy as well as disagreement in the literature regarding whether pregnancy is a risk factor for increased rates of IPV.[4] Where investigated some studies have shown an increased risk of IPV exposure during pregnancy compared to postnatally,[6] while others have found a decreased risk from pre-pregnancy to pregnancy.[7,8] A qualitative study investigating IPV exposure patterns during pregnancy showed differing patterns in the group studied, finding that for approximately one third of women, pregnancy was a protective period, for another group violence worsened during pregnancy and for the largest group (approximately 55%), violence patterns were consistent with pre-pregnancy exposure.[9] Given the unique pregnancy-related and early-life outcomes associated with exposure to IPV in the antenatal and early postpartum period, more work is needed to understand patterns of IPV during this critical period and drivers of differing trajectories of exposure in women perinatally.

1.1.2 Intimate partner violence in the South African context

The epidemic of IPV is particularly high in low and middle income countries (LMICs), including South Africa. There is no reliable national data on prevalence of IPV in South Africa; however, multiple research studies have reported IPV prevalence in specific communities, reporting rates of current IPV between 15-31%[10-12] and lifetime prevalence up to 55%.[13] Indeed, South Africa has among the highest burdens of interpersonal violence in the world.[10,14] A study of injury in South Africa conducted in 2000, found that interpersonal violence was the second leading cause of healthy years of life lost, after unsafe sex, accounting for 1.7 million disability adjusted life years (DALYs) or 10.5% of all DALYs.[15] Within the category of interpersonal violence, IPV towards women accounted for 50% of the total attributable DALYs.[15] A 2009 study by the South African Medical Research Council reported that IPV was the leading cause of death of female homicide victims, with 56% of female homicides being committed by an intimate partner.[16] The mortality rate from IPV in South Africa was reported as 8.8 per 100,000 women, one of the highest reported femicide rates globally.[17] This amounts to one woman being killed by an intimate partner every 8 hours.[16]

Consideration of the historical context of violence and health disparities in South Africa is important. A high prevalence of murder, gang violence, rape and community violence co-occur.[14] The roots of these high levels of violence can be linked to South Africa's colonial and apartheid past, including the impacts of systemic racism, impoverishment, migrant labour and constructions of masculinity.[18] Despite post-apartheid policies to improve economic equality, economic disparities have grown (GINI coefficient of 0.56 in 1995 to 0.63 in 2015)[18,19] and are projected to worsen following the coronavirus epidemic. A study including survey data from 63 countries found that income inequality, high gender inequality and low economic development are key predictors of violence. Among the 63 included countries, South Africa

had the worst income inequality and highest homicide rates.[20,21] As a consequence of poverty and inequality, many young men resort to demonstrations of power, strength and controlling behavior, often directing anger or frustration into violence against women.[22-25]

1.1.3 Intimate partner violence: definitions and considerations

Intimate partner violence can manifest in many ways, it can be bi-directional (both partners are perpetrators) and include female to male, as well as male to female, perpetration. Throughout this thesis use of the term "IPV exposure" refers to maternal report of IPV perpetrated by her partner, and is inclusive of acts of psychological, physical or sexual violence. The WHO categorizes psychological violence or abuse as "insults, belittling, constant humiliation, intimidation (e.g. destroying things), threats of harm, threats to take away children"; physical violence includes acts of physical abuse such as "slapping, hitting kicking or beating"; and sexual violence includes sexual coercion or forced sexual acts (Figure 1.2).[26]

Physical violence by an intimate partner
- Was slapped or had something thrown at her that could hurt her
- Was pushed or shoved
- Was hit with fist or something else that could hurt
- Was kicked, dragged or beaten up
- Was choked or burnt on purpose
- Perpetrator threatened to use or actually used a gun, knife or other weapon against her

Sexual violence by an intimate partner
- Was physically forced to have sexual intercourse when she did not want to
- Had sexual intercourse when she did not want to because she was afraid of what partner might do
- Was forced to do something sexual that she found degrading or humiliating

Emotional abuse by an intimate partner
- Was insulted or made to feel bad about herself
- Was belittled or humiliated in front of other people
- Perpetrator had done things to scare or intimidate her on purpose, e.g. by the way he looked at her, by yelling or smashing things
- Perpetrator had threatened to hurt someone she cared about

Figure 1.2 World Health Organisation categorization of acts by type of intimate partner violence.

Psychological or emotional violence is the most common form of IPV, yet it is often excluded from IPV research. A potential reason for this includes "lack of agreement on standard measures of emotional/psychological partner violence" as cited by the WHO in their 2013

review of health effects of IPV, which only included measures of physical or sexual violence.[1] Specifically, this lack of agreement refers to the existence of two commonly used operational definitions, including psychological aggression (e.g. yelling or insults) and coercion or controlling behaviors (e.g. isolation or control). This thesis uses the former definition, inclusive of threats, humiliation, insults and intimidation (Figure 1.2), which is based on the 2005 WHO multi-country study on women's health and domestic violence against women.[26] The health impacts of emotional IPV are less studied than physical and/or sexual IPV, but emerging evidence suggests that emotional IPV may have a unique and sometimes greater impact on maternal mental and physical health compared to physical IPV.[27-30] An aim of this thesis is to assess the differential impact of IPV sub-types on outcomes considered in a South African population cohort.

1.1.4 Maternal intimate partner violence and child exposure

Global prevalence estimates of child witnesses of IPV are limited,[31,32] though research suggests that many young children are witnessing IPV[33-35] and those under 5 years are disproportionately represented in this group as they typically spend more time in the home compared to older children.[33,34,36] Violence exposure for South African children is pervasive. A birth cohort, Birth to Twenty Plus (n=2,024), the longest running cohort study in Africa, investigated prevalence of multiple categories of violence exposure (community violence, domestic violence, school violence, peer violence and sexual or physical violence victimization). The authors found violence exposure to be widespread, with one third (36%) of the cohort experiencing all forms of violence measured by 22 years of age.[35] Only 1% had not experienced any measured form of violence and between birth and six years of age, 49.9% of children had experienced violence in their homes.[35] Another South African study found that up

to 45% of children had witnessed their mother being beaten,[14] highlighting the significant proportion of South African children exposed to IPV in their home.

Exposure to IPV is increasingly recognized as a distinct category of child maltreatment.[37] However, it is also important to note that children in homes with IPV are also at greater risk of being abused or neglected themselves.[38,39] This direct abuse may compound the negative effects of IPV exposure. There is overlap in psychosocial or behavioral problems in children exposed to IPV and those directly abused. A review of literature investigating children exposed to parental violence versus those directly abused noted that in some studies there were similar associations between each of these exposures and behavioral and psychological problems.[40] This suggests that when IPV occurs in the home it can have detrimental effects on children which may be similar to direct abuse. Further, IPV exposure in childhood increases the likelihood of that child perpetrating violence in adulthood, being victimized in adulthood or abusing their own children.[41,42] Indeed, as noted by the United Nations Children's Fund (UNICEF), the single strongest predictor of whether children become perpetrators or victims of domestic violence in adulthood is whether they grew up in a home where there was domestic violence.[32] Together, these findings represent an intergenerational cycle of violence detrimental to the health and well-being of multiple generations.

Children of mothers exposed to IPV have increased risk of physical and mental health problems that extend beyond childhood into adolescence and adulthood.[43-45] IPV may compromise health-care of children, undermine the parent-child relationship and create a family atmosphere of fear or control as well as increase the likelihood of child-abuse or neglect.[46-48] Preventing the long-term health effects of violence exposure on children is critical. Though much research has investigated health outcomes in children exposed to IPV, there is a lack of consideration for the

complex relationship with maternal mental health and behavior. Better understanding of these relationships is needed to inform prevention and intervention approaches aimed at improving outcomes for both women and children.[49]

Throughout this thesis maternal report of IPV by her partner is intended to encompass potential direct and indirect exposure for her child. Specifically witnessing or overhearing domestic violence or being impacted by associated maternal mental ill-health including altered maternal behavior, dysfunctional family dynamics or being aware of the abuse or threatening behavior and its aftermath.

1.1.5 Conceptual underpinnings

This thesis explored the impact of IPV on child growth and developmental outcomes and the potential mechanisms underlying these relationships. The conceptual underpinning of this thesis is a framework developed by Yount et al,[50] which proposes that IPV may affect children directly or indirectly through spillover effects on family members and other family processes.

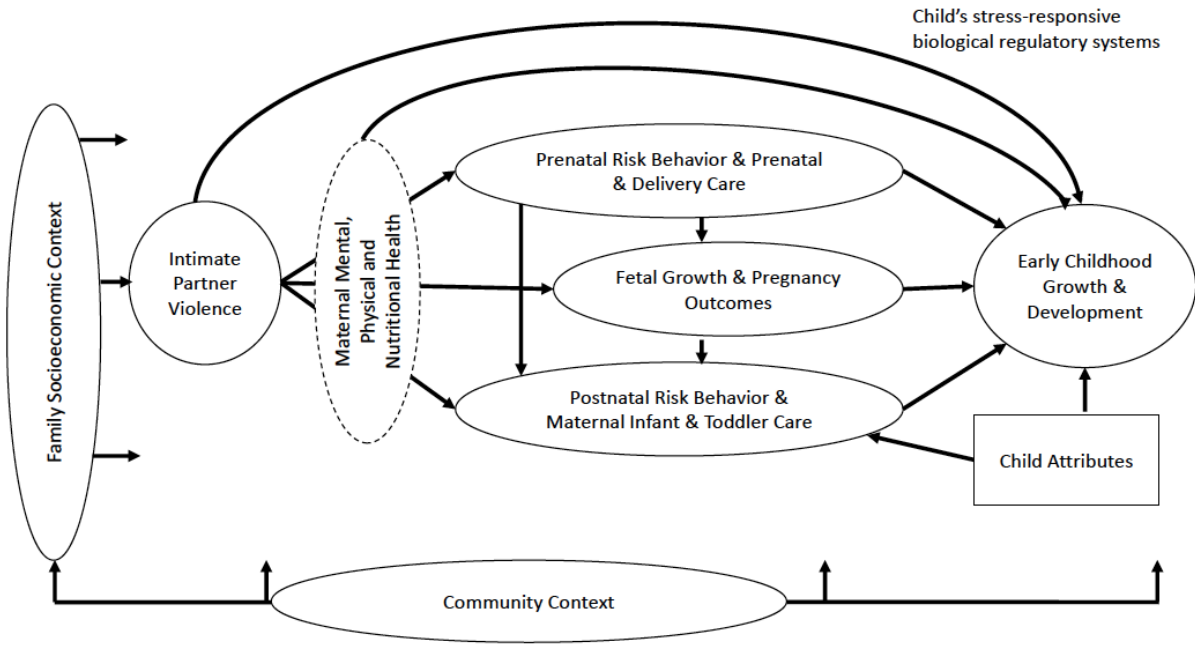

Figure 1.3 Conceptual framework of possible direct and indirect pathways by which intimate partner violence may affect a child's growth and development in early life.[50] *(reproduced with permission)*

This framework depicts the complexity of the relationships between the outcomes explored in this thesis, namely food insecurity in pregnancy, growth at birth and through infancy and child developmental outcomes in early life, which represent a complex web of interrelated factors. A review of existing literature on relationships between explored outcomes and exposure to maternal IPV is provided below.

1.1.6 Overview of potential pathways of impact: intimate partner violence and child health

In high-risk communities such as South Africa, investigation of potential pathways whereby child exposure to IPV affects developmental and growth outcomes is critical in order to understand how policies and programs might mitigate the risk of negative outcomes in young children exposed to IPV. The effects of IPV on mothers and their exposed children can manifest in many ways. The conceptual framework (Figure 1.3) proposed by Yount *et al*, illustrates multiple potential pathways of impact and these may exert influence on infant or child outcomes both *in utero* and postnatally. Potential mechanisms underlying the relationship between IPV exposure and child health can be broadly categorized as biological or behavioral/psychological in nature. The former includes genetic/epigenetic factors and dysregulation of several stress responsive biological regulatory systems. The latter includes compromised maternal mental health, such as maternal depression or substance use, affecting care giving behavior, childcare practices, reduced maternal efficacy and financial power and maternal-child secure attachment, as well as child processes such as self-regulatory behavior or coping, all of which may impact child health outcomes. Maternal behavioral mechanisms are the main hypothesized mediators underlying relationships between IPV and child health explored in this thesis.

The pathways via which maternal IPV impacts child health outcomes may depend on timing of exposure. During pregnancy, IPV exposure has been linked to later and decreased

engagement with antenatal care, creating missed opportunities for preventative care or hospitalizations for fetal and pregnancy complications.[51,52] Perinatal IPV has been shown to predict higher emotional distress in pregnancy,[53] higher scores for depressive and post-traumatic stress symptoms,[54-56] higher perinatal common mental disorders[57] and higher prevalence of postnatal depression[58-60] as well as thoughts of self-harm.[58] Multiple studies have confirmed a link between IPV and smoking, alcohol or drug use during pregnancy or postnatally[51,61-63] which have well-established links with poorer child development. Postnatally, exposure to maternal IPV may impact children directly through stress responsive biological regulatory systems[50,64] or indirectly through the increase in behavioral and psychological risks in mothers by compromising maternal care and maternal-infant bonds through infancy.[65,66] The psychological and behavioral effects of IPV may disrupt routine preventive care, increasing morbidity and infection and impacting child health in infancy and through the long-term. Multiple studies of child health outcomes from homes with domestic violence have shown increased rates of illness, infection and hospitalization, including increased odds of respiratory infection,[67,68] diarrhea,[67] emergency room visits,[65] lower immunization levels and poorer general health.[69-71] IPV exposure may adversely impact maternal care and stimulation required for healthy growth and development.[72,73] IPV in the home has been linked to poorer quality parenting and a lack of parental warmth and affection as well as less secure attachment in mother-child relationships.[41,48,74]

Therefore, there are multiple potential pathways between IPV and adverse child health which represent a complex network of interrelated factors, however few have been formally investigated as mediators. Discussion and investigation of potential pathways whereby maternal IPV affects children's health is critical to inform public health policies and programs that might mitigate the risk of IPV exposure. Further detail is provided below reviewing

existing literature on IPV and thesis outcomes explored as well as potential mediators of these relationships.

1.2 Maternal intimate partner violence and child nutrition or growth

1.2.1 Intimate partner violence in pregnancy

Many risk factors for IPV during pregnancy are consistent with those factors that confer general risk for IPV at any time. These include lower levels of education, lower socioeconomic status, substance use, younger age, a history of childhood maltreatment and cultural gender norms.[4,5,75] However, pregnancy does also carry unique risk factors for IPV, for example, conflict arising from unwanted pregnancy,[51] increased financial strain[76,77] or her partner doubting the paternity of a child.[9] In turn, IPV is associated with risky behaviors that may impact maternal and fetal health, such as later entry into antenatal care, non-attendance at antenatal visits, reduced maternal nutrition or increased substance use by the abused mothers.[51,52] Further, in LMIC contexts, poverty and gender inequalities contribute to structural determinants of violence[75] and often translate into men having greater economic power within the relationship, acceptability of violence towards women and controlling male behaviors which affect their partner's autonomy.[76,78,79] Violence towards pregnant women is of particular concern given the unique pregnancy-related adverse health outcomes for both mothers and their babies.

1.2.2 Intimate partner violence in pregnancy and in utero nutrition or growth at birth

IPV exposure during pregnancy is associated with multiple adverse growth outcomes at birth, including delivering a low birth-weight, preterm or small for gestational age infant.[80,81] For pregnant women, it has been linked to poorer maternal nutrition and inadequate gestational weight gain,[82] which may compromise fetal growth. Emerging literature has found associations

between IPV indicators of nutrition in pregnancy, specifically food insecurity,[83-85] identifying a bi-directional relationship[86] whereby greater food insecurity increased the likelihood of experiencing IPV as well as increased rates of perpetration and victimization in households experiencing food insecurity.[85] The implications of IPV exposure during pregnancy on *in utero* nutrition and growth outcomes at birth represent a significant public health burden. Impaired fetal health through altered uterine environments may have compounding affects beyond birth outcomes. IPV in pregnancy is an established risk factor for low birth weight and preterm birth,[80,81] which may impact infant and child growth as well as development throughout the life course.[38,87] A framework developed by UNICEF recognises the basic, underlying causes of undernutrition and the immediate and long-term impact on health through adulthood (Figure 1.4). The 2013 Lancet series on maternal and child malnutrition in LMIC settings estimates that fetal growth restriction is an underlying cause in 12% of child deaths.[88] Associations between IPV and fetal growth restriction may be particularly important given the adverse impact on longitudinal child growth, child development and long-term health.[89-91] Indeed, a key conclusion of paper 1 in the 2013 series is that "Undernutrition during pregnancy, affecting fetal growth, and the first 2 years of life is a major determinant of both stunting of linear growth and subsequent obesity and non-communicable diseases in adulthood."[88]

1.2.3 Intimate partner violence and child growth

Beyond fetal growth restriction, there is growing evidence that IPV exposure is detrimental to maternal behaviors relating to child growth outcomes through childhood. Studies investigating this link have shown associations between maternal IPV exposure and decreased rates of initiation and duration of breastfeeding as well as an increased risk of child stunting, wasting or being underweight.[93-97] Studies have yielded results which lack consistency across

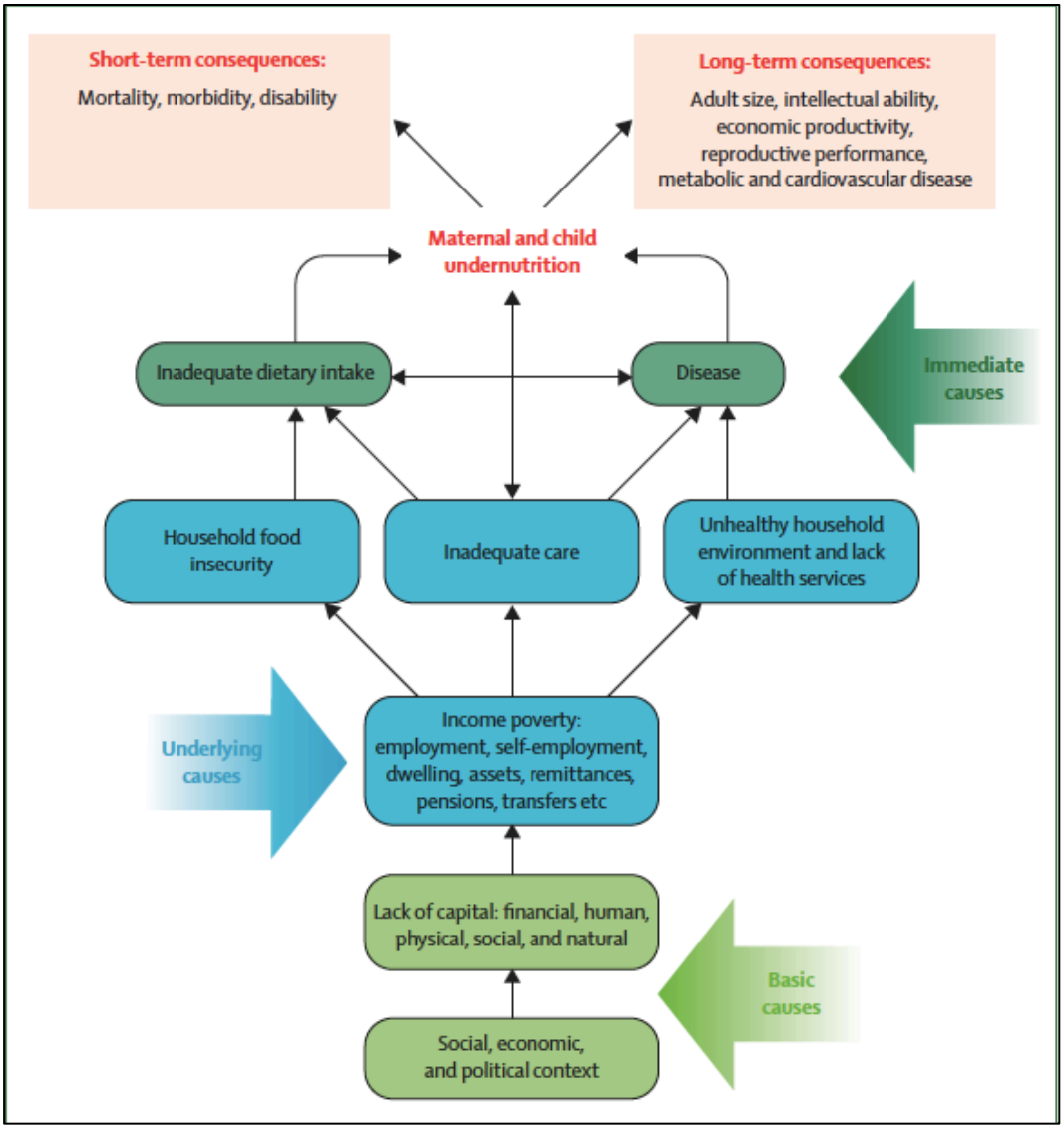

Figure 1.4 Framework of the relations between underlying structural and immediate causes for maternal and child undernutrition and its short-term and long-term consequences.[92]
(reproduced with permission)

populations and geographies and depending on definition of exposures.[98-100] For example finding associations only where more severe abuse[99] or extreme malnutrition (severe stunting)[98] was investigated and not for milder exposures or outcomes. A multi-country study including data from five national Demographic and Health Surveys predicted higher odds of stunting in children of IPV exposed women but only in one of the included countries.[98] More recently, two large multi-country studies have substantiated a link between IPV and stunting.[101,102] One of these studies, including data from 29 countries, found an increased risk of stunting in children whose mothers had experienced any lifetime physical or sexual IPV

(emotional IPV was not explored).[101] The other, including data from 137 LMIC countries, found that 2.1 million cases of stunting globally were associated with physical IPV and found the highest regional population attributable fraction (PAF) for physical IPV and stunting was found in Sub-Saharan Africa (5.3% PAF).[102]

1.2.4 Poor growth and implications for child and adolescent health

Evidence suggests that poor growth in early life adversely impacts a range of child health and developmental outcomes. Linear growth faltering, leading to child stunting, and associated with malnutrition, has far-ranging implications and has been shown to increase the risk of death from infectious disease, with increasing risk based on severity of malnutrition.[103,104] Stunting is a well-established risk factor for poor motor and cognitive development as well as adjustment problems in childhood.[105,106] Early life is likely a sensitive time whereby children exposed in the first years of life may face unique risk for poorer long-term health. Several longitudinal studies have shown that stunting before age 2 or 3 years predicts poorer cognitive and academic outcomes through childhood and adolescence.[107,108] A study from Guatemala found that growth from birth to 24 months but not from 24 to 36 months was associated with delayed child development.[109] Results pooling data from five cohorts showed that weight gain in the first 2 years was associated with school outcomes[110] and analyses from the COHORTS group suggest that growth in the first 2 years of life, but not at later ages, is associated with academic performance.[111] Given the potential impact of poor growth on child health, particularly in early life, improved understanding of risk factors for poor growth such as IPV may be critical to improving potential globally.

1.2.5 Potential mechanisms underlying the relationship between IPV and child growth

Evidence of an underlying link between IPV and child growth is increasing, however, there remain critical gaps in the literature. Among them, as cited by Yount and colleagues,[50] is an

inconsistent approach in research of the measurement of IPV, with the majority of studies reporting only physical or sexual IPV and often only lifetime exposure rather than recent exposure. Further, there are limited studies formally investigating pathways of impact in the relationship between IPV and child growth.[112] A summary of key articles investigating IPV and early-life growth is presented in Table 1.1. Of these articles, only two formally investigated potential mediators, however neither found sufficient evidence that factors explored explained the underlying relationship between IPV and child growth.

Several potential mechanisms through which maternal IPV may impact in utero or early-life growth have been proposed. First, IPV during pregnancy may impact fetal growth through chronic psychological stress, elevating stress hormones.[113] Second, it may impact psychological wellbeing, increasing rates of depression as well as risky lifestyle habits, including substance use, which in turn, may reduce placental blood flow[114] or compromise maternal nutrition (e.g. food insecurity, vitamin deficiencies).[115] Third, postnatal IPV has been linked to increased maternal depression and substance use,[116] which may impact a woman's ability to care for her child, for instance by increasing the risk of child neglect or diverting financial resources from health care costs or nutritionally adequate food.[117] Fourth, maternal efficacy and financial power within a family is often impacted by abusive relationships, or partner control, further exacerbating these issues.[118] Fifth, witnessing IPV has been shown to increase psychological stress in children, which may increase oxidative stress[119,120] and reduce metabolic levels.[121] Lastly, children exposed to IPV have a higher risk of infection and hospitalizations,[122] both of which are associated with faltering growth, in particular diarrhoeal diseases,[67] with emerging evidence linking IPV exposure to increased risk of respiratory illness.[67] Despite this evidence, few studies have formally investigated key mediators in the IPV-infant growth relationship, particularly in the postnatal time period.

Table 1.1 Overview of key articles investigating intimate partner violence and child growth postnatally

Author, year	Study setting	Age	IPV definition	Outcome(s)	Mediation	Findings
Sobkoviak RM, 2012[100]	Liberia (n=2467)	Birth to 48 months	Past year and lifetime Emotional and Physical IPV (combined category) and Sexual IPV	WFAZ, WFHZ, LFAZ (continuous) & Wasting,Underweight, Stunting	None explored	Maternal reports of sexual IPV in the prior year (but not physical or emotional IPV) predicted lower adjusted z-scores for LFAZ and WFHZ as well as higher odds of stunting and underweight.
Salazar M, 2012[123]	Nicaragua (n=478)	40 to 46 months	Emotional, Physical & Sexual IPV (during pregnancy)	LFAZ (continuous)	None explored	Maternal exposure to any IPV during pregnancy was associated with lower LFAZ. A separate analysis of each IPV type showed that emotional, physical or sexual IPV during pregnancy were not significantly associated with lower LFAZ.
Neamah HH, 2018[93]	Tanzania (n=1031)	24 to 29 months	Lifetime IPV (Physical & Sexual)	Stunting	Examined alcohol use, positive–negative cognitive stimulation, number of adults and/or children at home, the head of the household, and depression. No evidence for mediation was found.	Exposure to lifetime physical and sexual IPV was associated with a higher risk of stunting.
Ziaei S, 2014[94]	Bangladesh (n=2027)	Birth to 60 months	Lifetime Physical or Sexual IPV	Stunting, Wasting & Underweight	None explored	Women with a lifetime experience of physical or sexual IPV were more likely to have a stunted child.
Chai J, 2016[101]	29 countries (204,000)	0 to 59 months	Lifetime Physical or Sexual IPV	Stunting or Wasting	None explored	Stunting in children was positively associated with maternal lifetime exposure to only physical or sexual IPV and to both forms of such violence. A small negative association between wasting and IPV was found.
Rico E, 2011[98]	5 countries (Egypt=3242; Honduras=8562; Kenya=3292; Malawi=6361; Rwanda=2587)	6 to 59 months	Lifetime Physical or Sexual IPV	Stunting and Severe Stunting	Adjusted for variables indicating maternal care seeking behavior e.g. vaccination, breastfeeding duration and planned pregnancy (insufficient evidence of mediation).	In Kenya, maternal exposure to IPV was associated with child stunting. In Malawi and Honduras, marginal associations were observed between IPV and severe stunting.
Rahman M, 2012[95]	Bangladesh (n=1851)	Birth to 60 months	Past year Physical and Sexual IPV	Stunting, Underweight, Wasting	None explored (adjusted for childhood illness and maternal decision making power)	Maternal experience of any physical or sexual IPV was associated with an increased risk of stunting and underweight but was not significantly associated with wasting.
Hasselmann MH, 2006[99]	Brazil (n=500)	1 to 24 months	Past year Verbal & Physical aggression	Weight-for-height z-score	None explored (adjusted for maternal alcohol and drug abuse)	A threefold severe acute malnutrition risk was found for children with parents reporting severe physical abuse, but not for those with parents reporting verbal aggression or more minor physical assaults.
Ackerson LK, 2008[96]	India (n=14,552)	12 to 36 months	Past year and lifetime Physical IPV	Stunting, Wasting, Low weight for age, and Low body mass index for age.	None explored (adjusted for maternal decision making autonomy)	Maternal report of multiple instances of past year IPV was associated with wasting, severely underweight for age, low body mass index for age and severely low body mass index for age.
Asling-Monemi K, 2009[124]	Bangladesh (n=3,164)	2, 6 and 12 months of age	Antenatal and lifetime Physical, Sexual and Emotional IPV	LFAZ, WFAZ (at birth & 24 months); change in both from 1-24 months	None explored	Exposure to any form of IPV was negatively associated with weight and length at birth and WFAZ and LFAZ at 24 months of age, as well as a change in weight and height from birth to 24 months of age.

Definitions: LFAZ= length-for-age z-score; WFAZ=weight-for-age z-score; WFHZ=weight-for-height z-score; Stunting defined as >2 standard deviations from mean of height-for-age z-score; Severe stunting as >3 standard deviations; Wasting defined as >2 standard deviations from mean weight-for-height z-scores; Underweight as >2 standard deviations from mean of weight-for-age z-scores.

In their comprehensive article reviewing existing literature on pathways of influence for antenatal and postnatal IPV on fetal and child growth, Yount and colleagues[50] conclude with "Ultimately, large, population-based intergenerational studies … are needed to assess fully the pathways by which domestic violence affects the nutrition and growth of children prenatally and through the toddler years."

Given the substantial threat to child and adult health and economic potential, it is critical to understand associations between IPV and child growth as well as the mechanisms underlying these relationships to inform prevention and intervention efforts. This thesis aims to address the limitations in the existing literature as discussed above by: i) investigating differential impacts of IPV sub-types on food insecurity in pregnancy and growth at birth as well as through infancy; and (ii) investigating hypothesized pathways for these relationships including potential behavioral (maternal depression, substance use) as well as biological (hospitalizations) mechanisms.

1.3 Maternal intimate partner violence and child cognitive development

Child exposure to IPV in the home has been linked to developmental and behavioral problems.[44,45,125-127] The majority of this research has focused on school-aged children or adolescents. Indeed, a recent review[64] noted that research investigating the developmental outcomes of infants and toddlers exposed to IPV is extremely limited, though early life may be a crucial time for the foundations of cognitive and social development. The first years of life represent a critical time where abuse or violence exposure, which often co-occur, can affect maternal mental health, caregiving and autonomy, which in turn can have significant implications for emerging brain architecture, functioning and long-term overall health of their children.[128] Indeed, a longitudinal study through 8 years found that exposure to interpersonal

trauma (maltreatment and/or witnessing IPV) in the first two years of life was associated with the poorest cognitive outcomes compared to other periods in childhood.[129]

Understanding the unique impacts of IPV at specific stages of child development is important; research suggests that there is a cascading and compounding effect of early trauma or violence exposure. In utero, IPV has been shown to affect birthweight and gestational age,[130] which impairs attachment and can have an effect into adulthood.[131] Early postnatal stressors, including exposure to IPV, abuse or neglect have been linked to altered infant and toddler stress reactivity[132,133] and regulation.[134] During toddlerhood, exposure to IPV may compromise self-regulation and increase behavioral problems.[135] Further, early life is a time of high risk of direct child exposure to IPV as children during this time rely heavily on maternal care and are more likely to be in the home.[33,34,36] During the preschool years, IPV may impact social development and studies have increasingly shown IPV impacts physical health, including respiratory health, gastrointestinal and nutritional health.[68,136,137] This compounding of negative outcomes associated with IPV exposure from pregnancy through the preschool years may compromise a child's potential to grow into a productive adult, impacting long term health and earning potential.[2,138]

Though there is limited research in the first two years of life, a recent study pooling data from 11 low and middle income countries investigating pre-school development (36-59 months) found associations between exposure to postnatal maternal IPV and poorer developmental outcomes (cognition, language, socioemotional development).[139] A summary of key articles investigating IPV and early-life development (specifically cognitive, language and motor outcomes) is presented in Table 1.2. Where investigated in a younger sample, studies have

Table 1.2 Overview of articles investigating exposure to intimate partner violence and early life child development

Author, year	Setting	Age	Exposure	Outcome(s)	Mediation	Findings
Udo IE, 2016[140]	USA (n=210)	3, 12 & 24 months	Past year Physical IPV (Conflict Tactics Scale-2)	Language development (Preschool language scale fourth edition, PLS-4); Neurological development (Bayley Infant Neurodevelopmental Screener, BINS)	Not explored (adjusted for maternal depression and stress during pregnancy)	Infants and toddlers born to women exposed to moderate levels of IPV had increased odds of language and neurological delay compared to infants and toddlers of women who experienced low levels of violence.
Neamah HH, 2018[93]	Tanzania (n=1031)	18-36 months	Lifetime Physical and Sexual IPV (Tanzania Demographic and Health Survey)	Cognitive, language and motor development (The Bayley Scales of Infant Development).	Not explored	Exposure to lifetime physical and sexual IPV was associated with lower scores for motor skills, expressive communication, receptive communication and cognitive development.
Rodriguez VJ, 2018[141]	South Africa (n=72)	12 months	Antenatal and past month Psychological and Physical IPV (Conflict Tactics Scale)	Cognitive, language, motor development (Bayley Scales of Infant Development-III).	Not explored	Postnatal physical IPV was associated with delays in cognitive and receptive language development, but only in unadjusted analyses.
Jeong J, 2020[139]	11 LMIC countries (Benin, Cambodia, Cameroon, DRC, Honduras, Jordan, Rwanda, Senegal, Timor-Leste, Togo, Uganda; n=15,502 households)	36-59 months	Past year Physical, Sexual and Emotional IPV (Conflict Tactics Scale)	Cognitive, literacy and numeracy, socioemotional, and physical development (Early Child Development Index)	Explored maternal and paternal stimulation (self reported behavior regarding engagement in following: reading books or looking at pictures together, telling stories, singing songs, taking the child outside of the home compound, playing with child, and naming, counting, or drawing things with child.)	IPV exposure was negatively associated with early childhood development (ECD). Analysis showed that the association between IPV and early child development was partially mediated through maternal and paternal stimulation.
Peterson CC, 2019[142]	US (n=79)	12, 24 & 36 months	Current Psychological, Physical, and Sexual IPV (Conflict Tactics Scale-2)	Expressive vocabulary (The Expressive Vocabulary Test, Second Edition, EVT-2); Receptive language (Peabody Picture Vocabulary Test, Fourth Edition, PPVT-4)	Not explored (adjusted for maternal depression)	Early exposure to IPV had a direct adverse effect on children's expressive language development. IPV adversely affected expressive language even when home quality was high, indicating that a supportive and stimulating home environment did not buffer effects of IPV on expressive language development.
Kliem S, 2019[143]	Germany (n=535)	6, 12, 24 months	Past year Physical IPV (based on single question)	Cognitive, language, motor development (Bayley Scales of Infant Development-III).	Not explored	Past year physical IPV was associated with child cognitive development from 12-24 months; path analysis indicates a causal influence.

found largely consistent associations between maternal IPV and delayed toddler development. For example, a Tanzanian study through three years of age found both lifetime physical and lifetime sexual IPV to be associated with reduced motor skills, language and cognitive development.[93] A US-based study similarly found that early life exposure to IPV, specifically intensity of exposure, increased the risk of language and neurological delay in infants and toddlers, finding that moderate or high levels of maternal past year IPV further increased this risk compared to low levels of IPV exposure.[140] However, a South African study found no association between postnatal exposure to IPV and developmental delay (dichotomous outcomes of delay for cognitive, language and motor development) at one year, after adjustment for confounders.[141]

Though these studies represent an emerging literature investigating postnatal exposure to IPV and child development in the first two years of life, there remain critical gaps in knowledge. As cited above, relating to literature on child growth outcomes, research focusing on exposure to IPV and child development often narrowly defines IPV as only physical or sexual abuse, though emotional IPV has been linked to similar or increased rates of ill-health in adult women, both physical and mental health outcomes, compared to physical IPV.[27-30] Additionally, the majority of studies, particularly in school-aged children, have been done in HICs, though LMICs have a higher burden of risk factors co-occurring with IPV, such as community violence, trauma, substance use disorders, poverty, food insecurity, mental illness as well as limited support networks. Indeed, some studies have estimated a 90% treatment gap for mental disorders in LMIC contexts.[144] This accumulation of risk factors and lack of existing treatment networks may further exacerbate associations between maternal IPV exposure and adverse child outcomes.

1.3.1 Mechanisms underlying the relationship between IPV and child cognitive development

Lastly, few studies have formally explored potential mediators to better understand pathways of impact. One study that did investigate pathways, found that maternal as well as paternal stimulation partially mediated the relationship between exposure to IPV and child developmental outcomes (cognition, literacy, physical development). Though several studies have highlighted poorer maternal parenting behaviors (e.g. greater aggression, less stimulation and poorer maternal-child attachment)[145-147] or maternal stress[148,149] as mechanisms underlying the effects of postnatal exposure to IPV on early-life development,[145-147] few have formally tested these. As noted by Kitzmann and colleagues[40] in their meta-analysis of studies investigating child exposure to IPV and broad developmental outcomes (academic performance, adjustment problems, psychological problems), there needs to be "increased attention to identifying the processes by which interparental aggression affects child development."[40] This thesis aims to address the limitations in the existing literature as discussed above by i) investigating differential impacts of exposure IPV sub-types on toddler developmental outcomes in an LMIC context and (ii) investigating hypothesized pathways for this relationship.

1.4 Rationale

Despite significant evidence that exposure to IPV affects maternal nutrition in pregnancy, in utero and postnatal growth, and child development, there are limitations to our existing knowledge. First, there is limited information from well-characterized longitudinal studies in these settings and a lack of investigation of associations in very young children, though children under 2 years may be particularly at risk for long-term health sequelae relating to IPV exposure. Second, few studies have adequately investigated potential mechanisms underlying associations between IPV and

developmental or nutritional outcomes such as food security and growth. Third, much of the existing data derives from HICs, rather than from LMIC settings, where the majority of the world's youth population lives and where many children are exposed to disproportionately high levels of poverty and violence-related risk factors. Investigating the effects of IPV in this context is therefore critical as in LMIC contexts there are often fewer programs in place to address IPV, and associated mental health issues and risk factors may be different than in higher income countries. This thesis aimed to broaden our understanding of the impact of violence and adversity on child development and growth, and the processes via which this occurs. By improving our understanding of this and the pathways by which child health is affected, we aimed to identify key areas for intervention. Adversity in early childhood has been linked to long lasting negative adult physical and mental health outcomes; early childhood represents a critical window to intervene.

1.5 Aim and objectives

The overall aim of this thesis is to provide insights into the patterns, predictors and impact of sub-types of maternal exposure to intimate partner violence on their children in a South African birth cohort study. A particular focus is understanding potential pathways of impact in the relationship between IPV and outcomes investigated.

Study objectives

1. To investigate the impact of maternal childhood trauma on longitudinal patterns of maternal perinatal exposure to emotional, physical and sexual intimate partner violence.

2. To investigate associations between maternal childhood maltreatment or IPV (emotional, physical, sexual) and food insecurity during pregnancy and whether maternal depression mediates these relationships.
3. To investigate whether antenatal IPV sub-types are associated with compromised intrauterine growth and whether maternal depression, alcohol or tobacco use mediate these relationships.
4. To investigate whether postnatal IPV sub-types are associated with reduced infant growth at 12 months and whether maternal postnatal psychosocial risk factors (depression, alcohol and tobacco use) or infant hospitalizations mediate these relationships.
5. To investigate whether maternal IPV sub-types are associated with poorer toddler cognitive, language and motor development, and whether maternal depression or alcohol dependence mediate these relationships.

1.6 Overview and structure of this thesis

This introductory chapter has introduced the topic of IPV and associated maternal and child health outcomes as well as potential mechanisms underlying these relationships. Next, a methods chapter is presented which includes a broad overview of the setting, participants, study visits and measures included. Specifically, Chapter 2 provides an overview of the cohort study from which this thesis emanates, the Drakenstein Child Health Study (DCHS), providing information on the study population, recruitment, measures employed and ethical considerations. Finally, this thesis includes four results chapters and a discussion chapter summarizing the key themes and contributions of this thesis as well as recommendations for future research and practice.

1.6.1 Outline of papers

The four results papers included in this thesis examine patterns of perinatal maternal exposure to IPV and potential consequences for mothers and their children. Each paper addresses gaps in the literature and advances our current understanding of the complex relationships between IPV and maternal or child outcomes, specifically by: considering recent emotional IPV in addition to physical and sexual IPV; investigating possible explanatory variables; utilizing longitudinal data and analysis where possible; and focusing on a LMIC population. A summary of these results chapters is presented in Table 1.3, below.

Table 1.3 Summary of thesis results chapters including mediators, outcomes and methodology.

Chapter/ Objective	Publication title	Exposure	Mediator	Outcome	Methodology
3 / 1	Maltreatment in childhood and intimate partner violence: A latent class growth analysis in a South African pregnancy cohort.	Maternal childhood maltreatment	N/A	Longitudinal patterns of IPV (by sub-type & combined)	Longitudinal latent class analysis describing IPV exposure patterns across 6 time points from pregnancy through two years postpartum. Linear regression investigating associations between maltreatment and IPV latent classes.
4 / 2	Food-insecure pregnant women in South Africa: a cross-sectional exploration of maternal depression as a mediator of violence and trauma risk factors.	IPV during pregnancy & maternal childhood maltreatment	Depression	Food insecurity in pregnancy	Cross sectional analysis during pregnancy; multivariable regression and mediation analysis.
5 / 3&4	Intimate Partner Violence and growth outcomes through infancy: a longitudinal investigation of multiple mediators in a South African birth cohort.	IPV during pregnancy and postnatal IPV	Maternal depression, alcohol, tobacco dependence; child hospitalizations	WFAZ and LFAZ at birth and 12 months	Cross sectional analysis of growth at birth and 12 months; linear regression and structural equation model for mediation.
6 / 5	Maternal emotional and physical intimate partner violence and early child development: investigating mediators in a cross sectional study in a South African birth cohort.	IPV at 24 months	Maternal depression and alcohol dependence	Developmental outcomes (24 months)	Cross sectional analysis at 24 months postpartum; linear regression.

Abbreviations: WFAZ=weight-for-age z-score; LFAZ=length-for-age z-score

Chapter 3 addresses the first objective of this thesis by describing patterns (utilizing latent class analysis) of IPV exposure by sub-type (emotional, physical and sexual) from pregnancy through 24 months postpartum. It investigates associations between type of childhood maltreatment and IPV latent class membership. This chapter includes a strong methodological focus to address research limitations to date; using longitudinal analysis methods to describe intensity and severity of IPV exposure by sub-type in the perinatal period, in contrast to the majority of studies which use cross sectional data. Further, a key aim of this paper is to investigate patterns of IPV by sub-type (emotional, physical and sexual) and associations with type of childhood maltreatment (emotional abuse/neglect, physical abuse/neglect or sexual abuse), expanding the current evidence base which focuses largely on only physical and/or sexual IPV.

Chapter 4 provides evidence of the possible impact of IPV, particularly emotional IPV, on food security during pregnancy and provides evidence that maternal depression is an explanatory variable in this relationship. Subsequent chapters build on this by investigating IPV and growth at birth as well as through infancy and potential pathways in these relationships. This chapter highlights the importance of comprehensive programs aimed at nutrition support or food security, as well as the importance of addressing multiple concurrent psychosocial risk factors (childhood maltreatment, IPV and depression) that may help to reduce food insecurity during pregnancy; extending the evidence base to LMIC settings, where these issues are highly prevalent but relationships are poorly understood.

Chapter 5 addresses objectives 3 & 4, investigating IPV and growth outcomes at birth as well as IPV and growth through infancy and potential explanatory variables for these relationships. As

mentioned above, there is emerging evidence, though with mixed findings, showing that postnatal IPV is associated with compromised child growth. This chapter addresses key gaps in the literature by employing a rigorous analytical approach, using longitudinal data collection and by inclusion of IPV sub-types. Further, few studies have formally investigated potential mediators in this relationship.

Chapter 6 addresses objective 5, investigating IPV and child developmental outcomes at 2 years of child age. As previously mentioned, there is relatively little research examining associations between IPV exposure and adverse developmental outcomes in infancy and early childhood, though this is a critical developmental period that can have significant implications for long-term health. Further, where investigated, including in older school-aged children, few studies incorporate a broad definition of IPV inclusive of emotional IPV in addition to physical or sexual IPV and few studies formally investigate potential explanatory factors for this relationship.

Finally, Chapter 7 summarizes the key themes across results chapters included in this thesis and considers the public health implications of these results. This chapter concludes with recommendations for both research and practice.

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Chapter 2. Study methodology

This chapter provides an overview of the Drakenstein Child Health Study, the birth cohort from which the source data for this thesis was drawn. It provides a brief overview of key measures used as well as ethical considerations.

2.1 Study design and population

2.1.1 Background: Drakenstein Child Health Study

Data for this thesis came from the Drakenstein Child Health Study, a multidisciplinary birth cohort investigating the determinants of child health in a South African community setting. The cohort consists of English, Afrikaans or isiXhosa speaking mother-infant dyads. The study investigates the role and interaction of possible risk factors in seven areas (environmental, infectious, nutritional, genetic, psychosocial, maternal and immunological risk factors, including maternal mental health and substance use) that may impact child health. The DCHS is located in a peri-urban area, in the town of Paarl within the Drakenstein subdistrict, 60 km outside Cape Town, South Africa with a population of approximately 200,000.

This is a semi-rural, accessible, low socioeconomic community. The local economy is based around commercial agriculture and light industry. The majority of the population (more than 90%) access healthcare in the public sector including antenatal and child health services. The public health system in Paarl is comprised of primary healthcare clinics and a centralized hospital, Paarl Hospital, where all study births as well as hospital admissions occur. Similar to many low-middle income countries (LMICs), there is a high prevalence of poverty-related risk factors such as

unemployment, malnutrition, alcohol misuse, tobacco smoke exposure and informal living conditions as well as a high burden of childhood diseases.

2.1.2 Recruitment and enrolment

Pregnant women (n=1,225) were enrolled between March 2012 and March 2015, with follow up visits through pregnancy, childbirth and postnatally. Participants were enrolled during their second trimester (20-28 weeks' gestation) from two primary health care clinics serving distinct population groups, TC Newman (serving a mixed ethnicity population) and Mbekweni clinic (serving a black African population). Pregnant women attending antenatal care at either of the study clinics were approached, where interested in study participation, women were consented antenatally and re-consented annually following birth. Inclusion criteria were women 18 years or older, at 20-28 weeks gestation, attending antenatal care at one of the two recruitment clinics and intending to remain in the area. Inclusion criteria were broad for the DCHS to ensure generalizability of results and the cohort population demographics are comparable to those of the source population with similar levels of education, employment and income.[1]

2.1.3 Study design and data collection

Following enrolment, pregnant women completed a battery of self-reported questionnaires at two antenatal visits. Birth measures were completed at Paarl Hospital by research nurses following birth. Mother-child dyads were then followed 6-monthly through at least 8 years of child age. Data from study visits included in the current thesis range from the enrolment visit to two years post-partum. Specific study visits and data collected are detailed in Figure 2.1. Due to the longitudinal

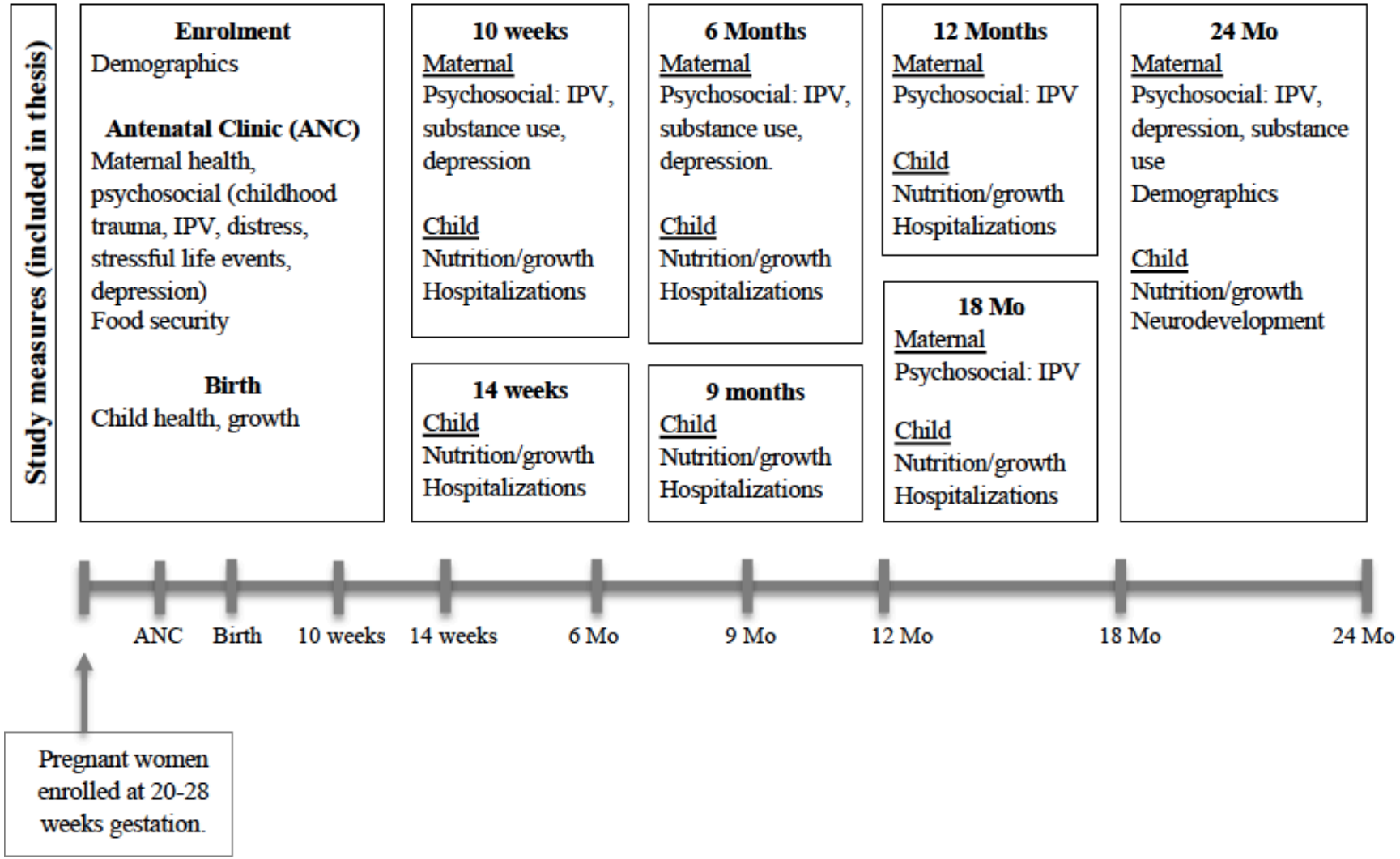

Figure 2.1 Summary of Drakenstein Child Health Study measures and data collection time points used in this thesis

nature of the parent study, sample sizes for each chapter differ, details of those lost to follow up (LTFU) and included sample are provided in the body of the relevant chapter.

2.2 Measures and data collection

Assessments and questionnaire completion were overseen by trained study staff, including occupational therapists, PhD students and research nurses. Trained fieldworkers administered the psychosocial study questionnaires to participants in their preferred language (English, Afrikaans, or isiXhosa). Research nurses completed all clinical measures including rigorous quality control procedures to ensure high quality of data collection. Fieldworkers and nurses were fluent in English and either Afrikaans or isiXhosa; all study staff were trained on all aspects of Good Clinical Practice. Details of included data are provided within each respective chapter. Briefly, key measures for the overall thesis include:

2.2.1 Intimate partner violence

The Intimate Partner Violence Questionnaire (IPVQ) is a 12-item inventory adapted from the WHO multicountry study[2] and the Women's Health Study in Zimbabwe[3] and assessed recent (past-year) exposure to emotional (4 of 12 questionnaire items), physical (5 of 12 items), and sexual abuse (3 of 12 items). Mothers were asked about exposure to partner behavior and frequency of occurrence ("never", "once", "a few times" or "many times"). Mothers completed the IPVQ at an antenatal visit and at 10 weeks, 6, 12, 18 and 24 months postpartum. Partner behavior indicating emotional IPV included having been threatened with physical harm, scared or intimidated by their partner, insulted or made to feel bad or having been humiliated in front of others. Physical IPV included being beaten or choked, slapped, pushed, shoved or hit with an object. Sexual IPV included being forced to have sex, afraid not to have sex or forced to do something sexual which

was degrading or humiliating. IPV outcomes used throughout the thesis include continuous scores as well as categorical variables.[4]

2.2.2 Maternal maltreatment in childhood

The Childhood Trauma Questionnaire (CTQ)[5] is a 28- item inventory assessing multiple domains of childhood abuse or neglect, including sexual, physical, and emotional abuse and physical and emotional neglect, occurring at or before the age of 12 years. The CTQ has been validated in similar low and middle income country settings[6,7] and has shown acceptable internal consistency in a South African sample.[8] Each item is scored on a frequency scale from 1 ("never true") to 5 ("very often true"); items are then summed to create an overall childhood maltreatment score whereby higher scores indicate greater abuse or neglect. Further, a continuous score is generated for each subscale (domain of abuse or neglect) within a range from 5 (no history of abuse or neglect) to 25 (very extreme history of abuse or neglect), resulting in domain-specific subscales. Lastly, dichotomous variables were generated indicating exposure using the following thresholds: physical neglect (score of ≥8); physical abuse (score of ≥8); emotional neglect (score of ≥10); emotional abuse (score of ≥9); and sexual abuse (score of ≥6).[5] Mothers completed the CTQ during pregnancy at 28-32 weeks' gestation.

2.2.3 Child growth

Infant birth length and weight measurements were conducted by trained labour ward staff, study staff abstracted these from patient folders. A comparison of study staff and labour ward staff infant anthropometry measurements was conducted in a subgroup of patients; there were no significant differences found.[9] Postnatal anthropometric measurements were done by trained study staff at 14

weeks, 6, 9 and 12 months. The infant's weight was measured in kilograms to the nearest 10 g and their length was measured in centimetres to the nearest 0.5 cm. Comprehensive quality control measures were in place including regular training and assessment of staff, routine calibration of equipment and taking multiple measurements.[9]

2.2.4 Child development

Bayley Scales of Infant and Toddler Development, third edition (BSID-III)[10] was used to measure toddler neurodevelopment. It is widely used to assess development in children ages 2 to 42 months and has been validated for use in South Africa.[11] Assessments for neurodevelopment were done at approximately 2 years of child age by trained physiotherapists and occupational therapists; supervision was done by a paediatric neurodevelopmental specialist.[12] Quality control and monitoring processes were implemented to ensure accuracy and consistency. In the current study, composite scores for cognition, language and motor development were used. The composite scores are calculated using a normal US population, and are standardized to have a mean of 100 and standard deviation of 15. Continuous composite scores as well as categorical outcomes are generated. Categories were defined as 'delay' (<2 standard deviations below mean), 'suboptimal development' (<1 standard deviation below mean) and 'no delay'.

2.2.5 Proposed mediators

Number of Hospitalizations included all-cause participant admissions to Paarl Hospital. Active surveillance was done by study staff at Paarl Hospital; surveillance continued after hours and over weekends. At routine study visits, mothers were asked whether children had been hospitalized,

where reported and missed by surveillance efforts, study staff would abstract relevant details of admission from hospital folders.

Validated questionnaires were administered to mothers antenatally, at 10 weeks and 6 months postpartum to assess maternal substance use and depression.[13] The Alcohol, Smoking and Substance Involvement Screening test (ASSIST) was used to assess maternal alcohol and tobacco dependence. Individual item responses were summed to generate total scores for both alcohol and tobacco dependence, with a higher score indicative of greater risk for substance-related health problems. The ASSIST has shown good reliability and validity in international, multi-site studies.[14] The Edinburgh Postnatal Depression Rating Scale (EPDS) is a 10-item self-report measure of recent depressive symptoms.[15] The EPDS has been validated in both postpartum and pregnant women[15] as well as in South Africa.[16,17] Each item is scored on a frequency scale ranging from 0 to 3. A total score is obtained by summing individual item responses, with a higher score indicative of more severe depressive symptoms.[15]

2.3 Ethical considerations

The DCHS was approved by the Faculty of Health Sciences, Human Research Ethics Committee, University of Cape Town (401/2009) and by the Western Cape Provincial Health Research committee. Mothers provided written informed consent at enrolment and were re-consented annually.

Mothers gave informed consent in their preferred language: English, Afrikaans or isiXhosa. Informed consent forms described the scope and aims of the DCHS study, including any potential

for harm or benefits and that mothers could withdraw participation at any time without impacting care for themselves or their children. Trained study staff administered all questionnaires and/or included assessments (developmental and growth); staff were additionally trained on the ethical conduct of violence research, including confidentiality, mandatory reporting and safety issues. Staff were trained to recognize signs of mental health issues (depression, PTSD symptoms and suicide risk) and to appropriately refer to care or social services in the Paarl area. Additionally, staff were trained to recognize circumstances endangering mothers or children, including Department of Health mandatory reporting requirements for child endangerment. Examples of referral facilities include Thusong Service Centre, the Western Cape Department of Social Services and Psychiatric staff at TC Newman clinic and Paarl Hospital. Further all women involved in the study received information regarding service providers in the area, including for issues of substance abuse, IPV and mental health issues), independent of self-reported or staff-identified mental or physical health issues.

Participants were informed at enrolment and during the annual reconsenting process that they may withdraw at any time from the study or decline to participate in certain aspects and that this would not affect the any care themselves or their child received. Interviews were conducted privately, data were de-identified and only accessible by study staff to ensure confidentiality. As far as possible, children's comfort was taken into account throughout all study visits and assessments - interviews were conducted in a private space and mothers and children were given breaks where lengthy interviews or assessments were conducted.

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Chapter 3: Maltreatment in childhood and intimate partner violence: a latent class growth analysis in a South African pregnancy cohort.

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Relevance of this paper to the thesis:

This Chapter addresses the first objective of this thesis by describing patterns (utilizing latent class analysis) of IPV exposure by sub-type (emotional, physical and sexual) from pregnancy through 24 months postpartum. It investigates associations between type of childhood maltreatment and IPV latent class membership. This chapter addresses research limitations to date by using longitudinal data and analysis to describe intensity and severity of IPV and to investigate these patterns by sub-type of IPV, expanding the current evidence base which focuses largely on only physical and/or sexual IPV.

Contribution of the student and co-authors:

I conceptualized the study aims and methodology together with my supervisors as well as co-authors (SH, AF, JH). I conducted all analyses, however, statistical advice and guidance was provided by JH. I wrote the initial manuscript draft and all co-authors reviewed it, providing conceptual and intellectual input. All authors were involved in the final draft of the manuscript.

3.1 Abstract

Intimate partner violence (IPV) is a significant global problem, prevalent in low and middle-income countries (LMICs). IPV is particularly problematic during the perinatal and early postnatal period, where it is linked with negative maternal and child health outcomes. There has been little examination of profiles of IPV and early life adversity in LMIC contexts. We aimed to characterize longitudinal IPV and to investigate maternal maltreatment in childhood as a predictor of IPV exposure during pregnancy and postnatally in a low resource setting. This study was nested in the Drakenstein Child Health Study, a longitudinal birth cohort. Maternal IPV (emotional, physical and sexual) was measured at six timepoints from pregnancy to two years postpartum (n=832); sociodemographic variables and maternal maltreatment in childhood were measured antenatally at 28-32 weeks' gestation. Associations between maternal maltreatment in childhood and IPV latent class membership (to identify patterns of maternal IPV exposure) were estimated using multinomial and logistic regression. We observed high levels of maternal maltreatment during childhood (34%) and IPV during pregnancy (33%). In latent class analysis separating by IPV sub-type, two latent classes of no/low and moderate sexual IPV and three classes of low, moderate, and high emotional and physical IPV (separately) were detected. In combined latent class analysis, including all IPV sub-types together, a low, moderate and high exposure class emerged as well as a high antenatal/decreasing postnatal class. Moderate and high classes for all IPV sub-types and combined analysis showed stable intensity profiles. Maternal childhood sexual abuse, physical abuse and neglect, and emotional abuse predicted membership in high IPV classes, across all domains of IPV (aORs between 1.99 and 5.86). Maternal maltreatment in childhood was associated with increased probability of experiencing high or moderate intensity IPV during and around pregnancy; emotional neglect was associated with decreasing IPV class for combined model. Intervening early to disrupt this cycle of abuse is critical to two generations.

3.2 Introduction

As discussed in Chapter 1, the WHO found lifetime prevalence rates of exposure to physical or sexual partner violence of 15% to 71% in a recent multi-country study.[1] The epidemic of intimate partner violence (IPV), predominantly affecting women, is particularly high in low and middle-income countries (LMICs), including South Africa.[2,3] Levels of violence in South Africa are some of the highest globally; the intimate female homicide rate in South Africa is 5.6 per 100,000, more than double the rate in the United States.[4] This amounts to one woman being killed by an intimate partner every 8 hours.[5] In South Africa interpersonal violence, including IPV, accounts for 10.9% of all disability-adjusted life years (DALYs).[6]

Of particular concern is violence toward pregnant women, as it carries unique pregnancy-related risk and can have long-term consequences for both maternal and child health. A review of African studies focussing on IPV during pregnancy, found that prevalence in African countries is among the highest globally, with reported rates from 2% (Nigeria) to 57% (Uganda).[7] IPV exposure has been linked to physical and psychological stress, anxiety, low energy, diminished social function and substance use disorders[8,9] all of which may impact fetal growth, development and neurocognitive outcomes in the children of exposed women[10-12] Further, IPV exposure during pregnancy has been linked to increased risk of pregnancy loss,[13] preterm labour, pregnancy complications and delivering low birth weight infants.[8,14,15] In the South African context, IPV also increases risk of maternal – and hence vertical - HIV infection.[16-18]

Few studies have investigated longitudinal patterns of IPV during pregnancy and the postpartum period. The limited existing evidence is inconsistent, with some studies showing an increased risk during pregnancy compared to postpartum[19] and others showing a decreased

risk from pre-pregnancy to pregnancy.[20,21] Where studies have found that pregnancy increases a woman's risk for IPV victimization, reasons for this have included increased financial strain[22,23] or conflict arising from an unwanted pregnancy.[24] Investigating longitudinal IPV exposure perinatally may provide insight into how pregnancy affects the pattern of maternal risk of IPV exposure over the course of this critical period. Further, few studies have looked at the intensity of IPV in women during this time of increased vulnerability.

Physical, sexual and emotional abuse or neglect during childhood is widespread in South Africa, with reported prevalence rates of 9% to 34%.[25,26] Studies in high-income settings have found links between physical abuse as well as sexual abuse in childhood and risk of IPV victimization[27] or perpetration in adulthood.[28] In particular, childhood sexual abuse has been well documented as a predictor of sexual revictimization.[29] There are limited data from African settings; these show that physical or sexual childhood abuse increases the risk of IPV in adulthood.[1] In addition, South African studies have shown a link between male childhood abuse and IPV perpetration[30,31] and an increased risk of IPV victimization where men or women had a history of childhood sexual abuse.[2,32] However, none of these studies investigated childhood emotional neglect or abuse, which typically occurs alongside other forms of abuse, and has a unique and sometimes compounding affect above physical or sexual IPV, in particular for mental health outcomes.[33-35]

The current study aimed to address critical gaps in the literature relevant to settings where high rates of childhood maltreatment and IPV co-occur. First, it investigated IPV exposure longitudinally, from mid-pregnancy through to 2 years following birth, to better understand patterns of risk for pregnant women. Second, it investigated the association of maternal maltreatment in childhood with perinatal and subsequent IPV, and the possibility of differential

associations across sub-types of both childhood maltreatment and adult IPV exposure. Importantly, data for this study were derived from a pregnancy cohort from a low resource setting in South Africa, where high rates of childhood maltreatment and IPV co-exist and where unique cultural and social factors may impact associations differently than in high-income country settings.

3.3 Methods

As discussed in more detail in chapter 2, this study is nested in the Drakenstein Child Health Study (DCHS), a multidisciplinary birth cohort investigating the determinants of child health in a peri-urban area in South Africa.[36] Here I briefly review the methods relevant to the specific aims of this chapter. Data used in the current study were collected from pregnant women enrolled into the DCHS from March 2012 to March 2015.

3.3.1 Setting

The DCHS is located in the Drakenstein area in the town of Paarl, a peri-urban area, 60 km outside Cape Town, South Africa with a population of approximately 200,000. More than 90% of the population access health care in the public sector including antenatal and child health services. This area has a well-established, free primary health care system. An area of focus in the DCHS is investigating maternal psychosocial risk factors of child health.[37]

3.3.2 Participants

Pregnant women were recruited from two primary health care clinics, Mbekweni (serving a predominantly black African community) and TC Newman (serving a mixed ancestry community). Mothers were enrolled in the DCHS at 20 to 28 weeks' gestation while attending routine antenatal care and are prospectively followed through their pregnancy until 5 years postnatally. Women were eligible for the study if they were 18 years or older, between 20-28

weeks gestation, planned attendance at one of the two recruitment clinics and intended to remain in the area. Data included in the current study were collected antenatally at 28-32 weeks' gestation and postnatally at 10 weeks, 6, 12, 18 and 24 months.

Between March 2012 and March 2015, 1225 pregnant women were enrolled into the DCHS antenatally; 88 (7.2%) mothers were lost to follow up antenatally, had a miscarriage or a stillbirth. Of the 1137 women who had live births, 100 mothers did not attend the second antenatal visit, where sociodemographic variables and childhood maltreatment data were collected. Of the 1037 mothers who did attend this visit, 832 (80%) were included in this analysis, restricted to those who contributed data for at least 3 of the 6 time points. A sensitivity analysis was done to compare all included variables between mothers included and excluded in the current analysis (Supplemental Table 3.1, further detail in Statistical Analysis section).

3.3.3 Measures

IPV exposure: The Intimate Partner Violence Questionnaire (IPVQ) is a 12-item inventory adapted from the WHO multicountry study[38] and the Women's Health Study in Zimbabwe[7] and assessed recent (past-year) exposure to emotional (4 of 12 questionnaire items), physical (5 of 12 items), and sexual abuse (3 of 12 items). Mothers were asked about exposure to partner behavior and frequency of occurrence ("never", "once", "a few times" or "many times"). Mothers completed the IPVQ at the 28-32 week antenatal visit and at 10 weeks, 6, 12, 18 and 24 months postpartum. Partner behavior indicating emotional IPV included having been insulted or made to feel bad, having been humiliated in front of others, intentionally scared or intimidated or threatened with physical harm. Physical IPV included being slapped, pushed, shoved, hit with an object, beaten or choked. Sexual IPV exposure was classified based on having been forced to have sex, afraid not to have sex or forced to do something sexual which

was degrading or humiliating. Using questionnaire responses mothers were grouped into four categories of exposure: no IPV where all past year behaviors were "never" experienced; isolated or low IPV was designated where any past year behaviors were experienced as "once" and none more frequently than once; moderate where past year behavior was experienced "a few times"; and high where "many times" was indicated. This was done at each of the six time points to investigate changing exposure patterns during the 2 year period of follow up. Scoring guidelines were devised for the purposes of this study, and were based on prior work in South Africa.[39]

Maternal Maltreatment in Childhood: The Childhood Trauma Questionnaire (CTQ)[40] is a 28-item inventory assessing three domains of childhood abuse (sexual, physical, and emotional), and two domains of childhood neglect (physical and emotional), occurring at or before the age of 12 years. Each item is scored on a frequency scale from 1 ("never true") to 5 ("very often true"), such that each subscale (domain of abuse or neglect) is scored on a spectrum from 5 (no history of abuse or neglect) to 25 (very extreme history of abuse or neglect). Dichotomous variables were included in the present analysis, as previously described, such that above threshold for each domain was defined as: physical neglect (score of ≥8); physical abuse (score of ≥8); emotional neglect (score of ≥10); emotional abuse (score of ≥9); and sexual abuse (score of ≥6).[40] Mothers completed the CTQ antenatally at 28-32 weeks' gestation.

Sociodemographic variables were collected from an adapted questionnaire used in the South African Stress and Health (SASH) study.[41] Maternal age, income [<R,1000/month (100USD) or >R1,000/month], education (any secondary versus completed secondary), employment and partnership status (single or married/marriage-like relationship) were self-reported antenatally at 28-32 weeks' gestation.

3.3.4 Ethical considerations

The DCHS was approved by the Faculty of Health Sciences, Human Research Ethics Committee, University of Cape Town (401/2009) and by the Western Cape Provincial Health Research committee. Mothers provided informed consent in their preferred language: English, Afrikaans or isiXhosa and were given R100 (approximately 8USD) for travel reimbursement to reach study sites. Study staff were trained on the content of questionnaires and ethical conduct of violence research, including confidentiality and safety issues. Interviews were conducted privately, data were de-identified and only accessible by study staff to ensure confidentiality. Staff were trained to recognise signs of mental health issues (depression, PTSD symptoms and suicide risk) as well as circumstances endangering mothers or children, including Department of Health mandatory reporting requirements for endangerment. Where identified, staff were trained to refer participants to appropriate care or social services in the Paarl area specialising in the issue identified (including support services for IPV, substance abuse and mental health issues). Further, all women involved in the study, independent of identified mental or physical health issues, receive information regarding social and support service providers in the area.

3.4 Statistical analysis

Latent class growth analysis (LCGA) was used to derive latent classes indicating severity patterns of emotional, physical and sexual recent IPV victimization separately and across the six time points included (pregnancy, 10 weeks, 6, 12, 18, 24 months). LCGA is a type of growth mixture modelling (GMM) in which there is no within-class variability modelled. Categorical IPV data (consisting of 4 categories of exposure: no, low, moderate and high) was used to estimate the latent classes. Compared to latent class analysis (LCA), LCGA of categorical data allows for a more parsimonious model. In the Mplus implementation, continuous Gaussian variables are assumed to underpin each categorical class-indicator, so the item thresholds are

also modelled more efficiently. LCGA was used to create longitudinal classes separately of IPV sub-types.[42]

A second analysis was done to investigate patterns across all sub-types of IPV. This analysis builds upon the association models discussed above – by utilizing latent class analysis (LCA) to determine combined latent classes for all IPV sub-types (across same 6 time points) to investigate differential profiles considering all IPV sub-types (sexual, physical & emotional). LCA was used as an analytic approach to allow within class variation to enable different patterns between groups of key variables to emerge within each class; thus allowing cross sectional and longitudinal heterogeneity to be captured. Both LCGA and LCA group individuals into classes based on profiles of indicator variables, allowing identification of heterogenous groups of homogenous person-centred patterns.[43]

LCGA and LCA analyses were completed in MPlus 8.0. Optimal number of classes were determined based on multiple statistical criteria, including Akaike Information Criterion (AIC) and sample size adjusted Bayesian Information Criterion (ssaBIC) as well as sufficient class size.[43] To ensure a meaningful class size and allow clinically relevant interpretation, we excluded any models where the smallest class was fewer than 30 women, similar to other studies.[44-46] To investigate associations of maternal maltreatment in childhood (by subtype) with LCGA and LCA class membership for IPV, we utilized the bias-adjusted 3-step approach, which takes into account inaccuracy of class assignment.[47,48] Using this 3-step approach, multinomial logistic regression analyses were performed; sociodemographic variables (education, employment, site of enrolment, income, maternal age and whether married) were included in the LCGA and LCA models as covariates.

All analyses were restricted to mothers who contributed data for at least three of the six time points to enable investigation of changes over time for all included women [832 (73.2%) of the 1137 women who had live births, were included]. A sensitivity analysis was done to ensure there were no meaningful differences for key variables (childhood maltreatment, antenatal IPV or sociodemographics) for mothers included compared to mothers excluded in the current analysis (Supplemental Table 3.1). No meaningful differences were found between for variables included in the present analysis.

3.5 Results

3.5.1 Sociodemographic, maternal maltreatment in childhood and IPV variables

The study sample was characterized by low levels of education, and a minority of mothers were employed (25%) or were married/in a stable relationship (40%). The majority were born in the study area (Paarl; 64%), and earned >R1,000 per month (USD100). Median age was 26.2 years

Table 3.1 Sociodemographic characteristics of study population by latent class membership (n=832)

Variable	Total sample	Emotional IPV (high exposure class)	Physical IPV (high exposure class)	Sexual IPV (high exposure class)
	n=832	n=37	n=69	n=58
Demographic variables[a]				
TC Newman	389 (47%)	27 (73%)	47 (68%)	48 (83%)
Maternal education				
Some secondary	531 (64%)	28 (76%)	52 (75%)	45 (78%)
Completed secondary	301 (36%)	9 (24%)	17 (24%)	13 (22%)
Maternal Birthplace				
Outside Paarl	302 (36%)	4 (11%)	9 (13%)	0 (0%)
Paarl	530 (64%)	33 (89%)	60 (87%)	58 (100%)
Maternal Employment				
Unemployed	628 (75%)	30 (81%)	61 (88%)	46 (79%)
Working	204 (25%)	7 (19%)	8 (12%)	12 (21%)
Partnership status				
Single	496 (60%)	18 (49%)	41 (59%)	36 (62%)
Married/marriage-like	336 (40%)	19 (51%)	28 (41%)	22 (38%)
Income				
<R1,000/mo	326 (39%)	13 (35%)	29 (42%)	303 (39%)
>R1,000/mo	506 (61%)	24 (65%)	40 (58%)	471 (61%)
Maternal age	26.2 (22.1, 30.9)	27.0 (23.6, 33.0)	24.7 (21.9, 29.2)	26.1 (22.2, 29.9)

[a]*demographic variables were collected antenatally at 28-32weeks' gestation*

(Table 3.1). Levels of childhood exposure to maltreatment were high, with over a third of the sample reporting at least one form of maltreatment and 5% reporting all five types (Table 3.2). Polyvictimization based on IPV class membership was prevalent; 44% of women were grouped into high or moderate IPV classes for at least one sub-type with 6% grouped into high or moderate classes for all three IPV sub-types, Table 3.2. IPV severity prevalence rates across time points and by sub-type are presented in Supplemental Table 3.2.

Table 3.2 Childhood maltreatment prevalence and polyvictimization in study population (n=832)

Variable	Total sample	Emotional IPV (high exposure class)	Physical IPV (high exposure class)	Sexual IPV (high exposure class)
Psychosocial variables	n=832	n=37	n=69	n=58
Childhood Maltreatment (above threshold) [a]				
Physical Neglect	279 (34%)	18 (49%)	32 (46%)	31 (53%)
Emotional Abuse	263 (32%)	23 (62%)	39 (57%)	41 (71%)
Emotional Neglect	230 (28%)	22 (59%)	34 (49%)	35 (60%)
Physical Abuse	189 (23%)	15 (41%)	29 (42%)	22 (38%)
Sexual Abuse	137 (16%)	13 (35%)	26 (38%)	25 (43%)
Any maltreatment	284 (34%)	24 (65%)	46 (67%)	42 (72%)
Polyvictimization : childhood maltreatment				
2 types	138 (17%)			
3 types	80 (10%)			
4 types	46 (6%)			
5 types	39 (5%)			
Polyvictimization: Intimate Partner Violence (overlapping class membership)[b]				
None	465 (56%)			
1 type	142 (17%)			
2 types	173 (21%)			
3 types	52 (6%)			

[a] *childhood maltreatment variables were collected antenatally at 28-32 weeks' gestation*
[b] *number and percentage of women exposed to high or moderate IPV for emotional, physical or sexual IPV classes.*

3.5.2 Emotional IPV latent class analysis and association with child maltreatment

Model fit statistics for models with a varying number of classes are presented in Table 3.3. A 3-class model was chosen for emotional IPV, based on lowest ssaBIC and AIC while retaining a meaningful class size; entropy was 0.732. Women in the first class were characterized by no or isolated/low emotional IPV over time with increased probability of emotional IPV exposure

Table 3.3 Fit statistics for LCGA and LCA models for IPV[a]

	# classes	ssaBIC	AIC	Entropy	Smallest class (%)
Emotional	**2**	5934.726	5920.792	0.779	171 (21)
	3	**5879.291**	**5859.165**	**0.732**	**37 (4)**
	4	5867.095	5840.775	0.78	12 (1)
	5	5872.415	5839.903	0.835	10 (1)
Physical	**2**	5617.393	5603.459	0.777	178 (21)
	3	**5578.992**	**5558.865**	**0.643**	**69 (8)**
	4	5569.026	5542.707	0.688	8 (1)
	5	5571.706	5539.194	0.728	8 (1)
Sexual	**2**	**2031.617**	**2017.684**	**0.883**	**58 (7)**
	3	2033.464	2013.337	0.909	11 (1)
Combined IPV	2	13221.576	13052.563	0.900	193 (23)
	3	12960.099	12705.804	0.863	98 (12)
	4	**12922.318**	**12582.743**	**0.879**	**67 (8)**
	5	12947.766	12522.909	0.871	63 (8)
	6	12991.713	12481.574	0.874	22 (3)

[a]*AIC = Akaike's information criterion; ssaBIC = sample-size adjusted Bayesian information criterion; Selected models appear in **bold**. All models included covariates. Childhood maltreatment variables collected at 28-32 weeks' gestation; IPV variables collected antenatally, at 10 weeks, 6, 12, 18 & 24 months postnatally.*

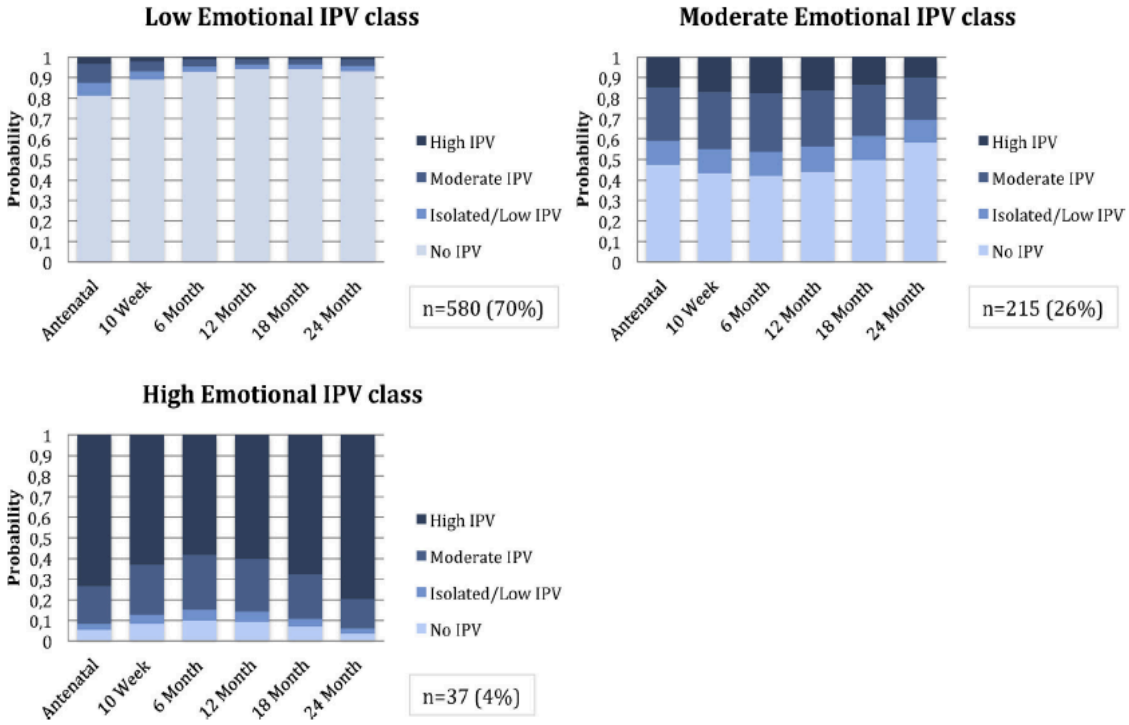

Figure 3.1 Emotional intimate partner violence latent classes: probabilities of exposure across visits

during pregnancy compared to postpartum (n=580; 70%). Women in the second class were characterized by moderate emotional IPV over time (n=215; 26%); those in the third class were characterized by high IPV across time points (n=37; 4%), Figure 3.1.

The no/low emotional IPV class was treated as the reference class for multinomial regression. Exposure to childhood abuse of all types was associated with membership in the high emotional IPV exposure class (versus the low/no exposure) [sexual abuse (OR 4.28; 95% CI 1.48, 12.39); emotional abuse (OR 4.31; 95% CI 1.67,11.13); physical abuse (OR 3.16; 95% CI 1.22, 8.18), emotional neglect (OR 2.76; 95% CI 1.31, 6.73) as well as physical neglect (OR 3.74; 95% CI 1.48, 9.44)], Table 3.4. Childhood experience of physical abuse (OR 2.01; 95% CI, 1.10, 3.69) and physical neglect (OR 1.67; 95% CI, 1.03, 2.70) was associated with membership in the moderate emotional IPV class, Table 3.4.

3.5.3 Physical IPV latent class analysis and association with child maltreatment

A 3-class model was chosen for physical IPV, based on lowest ssaBIC and AIC as well as meaningful class size; entropy was 0.643, Table 3.3. Women in the first class were characterized by low/isolated or no IPV with slightly increased probabilities of exposure during pregnancy, compared to postpartum (n= 498; 60%); women in the second class were characterized by moderate physical IPV over time (n=265; 32%); and women in the third class were characterized by high IPV over time (n=69; 8%), Figure 3.2.

Exposure to each of the child maltreatment domains was significantly associated with membership in the high physical IPV class compared to the no/low physical IPV class. Exposure to child maltreatment increased this risk by between 2 to 5-fold [sexual abuse (OR 5.86; 95% CI 2.63, 13.08; p-value <0.001), emotional neglect (OR 3.30; 95% CI 1.63, 6.64),

Table 3.4 Maternal childhood maltreatment type and associations with maternal perinatal IPV latent class membership by IPV sub-type (n=832)

	Childhood maltreatment type[a]	Emotional IPV: High vs Low class				Emotional IPV: Moderate vs Low class			
		OR[b]	AOR[c]	95% CI	p-value	OR[b]	AOR[c]	95% CI	p-value
Emotional IPV	Sexual Abuse	5.85	4.28	1.48; 12.39	0.007	1.99	1.54	0.87; 1.00	0.135
	Emotional Neglect	3.30	2.76	1.31; 6.73	0.025	1.82	1.69	0.99; 2.86	0.050
	Emotional Abuse	6.62	4.31	1.67; 11.13	0.003	2.16	1.68	0.99; 2.84	0.053
	Physical Neglect	5.99	3.74	1.48; 9.44	0.005	2.24	1.67	1.03; 2.70	0.036
	Physical Abuse	4.37	3.16	1.22; 8.18	0.017	2.19	2.01	1.10; 3.69	0.024
	Childhood maltreatment type[a]	**Physical IPV: High vs Low class**				**Physical IPV: Moderate vs Low class**			
		OR[b]	**AOR[c]**	**95% CI**	**p-value**	**OR[b]**	**AOR[c]**	**95% CI**	**p-value**
Physical IPV	Sexual Abuse	6.81	5.86	2.63; 13.08	<0.001	1.32	0.88	0.45; 1.71	0.706
	Emotional Neglect	3.28	3.30	1.63; 6.64	0.001	0.96	0.67	0.94; 1.30	0.238
	Emotional Abuse	4.20	2.89	1.33; 6.30	0.007	1.80	1.57	0.87; 2.81	0.134
	Physical Neglect	4.47	2.79	1.40; 5.56	0.004	1.45	1.20	0.70; 2.07	0.518
	Physical Abuse	5.20	4.95	2.10; 11.70	<0.001	1.51	1.24	0.59; 2.63	0.569
	Childhood maltreatment type[a]	**Sexual IPV: High vs Low class**							
		OR[b]	**AOR[c]**	**95% CI**	**p-value**				
Sexual IPV	Sexual Abuse	6.81	5.44	2.43; 12.19	<0.001				
	Emotional Neglect	2.37	1.89	0.95; 3.79	0.070				
	Emotional Abuse	5.15	3.31	1.60; 6.94	0.001				
	Physical Neglect	7.09	4.38	2.04; 9.41	<0.001				
	Physical Abuse	5.07	4.54	2.07; 9.94	<0.001				

[a] *Childhood maltreatment sub-types included as dichotomous exposure (data collected antenatally at 28-32 weeks' gestation).*

[b] *Unadjusted multinomial logistic regression model. Odds ratios generated for each childhood maltreatment type and association with maternal membership in indicated IPV exposure class (high versus low and moderate versus low exposure over time). All childhood maltreatment types were included in separate models because of collinearity between maltreatment sub-types.*

[c] *Adjusted multinomial logistic regression models were controlled for key sociodemographic variables (maternal age, maternal income, maternal employment, maternal education, site of enrolment and partnership status, collected antenatally at 28-32 weeks' gestation). All childhood maltreatment types were included in separate models because of collinearity between maltreatment sub-type.*

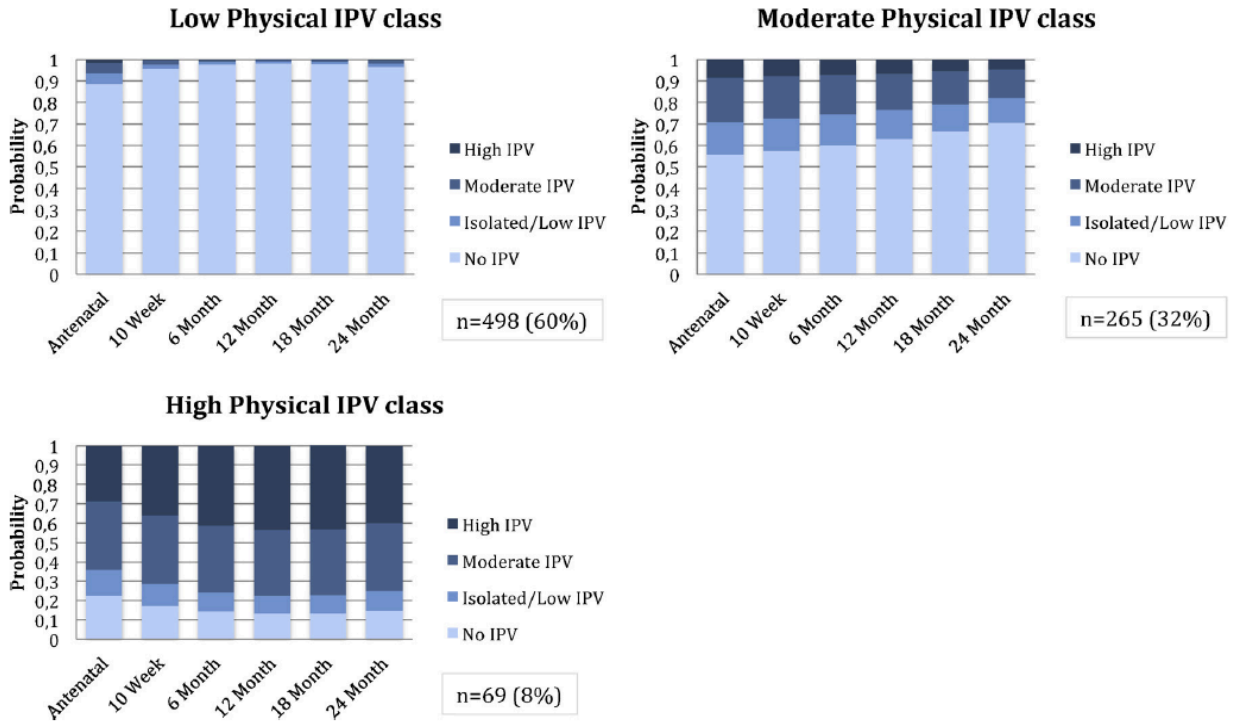

Figure 3.2 Physical intimate partner violence latent classes: probabilities of exposure across visits.

emotional abuse (OR 2.89; 95% CI 1.33, 6.30), physical neglect (OR 2.79; 95% CI 1.40, 5.56), physical abuse (OR 4.95; 95% CI 2.10, 11.70), Table 3.4. No domains of childhood exposure to maltreatment were significantly associated with membership in the moderate physical IPV class (versus the no/low physical IPV class).

3.5.4 Sexual IPV latent class analysis and association with child maltreatment

For the LCA model of sexual IPV, the 2-class solution was chosen based on lowest ssaBIC and comparable AIC (to the 3-class solution) while retaining a meaningful class size; entropy was 0.879, indicating a good degree of class separation, Table 3.3. Women in the first class were characterized by low/no sexual IPV over time (n=774;93%); women in the second class were characterized by high or moderate IPV over time (n=58; 7%), Figure 3.3.

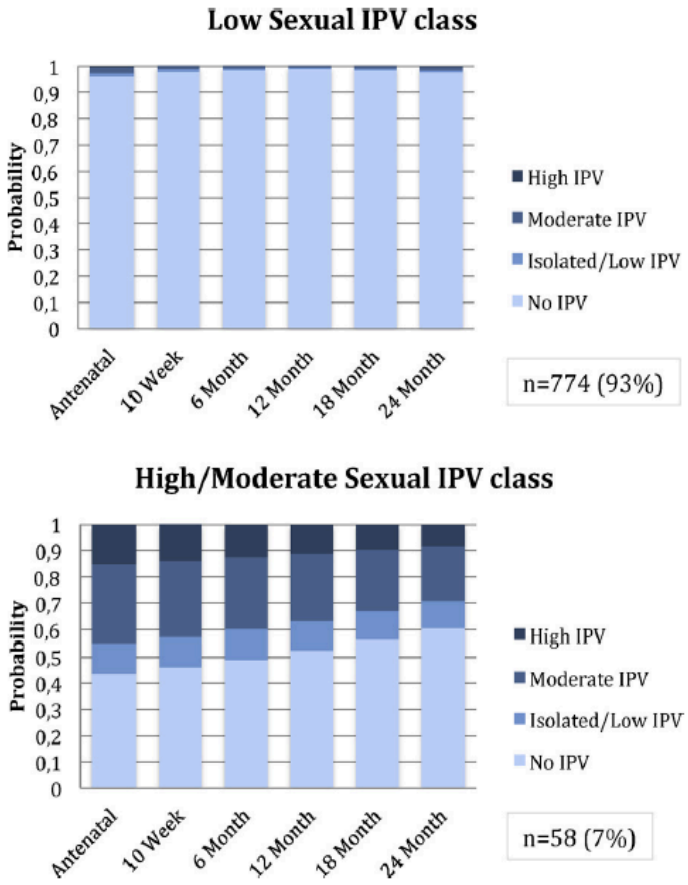

Figure 3.3 Sexual Intimate Partner Violence Latent classes: probabilities of exposure across visits

Table 3.5 Maternal childhood maltreatment type and associations with maternal perinatal IPV combined latent class membership (n=832)

Combined IPV classes	Childhood maltreatment type[a]	High vs Low class OR[b]	AOR[c]	95%CI	p-value
	Sexual Abuse	4.23	2.97	1.50; 5.91	0.002
	Emotional Neglect	2.45	1.99	1.11: 3.59	0.020
	Emotional Abuse	3.89	2.46	1.31; 4.61	0.004
	Physical Neglect	4.5	2.93	1.63; 5.31	<0.001
	Physical Abuse	4.71	3.61	1.85; 7.01	<0.001
	Childhood maltreatment type[a]	**Moderate vs Low class OR[b]**	**AOR[c]**	**95%CI**	**p-value**
	Sexual Abuse	1.48	1.33	0.79; 2.27	0.296
	Emotional Neglect	1.01	0.96	0.55; 1.66	0.890
	Emotional Abuse	1.75	1.64	0.99; 2.75	0.061
	Physical Neglect	1.36	1.16	0.73; 1.86	0.540
	Physical Abuse	2.06	2.23	1.26; 3.93	0.006
	Childhood maltreatment type[a]	**Decreasing vs Low class OR[b]**	**AOR[c]**	**95%CI**	**p-value**
	Sexual Abuse	2.37	1.93	0.94; 4.00	0.074
	Emotional Neglect	2.26	1.96	1.04; 3.66	0.037
	Emotional Abuse	2.33	1.75	0.92; 3.35	0.090
	Physical Neglect	1.36	1.16	0.73; 1.86	0.540
	Physical Abuse	2.02	1.46	0.66; 3.27	0.350

[a] *Childhood maltreatment sub-types included as dichotomous exposure (data collected antenatally at 28-32 weeks' gestation).*

[b] *Unadjusted multinomial logistic regression model. Odds ratios generated for each childhood maltreatment type and association with maternal membership in indicated IPV exposure class (high versus low, moderate versus low and decreasing versus low exposure over time). All childhood maltreatment types were included in separate models because of collinearity between maltreatment sub-types.*

[c] *Adjusted multinomial logistic regression models were controlled for key sociodemographic variables (maternal age, maternal income, maternal employment, maternal education, site of enrolment and partnership status, collected antenatally at 28-32 weeks' gestation). All childhood maltreatment types were included in separate models because of collinearity between maltreatment sub-type.*

Childhood exposure to sexual abuse (OR 5.44; 95% CI 2.43, 12.19), emotional abuse (OR 3.31; 95% CI 1.60, 6.94), physical neglect (OR 4.38; 95% CI 2.04, 9.41) and physical abuse (OR 4.54; 95% CI 2.07, 9.94) was associated with membership in the high/moderate sexual IPV class, Table 3.4.

3.5.5 Latent class analysis of maternal maltreatment in childhood and all IPV sub-types

To investigate profiles of maternal IPV across sub-types, latent class analysis was done. A four class model was chosen based on lowest ssaBIC (compared to the 3-class model), Table 3.5. Smallest class size was n=67 (8%); entropy was 0.879. Class 1, high IPV combined class (n=67), was characterized by high physical, emotional and sexual IPV from pregnancy to 2 years postnatally. Class 2, decreasing IPV combined class (n=82), was characterized by high/moderate antenatal IPV across sub-types, with decreasing probability of IPV exposure through 2 years postnatally. Class 3, moderate IPV combined class (n=160), was characterized by moderate

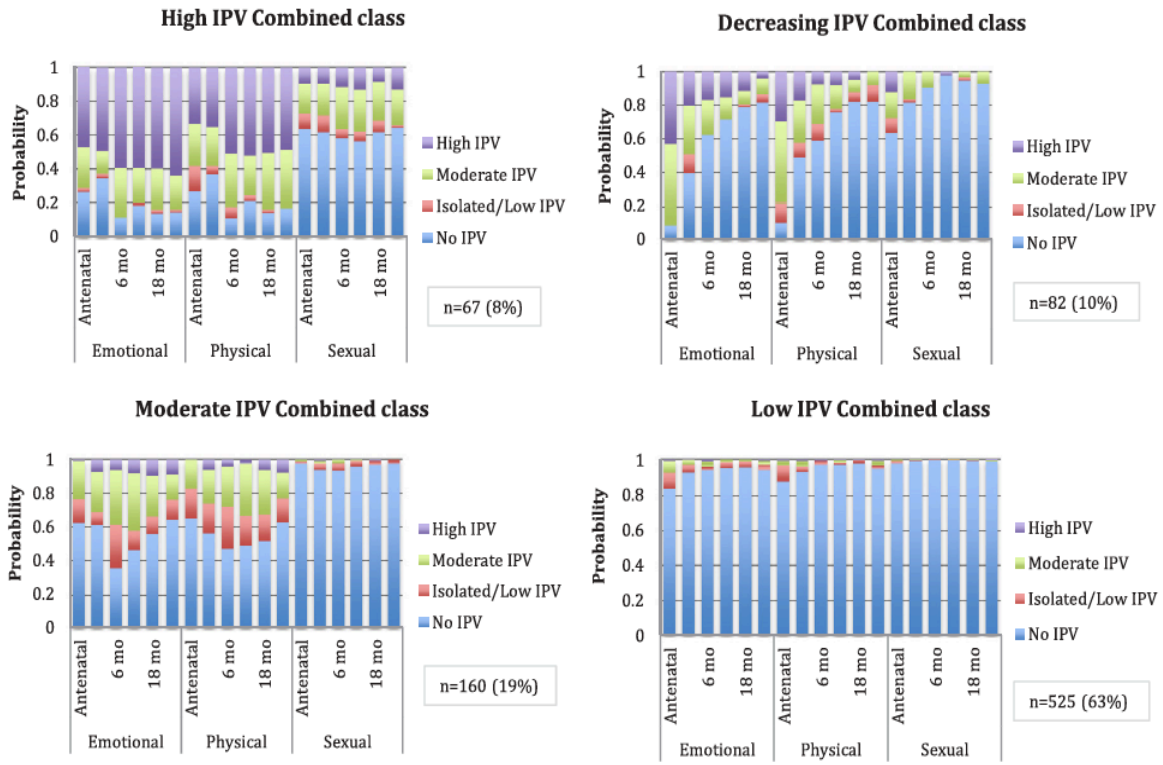

Figure 3.4 Latent class analysis of combined IPV sub-types (emotional, physical and sexual IPV).

emotional and physical IPV over time and very low sexual IPV. Class 4, low IPV combined class, (n=525) had low/no probabilities of IPV across sub-types through 2 years postnatally, Figure 3.4.

Exposure to each of the child maltreatment domains was significantly associated with membership in the high combined IPV class (class 1) compared to the no/low IPV class (class 4). Exposure to child maltreatment increased this risk by between 2 to 3.6-fold [sexual abuse (aOR 2.97; 95% CI 1.50, 5.91), emotional neglect (aOR 1.99; 95% CI 1.11, 3.59), emotional abuse (OR 2.46; 95% CI 1.31, 4.61), physical neglect (aOR 2.93; 95% CI 1.63, 5.31), physical abuse (aOR 3.61; 95% CI 1.85, 7.01), Table 3.5. Maternal childhood exposure to physical abuse was significantly associated (aOR 2.23; 95%CI 1.26, 3.93) with membership in the moderate compared to low IPV class. Childhood emotional neglect was significantly associated (aOR 1.96; 95% CI 1.04, 3.66) with membership in the decreasing (versus low) IPV class.

3.6 Discussion

In this birth cohort study, based in a peri-urban area of South Africa, there were high reported levels of maternal maltreatment in childhood as well as IPV during pregnancy and during the postpartum period. The current study investigated longitudinal patterns of IPV severity, both separately by IPV sub-type (emotional, physical, sexual) and longitudinal patterns where all IPV sub-types were combined. In both analyses mothers were grouped into patterns of high, moderate and low exposure groups, indicating chronic exposure where present. However, also emerging in the combined analysis, was a group of mothers with very high levels of IPV antenatally – representing 10% of the sample, this is both a large proportion of women as well as women with exposure probabilities approximately as high as those in the high longitudinal exposure group. For

both analyses considering longitudinal patterns of IPV, membership in the high versus low class was associated with all types of maternal childhood maltreatment, indicating a relationship between maternal childhood maltreatment and severity of adult exposure to IPV.

Previous South African studies have reported lower prevalence of IPV during pregnancy across sub-types (emotional at 15%-19.2%;[49,50] physical at 4.7%-15%;[50,51] and sexual at 2%- 3.2%[6,50]). In our sample, prevalence of recent IPV during pregnancy was very high, with 24%, 18% and 6% of mothers reporting exposure for emotional, physical and sexual IPV respectively. This may be due to a number of factors. Few studies in South Africa have reported pregnancy rates of IPV, specifically by sub-type, though rates from our sample are within ranges where combined (30% for physical+sexual IPV[2]) or reported from other African countries, such as Nigeria (39%, any-type IPV[7]). Further, of the two other South African studies reported, one was in Durban, which has lower overall rates of violence than the Western Cape, where the current study is located. The other was restricted to a sample of Black African participants, whereas reported rates were slightly higher in the mixed-ancestry community included in our study sample. Culture and gender norms within focal communities may in part explain our high prevalence of IPV. Zembe and colleagues investigated social risk factors and relationship power inequity and IPV in a sample in the Western Cape, finding high acceptability of violence in intimate relationships as well as gender norms supporting aggressive masculinity and subservient femininity, particularly in historically marginalized groups such as those included in the present study.[52]

Distinctive patterns of longitudinal IPV exposure emerged, when investigating separate IPV sub-type profiles, classifying women into high, moderate and low exposure groups over time for

emotional and physical IPV and a high/moderate and no/low exposure group for sexual IPV. As expected the largest classes for each IPV sub-type were characterized by no/low IPV exposure. However a significant proportion of women were in high or moderate classes and, importantly, in low exposure groups there was an increase in IPV exposure during pregnancy across all IPV sub-types. Childhood physical, emotional and sexual abuse, as well as physical neglect, were all significantly associated with membership in the high IPV exposure classes compared to no or low exposure classes.

There was a large degree of longitudinal stability within classes, which indicates a consistent and repeated pattern of IPV exposure, based on IPV sub-type and intensity of exposure, from pregnancy through two years postpartum. Further, a large proportion of women (30-40%) were grouped into high or moderate classes for both physical and emotional IPV. These women exhibit sustained risk and were exposed to prolonged high or moderate intensity IPV. Though this may be a pattern already established and unrelated to pregnancy, it appears to be present during, and persists following, pregnancy. Given that negative child health outcomes have been linked to IPV exposure in utero as well as during early life, this pattern of sustained exposure may represent an important risk to not only the mental and physical well-being of these mothers, but also to that of their children. Women grouped into high or moderate exposure classes over time are key to identify early through screening conducted during routine antenatal care. The majority of women in South Africa access antenatal care and would benefit from targeted screening and referral, particularly for those exposed to ongoing high or moderate IPV.

Our study identified a second risk group, which emerged across emotional and physical IPV sub-types. The largest class of women for both emotional (70%) and physical IPV (60%) exhibited a pattern of increased probability of exposure during pregnancy relative to the postpartum time-points. This is consistent with some previous longitudinal studies, which found increased IPV exposure during pregnancy compared to postpartum.[19] However, there is not a consensus as other studies have cited a reduction in IPV prevalence during pregnancy, compared to pre-pregnancy prevalence.[20,21] This may link to risk associated with increased financial strain during pregnancy,[22] conflict arising from unwanted pregnancy, substance use[24] or traditional gender norms.[7] Higher prevalence during pregnancy may be linked to relationship status as pregnant women are more likely to be partnered. The majority of women in the current study exhibited higher probabilities of IPV exposure during pregnancy; as mentioned, given that the vast majority of women in South Africa attend antenatal care, this provides a critical opportunity to screen for IPV in those with sustained risk over time as well as in women who have increased risk during pregnancy.

A second focus of this study was to inform understanding of the cycle of abuse. In our LMIC sample of women, childhood sexual, physical and emotional abuse, and physical neglect were found to be associated with membership in high IPV exposure classes. The strength of these associations was high, with two to five-fold increased odds depending on type of childhood maltreatment, for women exposed. Our study confirms and extends previous findings linking sexual maltreatment[2,29,32] or physical childhood maltreatment and IPV in adulthood.[53,54] However, previous research has not found increased risk for those exposed to emotional abuse.[55] Notably, we did not find particular evidence of specificity in terms of transmission of risk from type of childhood exposure to type of adult IPV.

Membership of high IPV classes was more robustly associated with early adversity than moderate class membership, particularly for physical IPV and sexual IPV. However, moderate emotional IPV exposure was significantly associated with most types of childhood adversity. This is potentially significant, as emotional IPV is often overlooked both in research and in public health settings, even though emotional IPV may have serious effects on maternal mental health and is often more prevalent than physical IPV. Further, these findings may indicate an important relationship between intensity of IPV exposure and maternal maltreatment in childhood as the strengths of association increased with membership in higher intensity classes across all sub-types of IPV. Further, given associations between early life adversity and adult exposure to violence, children of women in the high or moderate exposure groups may already be at increased risk for victimization in adulthood as well as negative health outcomes during childhood.

To further investigate the cycle of abuse across the lifespan, we explored overall patterns for combined IPV sub-types. This approach allowed investigation of differential patterns across IPV sub-types, important given that these are known to co-occur. Expected patterns emerged for three classes (high, moderate and low classes), these patterns were similar to those that emerged when investigating IPV sub-types separately, as described above. However, an interesting additional class emerged with a very high probability of exposure to IPV during pregnancy, which decreased over time. There were signals for this in the LCGA analysis by separate IPV sub-types, where the largest class of women had slightly elevated levels of IPV antenatally. However, in the combined analysis, antenatal probabilities were extremely high for moderate or high levels of IPV (almost 100% for emotional IPV, 80% for physical IPV and 30% for sexual IPV), which decreased to 20%, 30% and 5% respectively by 2 years postpartum. Importantly, this group was 10% of the study

sample and so represents a large proportion of pregnant women in the population. This decrease may be due to mothers exiting violent relationships after birth of their child. Alternatively this pattern could represent a high risk for IPV during pregnancy associated with conflict related to financial strain or an unexpected pregnancy which dissipates with time. For these women, though the risk decreases postnatally, there are significant health risks for their child linked to in utero exposure. Importantly, screening during antenatal care provides a critical opportunity to intervene.

In the combined IPV class analysis, similar to the analysis by IPV sub-type, all domains of maternal childhood maltreatment were significantly associated with membership in the high versus low class. However, in looking at the childhood maltreatment patterns predicting membership of moderate vs low combined IPV class, only childhood physical abuse reached significance in our cohort. Where analysis split IPV subtypes for the mothers, all childhood maltreatment groups (with the exception of sexual abuse) was associated with moderate emotional IPV class membership and only the no childhood maltreatment group was associated with moderate physical IPV class membership. This suggests a differential relationship between maternal childhood maltreatment and later emotional IPV, an association which may be lost when IPV sub-types are combined. In combined IPV models, emotional neglect in childhood was associated with membership in the decreasing IPV class, other childhood maltreatment variables were not. This group shows very high probabilities during pregnancy, a critical time for both maternal and child health. Further work is needed to better understand the increased risk for IPV during the antenatal period as well as factors which support the decrease in risk postnatally, patterns that may be due to other personal, community or family-level factors and which may provide useful targets for intervention strategies.

Importantly, polyvictimization was prevalent in the current study; 38% of women were exposed to two or more types of maltreatment in childhood and 27% were exposed to two or more types of IPV. Further, the combined IPV sub-type LCA analysis, underscores the prevalence of polyvictimization across IPV sub-type, including the frequency and intensity of exposures, which were largely stable across sub-types. There is a dearth of evidence from LMIC settings, where unique cultural and social factors may impact associations differently than in high-income country settings. This may be particularly relevant in environments such as South Africa, with high rates of child maltreatment as well as IPV exist. High levels of violence in South Africa generally may facilitate a culture where IPV is normalized, thereby increasing the risk of cumulative or long-term exposure as women remain in problematic relationships.[52,56] The relatively low levels of education and economic power of women in South Africa may further exacerbate the vulnerability of mothers to IPV.[7] Given the negative physical and mental health outcomes associated with IPV exposure, for both mothers and children, it is essential that we understand the specific processes via which early adversity confers risk, and consider potential intervention targets and optimal time points to intervene.

Guidelines on care of women exposed to domestic violence in South Africa and the Western Cape are available, however, existing guidelines are not universally adopted and the implementation is often lacking in continuity and poorly coordinated.[57] More effective procedures are in place for sexual abuse than for physical or emotional IPV which may be more difficult to recognise. There is much work that is required to ensure that women in need are identified and supported in accessing care or resources. Previous studies have found that healthcare providers may resist identifying and managing IPV as a health issue, especially given its complexity and the need for

long-term support.[57] Low levels of IPV identification have been noted, even though women routinely present with physical and mental symptoms indicative of IPV exposure, including injury, anxiety and depression.[57,58] One study found that only 10% of women presenting at primary care facilities while suffering from IPV were identified as such.[57] IPV is a complex issue, requiring a multi-sectorial approach to address risk factors and provide support to women affected. Nonetheless, the majority of pregnant women in South Africa present to primary health facilities for antenatal care, offering a critical opportunity for identification and referral. The present study offers insight into patterns of IPV exposure during and following pregnancy as well as key risk factors, which may be possible to adapt for screening purposes in primary healthcare facilities. In low resource settings, it may be necessary to triage resources to identify the most critical cases. The longitudinal profiles described in the current research indicate that many women are at sustained risk of exposure during and following pregnancy, with a key group emerging that is at increased antenatal risk. This highlights the need for a universal screening program at the primary healthcare level, with a priority focus given to pregnant mothers.

3.6.1 Strengths and limitations

Although inclusion criteria for the DCHS were broad to ensure generalisability, recruitment was done during antenatal care visits; mothers who did not present for antenatal care were therefore not captured, which may have resulted in the highest risk mothers being underrepresented in the sample. There may be some bias present due to the timing of assessments, which had shorter intervals between the 1st/2nd and 2nd/3rd study visits compared to subsequent 6-monthly visits. This may have affected the patterns of IPV reported across time. In addition, 205 mothers who were enrolled in the study were not included in the analysis due to incomplete data, although there was

no evidence that these excluded mothers differed from the wider sample on key risk factors. Finally, due to collinearity of types of childhood maltreatment, each was included in a separate model, we were therefore unable to determine additive risk for a particular type of childhood maltreatment.

Despite these limitations, the current study is among the first to investigate associations between sub-types of maternal maltreatment in childhood and adult IPV exposure in a LMIC. A key strength includes longitudinal assessment of IPV exposure. Our findings corroborate previous research and build upon it by investigating sub-types of IPV during pregnancy including investigating intensity of exposure. Two key groups emerged in our research – one at sustained risk of high or moderate IPV during pregnancy and postpartum; the second exhibited increased probability of IPV exposure during pregnancy compared to postpartum. The majority of women in South Africa access antenatal care and both of these groups would benefit from targeted screening and referral, particularly during this sensitive period for both maternal and child health.

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Supplementary Table 3.1 Sensitivity analysis of key study variables

		Included sample (n=832)	Excluded sample (n=205)	Total sample, n	p-value
Demographic variables[a]					
	TC Newman	381 (47)	123 (60)	1037	0.074
Maternal education					
	Some secondary	531 (64)	114 (57)	1030	0.087
	Completed secondary	301 (36)	85 (43		
Maternal birthplace					
	Outside Paarl	302 (36)	83 (42)	1030	0.156
	Paarl	530 (64)	116 (58)		
Maternal Employment					
	Unemployed	628 (75)	133 (68)	1026	0.058
	Working	204 (25)	62 (32)		
Partnership status					
	Single	496 (60)	115 (57)		
	Married/marriage-like	336 (40)	85 (43)	1031	0.572
Income					
	<R1,000/mo	327 (39)	68 (33)	1037	0.118
	>R1,000/mo	506 (61)	136 (67)		
Maternal age		26.2 (22.1, 30.9)	24.7 (21.3, 29.9)	1037	0.053
Childhood Maltreatment (above threshold)					
	Physical Neglect	279 (34)	83 (41)	1037	0.061
	Emotional Abuse	263 (32)	53 (25)	1037	0.100
	Emotional Neglect	230 (28)	70 (34)	1037	0.060
	Physical Abuse	189 (23)	39 (19)	1037	0.273
	Sexual Abuse	137 (16)	33 (16)	1037	0.931
Intimate Partner Violence (above threshold)					
	Emotional	205 (25)	45 (22)	1035	0.121
	Physical	154 (19)	32 (16)	1035	0.391
	Sexual	50 (6)	11 (5)	1035	0.427

[a]*demographic variables were collected antenatally at 28-32weeks' gestation*

Supplementary Table 3.2 Intimate partner prevalence by sub-type and visit time point[a]

	Antenatal n (%)	10 Weeks n (%)	6 Months n (%)	12 Months n (%)	18 Months n (%)	24 Months n (%)
Number of mothers	*832*	*582*	*560*	*663*	*581*	*570*
Emotional IPV						
No IPV	557 (67)	445 (76)	401 (72)	497 (75)	458 (79)	451 (79)
Isolated/Low	70 (8)	32 (6)	35 (6)	30 (5)	26 (5)	28 (5)
Moderate	128 (15)	63 (11)	72 (13)	77 (12)	50 (9)	42 (7)
High	77 (9)	42 (7)	52 (9)	59 (9)	47 (8)	49 (9)
Physical IPV						
No IPV	586 (70)	447 (77)	421 (75)	510 (77)	463 (80)	454 (80)
Isolated/Low	92 (11)	40 (8)	44 (8)	35 (5)	31 (5)	28 (5)
Moderate	102 (12)	59 (10)	57 (10)	76 (12)	51 (9)	50 (9)
High	52 (6)	36 (6)	38 (7)	42 (6)	36 (6)	38 (7)
Sexual IPV						
No IPV	760 (91)	544 (94)	523 (93)	627 (95)	553 (95)	539 (95)
Isolated/Low	22 (3)	11 (2)	10 (2)	9 (1)	8 (1)	4 (1)
Moderate	33 (4)	22 (4)	21(4)	17 (3)	15 (3)	18 (3)
High	17 (2)	5 (1)	6 (1)	10 (2)	5 (1)	9 (2)

[a]*Descriptive data for categories of IPV exposure by visit time point (these categories were used to generate latent classes).*

Chapter 4. Food insecure pregnant women in South Africa: Maternal depression mediates violence and trauma risk factors.

Final published version:

Barnett W, Pellowski J, Kuo C, Koen N, Donald KA, Zar HJ, Stein DJ. Food-insecure pregnant women in South Africa: a cross-sectional exploration of maternal depression as a mediator of violence and trauma risk factors. *BMJ open* 2019; **9**(3): e018277.

Relevance of this paper to the thesis:

This Chapter investigates associations between IPV sub-types or maternal childhood trauma and food security during pregnancy as well as whether maternal depression mediates these relationships. This Chapter provides evidence of the association between IPV, particularly emotional IPV, and food insecurity during pregnancy and that maternal depression is an explanatory variable in this relationship; extending the evidence base to LMIC settings, where these issues are highly prevalent but relationships are poorly understood. Subsequent chapters build on this by investigating IPV and growth at birth as well as through infancy and potential pathways in these relationships.

Contribution of the student and co-authors:

Myself and JP conceptualized the analysis; I wrote the first draft of the manuscript. HJZ is principal investigator of the parent study; DS leads the psychosocial study aspects; NK and KD are coinvestigators and contributed to the study design and implementation. JP conducted the data analysis. CK, JP and DS provided critical inputs on the manuscript. All authors read and approved the final manuscript.

4.1 Abstract

Objectives: Better understanding of psychosocial risk factors for food insecurity (FI) during pregnancy, and how they interact is crucial, given long-term health implications for maternal and child health. We investigated the association between maternal childhood trauma as well as intimate partner violence (IPV) and FI among pregnant women in South Africa, in the Drakenstein Child Health Study, and whether maternal depression mediates these relationships.

Setting: Two primary care clinics in Paarl, South Africa.

Participants: 992 pregnant women; inclusion criteria were clinic attendance and remaining in area for at least 1 year; women were excluded if a minor.

Methods: We examined psychosocial predictors of FI using multivariate regression. Mediation analyses investigated whether depression mediated the relationship between IPV and FI as well as between childhood trauma and FI, including disaggregation by two study communities. FI was assessed using an adapted US Department of Agriculture food security scale; households were coded as food insecure where 2 of 5 affirmative responses were recorded.

Results: Among 992 pregnant women there were high rates of IPV (7-27%), depression (24%), and childhood trauma (34%). In multivariate cross-sectional analysis, emotional IPV (aOR 1.60; 95% CI 1.04,2.46), depression (aOR 1.05; 95% CI 1.01,1.08) and childhood trauma (aOR 1.52; 95% CI 1.08,2.15) predicted FI. In mediation models depression partially mediated the relationship

between emotional IPV and FI as well as physical IPV and FI; depression partially mediated the relationship between childhood trauma and FI. Differing degrees of mediation were found when applied to communities.

Conclusions: Antenatal maternal depression, IPV and childhood trauma were highly prevalent and associated with FI. Depression, IPV and trauma screening services should be considered within routine antenatal care and may offer an opportunity to identify and intervene. Community level differences in risk and in mediation analyses indicate that contextual tailoring of interventions may be important.

Strengths & Limitations of this study:

- There are few studies investigating depression as a mediator in relationships between subtypes of maternal intimate partner violence or childhood trauma and food insecurity during pregnancy.
- This study extends existing related research to a low resource African population with a large sample size.
- The current study was a cross-sectional analysis; therefore further research is needed to assess the direction of causality, and if differences exist by trimester and postpartum.

4.2 Background

Food insecurity is the lack of nutritionally adequate and safe food or a limited ability to acquire necessary food in socially acceptable ways.[1] The Food and Agriculture Organization (FAO) estimates that 689 million people worldwide (1 in 10) suffer from severe food insecurity (2014-2016); Africa has the highest prevalence of severe food insecurity (27.4%), almost four times the prevalence of other regions.[2] Studies have shown a link between food insecurity and poor pregnancy outcomes, including low birth weight,[3] gestational diabetes, and pregnancy complications.[4] In addition, young children in food insecure households have poorer general health[5-7] increased probability of being hospitalized,[6,8] lower levels of parent-child attachment,[9] and increased developmental delays.[9-11] Chronic hunger in childhood has also been linked to a higher likelihood of chronic medical conditions, such asthma, heart conditions, kidney disease or allergies.[12] Pregnant women may be particularly vulnerable to food insecurity due to increased nutrient demands and the inability to continue working, leading to financial strain.

Maternal mental health disorders are prevalent in low and middle-income countries (LMICs). Maternal mental health problems such as depression[13] and psychosocial risk factors such as stressful life events, intimate partner violence and trauma[14-17] are associated with food insecurity as well as poorer pregnancy outcomes such as low infant birth weight,[18] impaired fetal[19] and infant growth and nutritional status[3,20] as well as poorer infant cognitive development.[8,21] Although the relationship between maternal trauma or violence exposures as well as mental health and food insecurity has been explored, few studies have investigated depression as a mediator in the relationship between other psychosocial risk factors (e.g. violence or trauma) and food insecurity.

Sun and colleagues, in a large US based study, found maternal childhood trauma to be linked to food insecurity during pregnancy and that depression mediated this relationship.[22] Others in the US have found similar links between childhood trauma and food insecurity, but have not investigated mental health pathways.[23] In another US based study, IPV was found to be a significant predictor of food insecurity, mediated by depression.[24] However, this study did not find differential associations between sub-types of IPV (emotional, physical and sexual), though others have.[25] The majority of studies have focused on high-income countries[14,16,22,24,26] or have used small sample sizes to explore associations.[14,23] The current study aims to extend previous research to a LMIC context and to analyse multiple exposures, maternal trauma, IPV and stressful events, which are often co-occurring and have a higher prevalence in LMIC settings in a large study sample.

Examining maternal psychosocial risk factors and mental health characteristics in relation to food insecurity in LMICs is important. Particularly in the context of high proportions of maternal headed and single parent households and given the high prevalence of maternal psychosocial risk factors, especially during pregnancy, when exposures can adversely affect both maternal and child long-term health. Food security is a managed process such that family members have some control over how they cope with food insecurity and who within the family experiences it.[26,27] This ability to manage the effects of food insecurity may be adversely affected by maternal psychosocial risk factors and maternal mental health.[16] Further, community level factors such as differences in stigma to accessing care, gender norms affecting agency or education levels for women, may have significant differential effects within communities. This community context may be important to understand how to best address key risk factors for food insecurity and to inform design of effective

interventions.

We therefore aim to explore associations between maternal psychosocial risk factors or mental health and food insecurity, disaggregated by two communities with different risk profiles and community level factors. We investigate whether depression acts as a mediator in the relationship between IPV or childhood trauma and food insecurity in a LMIC context, (see Figure 4.1: conceptual framework). This extends the evidence base to geographic regions where these issues are highly prevalent but the relationships between these variables are poorly understood and rarely investigated.

Given the long-term health implications of food insecurity for child development as well as maternal and child mental and physical health,[12-15] understanding how risk factors for poor child health outcomes interact is critical to inform public policy to address the most urgent modifiable risk factors. Previous published findings from this cohort have shown links between psychosocial risk factors and food insecurity during pregnancy;[28] this paper builds upon that research by investigating the mediational effects of maternal depression on the relationship between emotional, physical and sexual IPV and food insecurity as well as maternal childhood trauma and food insecurity. Addressing food insecurity during pregnancy

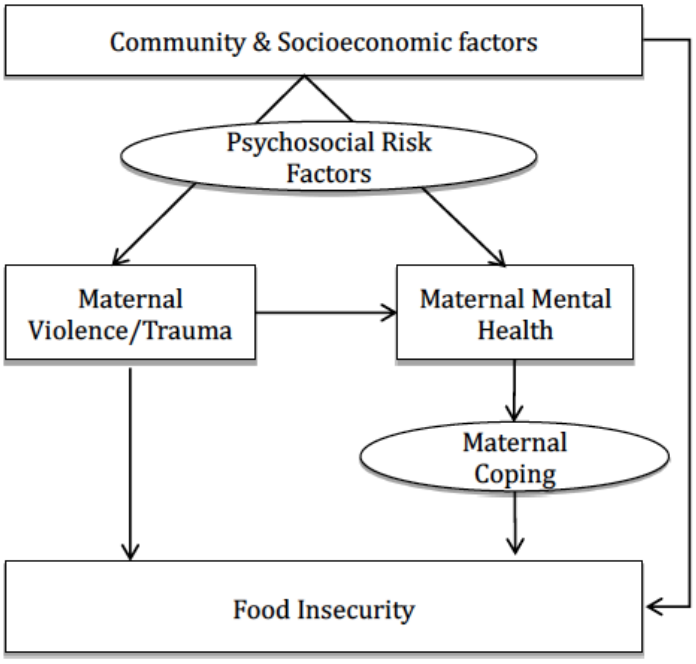


Figure 4.1 Conceptual framework

offers an opportunity to link antenatal care with nutritional programs and manage associated mental health risk factors at a time when those risk factors impact not only the mother's safety and well being but also infant outcomes after birth.

4.3 Methods

The Drakenstein Child Health Study (DCHS) is a multidisciplinary population-based birth cohort study located in a peri-urban area, 60 km outside of Cape Town, South Africa. It is a low socioeconomic community comprising approximately 200 000 people predominantly of mixed-ancestry (62.5%; 13.5% Caucasian; 22.7% Black African).[29] The district is characterized by a high prevalence of a range of health risk factors such as single-parent households, depression, childhood trauma, IPV, poverty, low levels of education (27.4% completing secondary school) and high unemployment (17.6%). The DCHS is a longitudinal cohort study following mother-child dyads through early childhood.[30,31] The current analysis utilises data from two antenatal visits: maternal psychosocial health and food security were measured at an antenatal visit between 28 to 32 weeks' gestation; sociodemographics were measured at the enrolment visit, at 20-28 weeks' gestation.

4.3.1 Participants

Pregnant women were enrolled from March 2012 to March 2015. Women were enrolled in their second trimester, between 20 to 28 weeks' gestation at two public sector primary health care clinics, one serving a predominantly mixed-ancestry population (TC Newman) and the other serving a predominantly Black African population (Mbekweni). Inclusion criteria were 1) attendance at one of the two study clinics and 2) intending to remain in the study area for at least

1 year. Mothers were excluded if they were under 18 years of age at enrolment or were not pregnant.

4.3.2 Measures

Maternal sociodemographics and mental health was measured using validated questionnaires administered by trained study staff across two antenatal visits. Mental health assessments included measures of intimate partner violence, depression, childhood trauma, stressful life events and psychological distress. The Intimate Partner Violence (IPV) Questionnaire used in this study was adapted from the WHO multi-country study[32] and the Women's Health Study in Zimbabwe.[33] Participants were dichotomized into exposed or unexposed for having experienced emotional, physical or sexual IPV in the past 12 months; exposure was defined as a score >1 indicating more than an isolated incident within each sub-type. The Edinburgh Postnatal Depression Scale (EPDS)[34] was used to measure depression; this scale has been validated for use with pregnant women and in a South African population.[35,36] The EPDS consists of 10 items referring to the past 7 days with each item assessed on a scale from 0 to 3. A total score was obtained by summing responses for all items and was included as a continuous score, with higher scores indicating more severe depressive symptoms; total scores were included in models. To give baseline cohort characteristics depression was dichotomized. A cut of score of ≥13 was used to classify women as depressed.[34] The Childhood Trauma Questionnaire[37] Short-Form was used to assess abuse and neglect experienced as a child. Each item was responded to on a 5 point scale ranging from *1=never true* to *5=very often true*. Continuous scores were used with a total possible range from 28 to 140. Where dichotomized, a cut off score of >36 was used to indicate exposure to childhood trauma, as described in the CTQ manual.[38] The Modified World Mental Health Life Events

Questionnaire, adapted based on items used in the South African Stress and Health Study (SASH) in South Africa,[39] to measure stressful or negative life events in the past year (e.g. serious illness, major financial crisis, serious discord with family or friends) Items were scored according to whether or not the event was experienced*, 0=no*, *1=yes*. Individual items were then summed to create a total score, ranging from 0 to 17, with higher scores indicating greater exposure to stressful life events. Dichotomous exposure to stressful life events was defined as experiencing at least one such event. The SRQ-20 is a WHO-endorsed measure of psychological distress.[40] The SRQ-20 consists of 20 items, which assess non-psychotic symptoms, including symptoms of depressive and anxiety disorders, scored according to whether or not the symptom was present, *0=no, 1=yes*. Individual items are summed to generate a total score ranging from 0 to 20, with higher scores indicating higher levels of psychological distress.[41] A cut off score of ≥8 was used to classify participants into high versus low risk, as has been used elsewhere.[41,42]

Sociodemographic variables including mother-reported household factors and maternal demographics were collected using an interviewer-administered questionnaire adapted from items used in the SASH Study.[39] Socioeconomic status (SES) was measured based on a composite score of asset ownership, household income, employment and education.[39] Social grants (receiving government support for child care or disability) were self-reported by mothers at enrolment.

Perceived food insecurity was assessed using an adapted version of the U.S. Department of Agriculture (USDA) Short Form Household Food Security Scale[1] which captures food hardship due to financial constraints. Specific questions asked about whether meals were made smaller for children in home, whether children skipped meals or went hungry and whether children in home

went a full day without eating - due to limited financial means within the home, as described previously.[28] Because of the wording, analyses were restricted to households with children. Questions included referred to children in the home as a conservative estimate of perceived food insecurity; studies have shown that parental buffering often mean that children are the last household members to experience food insecurity.[43,44] Five items were used and an affirmative response to two or more items was coded as being food insecure.

4.3.3 Ethics

Ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee, University of Cape Town (401/2009) and the Provincial Research committee. Mothers gave written informed consent at enrolment.

4.3.4 Patient and public involvement

Prior to study initiation, local stakeholders (Department of Health staff and managers) were involved in the planning of the parent study, the Drakenstein Child Health birth cohort study. Patients and public were not involved in conceptualization or analysis of the specific aims reported in the current study, however, study findings are routinely fedback to the study community.

4.4 Statistical analysis

All data were analysed using SPSS. Univariate logistic regression analyses were conducted to determine the bivariate relationship between food insecurity and demographic and psychosocial predictors. Odds ratios (ORs) with p-values were calculated to determine the strength of these associations. A hierarchical multivariate logistic regression analysis was conducted to independently evaluate IPV exposure and trauma/stress on food insecurity prior to the addition of

mental health risk factors, while controlling for demographic variables. Block 1 included community, maternal income, and maternal education. Block 2 included recent experiences of emotional, physical, and sexual IPV as well as maternal childhood trauma and stressful life events. Finally, Block 3 added depression and psychological distress. To determine whether depression played a mediating role on the relationship between IPV and food insecurity, meditational analyses were conducted using PROCESS macro.[45] Model number 4 was used and indirect effects were bootstrapped using 1000 samples. Beta coefficients and standard errors are reported for all paths and 95% confidence intervals are reported for the indirect effects. Models were conducted for the full sample and then for each community individually; models were split by community because of the socioeconomic, cultural, clinical and psychosocial differences between the two communities that could have significant bearings on the results of the mediation models. This process was replicated for depression as a mediator of the relationship between childhood trauma and food insecurity. Mediation models controlled for community, maternal income, maternal education, social grants, number of children in the household and HIV status; childhood trauma was controlled for in all IPV mediation models and emotional, physical, and sexual IPV was controlled for in the childhood trauma mediation models.

4.5 Results

A total of 1225 pregnant women were enrolled between March 2012 and February 2015; of these, 992 women had complete data and were included in the analysis. Missing data resulted from non-attendance at the second antenatal visit where psychosocial data was collected. A sensitivity analysis was therefore only done on sociodemographic variables (clinic, education, income, employment, social grants and whether married); those mothers included in the present analysis

Table 4.1 Maternal demographic and psychological variables

	Overall n (%)	TC Newman n (%)	Mbekweni n (%)	X^2	p-value
Number of mothers	992	443	549		
Mean age of mother (SD)	26.6 (5.8)	25.7 (5.4)	27.3 (5.9)	-4.543*	***
Food insecurity					
Secure	685 (69.1)	387 (87.4)	298 (54.3)	125.53	***
Insecure	307 (30.9)	56 (12.6)	251 (45.7)		
Race					
Black	548 (55)	6 (1)	542 (99)	943.05	***
Coloured	443 (45)	437 (99)	6 (1)		
SES Quartiles					
Lowest SES	258 (26)	81 (18)	177 (32)	37.27	***
Low-moderate SES	261 (26)	117 (26)	144 (26)		
Moderate-high SES	242 (24)	109 (25)	133 (24)		
Highest SES	231 (23)	136 (31)	95 (17)		
Maternal Income					
<R1,000/month	767 (77)	330 (74)	437 (80)	7.86	*
R1000-R5000/month	212 (21)	103 (23)	109 (20)		
R5000-R10,000/month	12 (1)	9 (2)	3 (1)		
Receive social assistance	491 (49)	221 (50)	270 (49)	0.085	0.798
Maternal education					
Some secondary	613 (62)	266 (60)	347 (63)	1.037	0.308
Completed Secondary	379 (38)	177 (40)	202 (37)		
Median number of children in household	1	1	1	22.191	**
Married/cohabiting	399 (40)	200 (45)	199 (36)	10.064	*
Employed	254 (26)	132 (30)	122 (22)	7.439	**
Maternal HIV	216 (22)	17 (4)	199 (36)	151.195	***
Psychosocial risk factors					
Past year IPV					
Emotional IPV	266 (27)	155 (35)	111 (20)	27.26	***
Physical IPV	216 (22)	106 (24)	110 (20)	2.18	0.14
Sexual IPV	68 (7)	49 (11)	19 (3)	22.179	***
Probable Depression (EPDS ≥ 13)	242 (24)	112 (25)	130 (24)	0.341	0.559
Childhood trauma	335 (34)	179 (40)	156 (28)	15.761	***
Psychological Distress	208 (21)	109 (25)	99 (18)	6.39	0.011
Stressful Life Events	449 (45)	265 (60)	184 (34)	68.467	***
Co-occurrence of psychosocial risk factors					
Depression & any IPV	122 (12)	68 (15)	54 (10)	6.911	**
Depression & childhood trauma	124 (13)	76 (17)	48 (9)	15.864	***
Childhood trauma & any IPV	154 (16)	101 (23)	53 (10)	32.304	***

*p<0.05, **p<0.01, ***p<0.001*; Note: Psychological risk factors listed where above threshold; IPV above threshold = score of >1 within each subtype (mothers experiencing more than an isolated incidence in past year); Depression above threshold = score ≥ 13; Childhood trauma above threshold where score > 36; Psychological Distress dichotomized into low and high risk categories where high risk = score ≥8; Stressful life events presented where greater than 1.*

versus the whole cohort differed significantly only regarding whether mothers received social grants (Supplementary Table 4.1). Detailed baseline demographic characteristics, stratified by recruitment site, are presented in Table 4.1. The median age of participants was 26.6 years [standard deviation (SD) 5.8]. The sample was characterized by low SES - 77% of mothers had a monthly income of less than R1,000 (approximately 100 USD), 49% of mothers were receiving

social assistance, 26% reported being employed and 38% completed secondary education (high school). A minority of mothers (40%) were married or with a partner. Food security, HIV prevalence and SES quartiles were significantly different between clinics as were the majority of psychosocial variables. Households in Mbekweni were much more likely to be food insecure than households at TC Newman (45.7% versus 12.6%). Mothers at TC Newman were significantly more likely to have experienced emotional and sexual past-year IPV as well as childhood trauma and stressful life events. Co-occurrence of mental health issues was prevalent, though more so at TC Newman. Overall, 12% of mothers had both depression and IPV, 13% depression and childhood trauma and 16% childhood trauma and any form of IPV.

In bivariate analysis (Table 4.2), antenatal food insecurity was significantly more likely among participants from Mbekweni (OR 5.82; 95% CI 4.20, 8.07), those who had not completed secondary school (OR 0.43; 95% CI 0.32, 0.57), mothers with lower income levels (OR 0.39; 95% CI 0.27, 0.56), mothers who had experienced emotional IPV (OR 1.44; 95% CI 1.07, 1.94) or physical IPV (OR 1.84; 95% CI 1.35, 2.52) in the past twelve months and mothers with higher levels of antenatal depression (OR 1.09; 95% CI 1.06, 1.12), childhood trauma (OR 1.49; 95% CI 1.13, 1.97) and psychological distress (OR 1.04; 95% CI 1.01, 1.08).

4.5.1 Hierarchical regression

A hierarchical logistic regression was done to investigate the additive impact of risk factor groups on food security (Table 4.2). Throughout all blocks, community, maternal education and maternal income remained significantly associated with food insecurity. In block 2 among IPV, trauma and stress risk factors, adjusting for maternal sociodemographic factors and community, emotional

Table 4.2 Hierarchical logistic regression of variables associated with food insecurity

			Block 1		Block 2		Block 3	
Variables	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Demographic variables								
Community	5.82 (4.20, 8.07)	***	6.02 (4.30, 8.41)	***	8.22 (5.60, 12.06)	***	7.85 (5.29, 11.66)	***
Maternal Income	0.39 (0.27, 0.56)	***	0.42 (0.28, 0.62)	***	0.44 (0.29, 0.66)	***	0.44 (0.29, 0.66)	***
Maternal Education	0.43 (0.32, 0.57)	***	0.42 (0.31, 0.58)	***	0.45 (0.32, 0.63)	***	0.46 (0.33, 0.64)	***
Intimate Partner Violence								
Emotional IPV	1.44 (1.07, 1.94)	*			1.67 (1.09, 2.56)	*	1.60 (1.04, 2.46)	*
Physical IPV	1.84 (1.35, 2.52)	***			1.41 (0.91, 2.18)	0.121	1.32 (0.85, 2.05)	0.216
Sexual IPV	1.62 (0.98, 2.68)	0.061			1.77 (0.92, 3.39)	0.085	1.50 (0.78, 2.89)	0.253
Trauma/Stress+								
Childhood Trauma	1.49 (1.13, 1.97)	**			1.66 (1.18, 2.33)	**	1.52 (1.08, 2.15)	*
Stressful Life Events	0.96 (0.90, 1.02)	0.157			0.98 (0.91, 1.06)	0.585	0.93 (0.86, 1.01)	0.089
Mental Health+								
Depression (EPDS)	1.09 (1.06, 1.12)	***					1.05 (1.01, 1.08)	**
Psychological Distress	1.04 (1.01, 1.08)	*					1.05 (1.00, 1.10)	0.080
			Block X^2(df)	p-value	Block X^2(df)	p-value	Block X^2(df)	p-value
			188.93 (3)	***	8.44 (2)	*	15.75 (2)	***

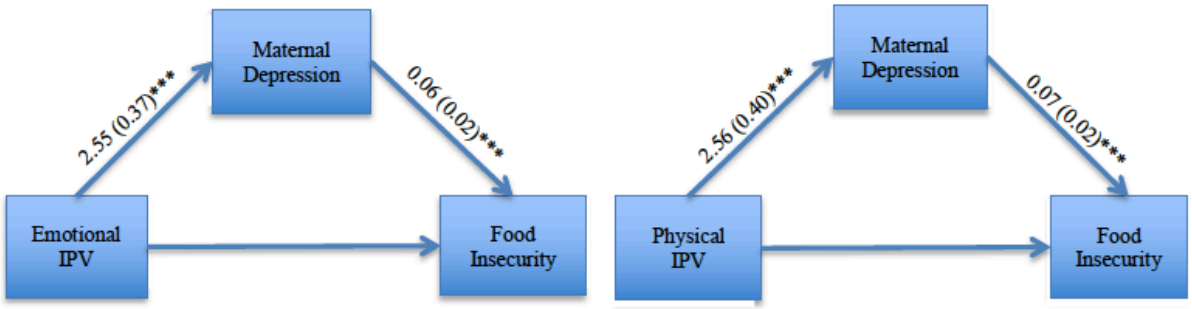
*p<0.05, **p<0.01, ***p<0.001
+ Trauma/Stress and Mental Health variables were included as continuous scores in regression analyses.

IPV and childhood trauma were significant predictors of food insecurity. In the final model (block 3), which incorporated all psychological variables and demographic variables, mothers from Mbekweni were almost eight times (aOR 7.85; 95% CI 5.29, 11.66) as likely as TC Newman mothers to experience antenatal food insecurity. Mothers who completed secondary school were 54% less likely to experience food insecurity (aOR 0.46; 95% CI 0.33, 0.64) compared to mothers who did not complete secondary school. Similarly, mothers with higher incomes were 56% (aOR 0.44; 95% CI 0.29, 0.67) less likely to experience food insecurity. Mothers who experienced emotional IPV in the past twelve months were 60% more likely (aOR 1.60; 95% CI 1.04, 2.46), mothers with higher depression scores on EPDS were 5% more likely (aOR 1.05; 95% CI 1.01, 1.08) and mothers with a history of childhood trauma were 52% more likely (aOR 1.52; 95% CI 1.08, 2.15) than mothers without these psychological risk factors to experience food insecurity.

4.5.2 Depression as a mediator of the relationship between IPV and food insecurity

In mediation models including both communities (Figure 4.2a), depression partially mediated the relationship between emotional IPV and food insecurity (direct effect p-value = 0.0001; indirect effect = 0.16, 95% CI 0.07, 0.29) and partially mediated the relationship between physical IPV and food insecurity (direct effect p-value=0.001; indirect effect = 0.17, 95% CI 0.07, 0.28). Sexual IPV was not tested in a mediation model because the bivariate relationship between sexual IPV and food insecurity was not significant (OR 1.62; p=0.06). Mediation models were split by community due to the high significance of recruitment community as an independent predictor of food insecurity; when split by community differing degrees of mediation were found. At TC Newman (Figure 4.2b), depression fully mediated the relationship between emotional IPV and food insecurity (direct effect p-value = 0.13; indirect effect = 0.24, 95% CI 0.05, 0.50) as well as

Figure 4.2a Combined community Meditational Models:* emotional IPV & physical IPV and food insecurity, n=992



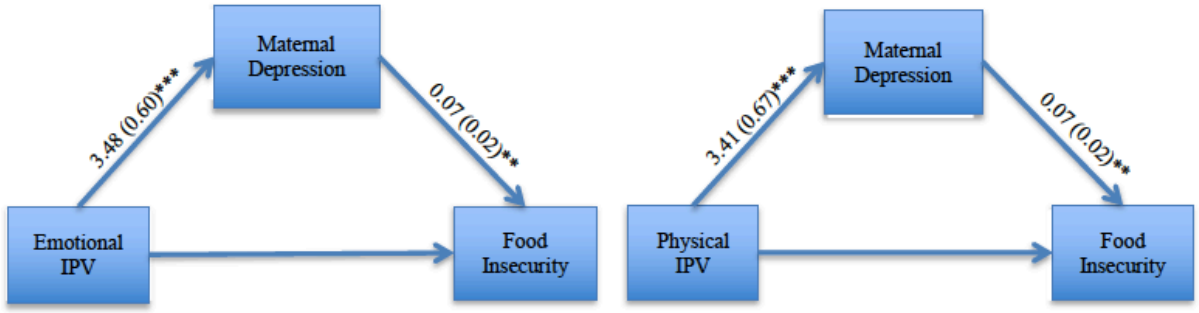
Direct Effect: 0.72 (0.18), p = 0.0001
Indirect Effect: 0.16 (0.06), Bootstrapped CI (0.07, 0.29)

*Depression **partially** mediates the relationship between emotional IPV and food insecurity.*

Direct Effect: 0.59 (0.19), p = 0.001
Indirect Effect: 0.17 (0.06), Bootstrapped CI (0.07, 0.28)

*Depression **partially** mediates the relationship between physical IPV and food insecurity.*

Figure 4.2b TC Newman Mediational Models:* relationship between emotional & physical IPV and food insecurity, n=443



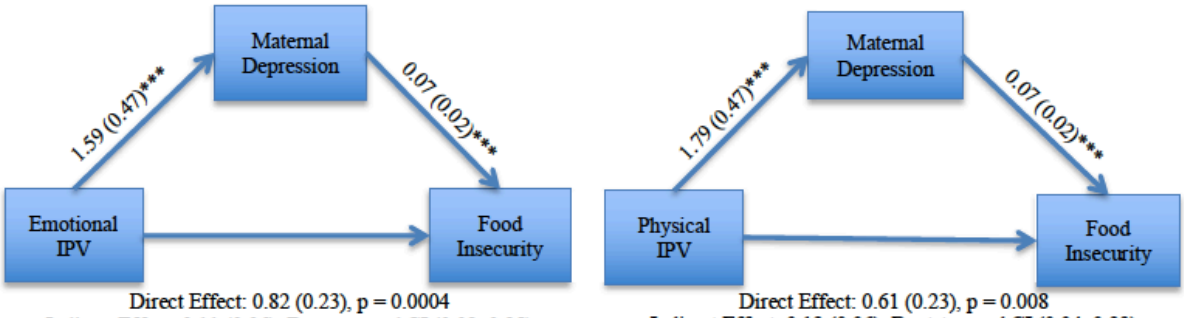
Direct Effect: 0.48 (0.31), p = 0.13
Indirect Effect: 0.24 (0.11), Bootstrapped CI (0.05, 0.50)

*Depression **fully** mediates the relationship between emotional IPV and food insecurity.*

Direct Effect: 0.48 (0.32), p = 0.14
Indirect Effect: 0.23 (0.11), Bootstrapped CI (0.06, 0.46)

*Depression **fully** mediates the relationship between physical IPV and food insecurity.*

Figure 4.2c Mbekweni Mediational Models:* relationship between emotional & physical IPV and food insecurity, n=549



Direct Effect: 0.82 (0.23), p = 0.0004
Indirect Effect: 0.11 (0.06), Bootstrapped CI (0.03, 0.25)

*Depression **partially** mediates the relationship between emotional IPV and food insecurity.*

Direct Effect: 0.61 (0.23), p = 0.008
Indirect Effect: 0.13 (0.06), Bootstrapped CI (0.04, 0.29)

*Depression **partially** mediates the relationship between physical IPV and food insecurity.*

*Covariates included in the models are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

between physical IPV and food insecurity (indirect effect = 0.23, 95% CI 0.06, 0.46). At Mbekweni (Figure 4.2c), depression partially mediated the relationship between emotional IPV and food insecurity (direct effect p-value = 0.0004; indirect effect = 0.11, 95% CI 0.03, 0.25) and partially mediated the relationship between physical IPV and food insecurity (direct effect p-value = 0.008; indirect effect = 0.13, 95% CI 0.04, 0.29).

4.5.3 Depression as a mediator of the relationship between childhood trauma and food insecurity

In mediation models including both communities (Figure 4.3), depression partially mediated the relationship between childhood trauma and food insecurity (direct effect p-value = 0.025; indirect effect = 0.13, 95% CI 0.05, 0.23). These mediation models were also split by community, due to the high significance of community as a risk factor for food insecurity. When applying mediation models to childhood trauma at TC Newman, depression did not mediate the relationship between childhood trauma and food insecurity (direct effect p-value = 0.0009; indirect effect 0.12, 95% CI -0.12, 0.35). Additionally, at Mbekweni, depression did not mediate the relationship between childhood trauma and food insecurity (direct effect p-value = 0.63; indirect effect 0.04, 95% CI -0.02, 0.13).

Figure 4.3 Mediational Models for both communities, TC Newman and Mbekweni investigating the relationship between childhood trauma and food insecurity

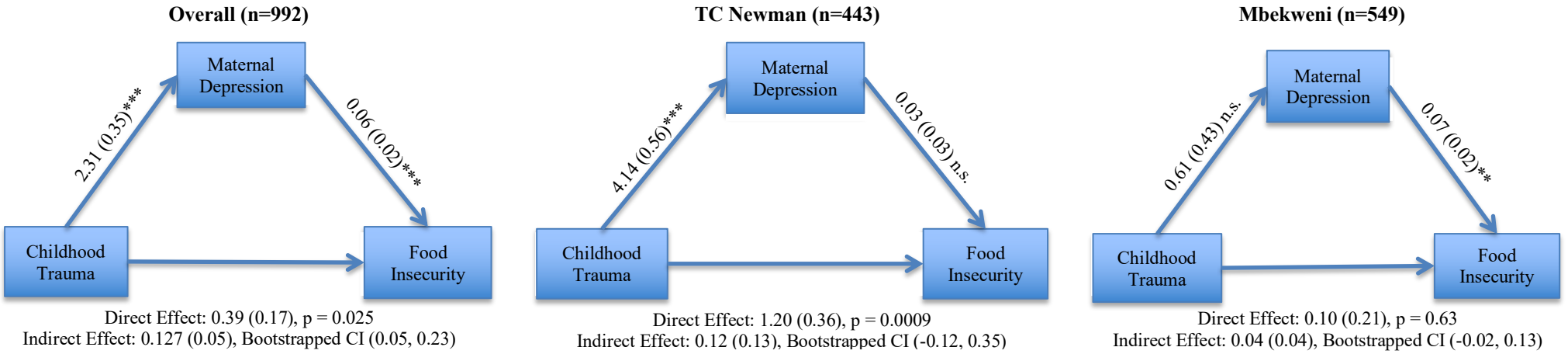


Figure 4.3 Mediation models for both communities, for TC Newman and for Mbekweni investigating depression as a mediator for childhood trauma and food insecurity. Depression **partially** mediated the overall relationship between childhood trauma and food insecurity, but **did not mediate** the relationship at TC Newman and **did not mediate** the relationship at Mbekweni. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and emotional, physical and sexual forms of IPV.

4.6 Discussion

My goal was to investigate the association between IPV or maternal childhood trauma and food insecurity during pregnancy, as well as to investigate maternal depression as a mediator for these relationships in a LMIC country, South Africa. I found significant effects of emotional IPV and maternal childhood trauma on antenatal food insecurity, after adjusting for community, maternal income and education. Mothers experiencing emotional IPV or with a history of childhood trauma were 60% and 52% more likely, respectively, to live in food insecure households while pregnant. Though previous studies have investigated links between IPV or childhood trauma and food insecurity, the current study extends this research to a low resource setting with a large sample size.

Hernandez and colleagues found that IPV was a significant predictor of food insecurity and that this was mediated by depression.[24] However, this US-based study did not find significant associations between subtypes of IPV and food insecurity - only a composite measure of IPV was found to be significant. Our research found that sub-types of IPV were differentially associated with food insecurity, with emotional IPV the only significant predictor in the final model. While mediation models split by site found a mediational effect of depression on this relationship at both clinics; emotional IPV did maintain a direct effect on food insecurity at Mbekweni. This may be an important distinction when planning effective interventions that consider community contexts; qualitative research has found that women feel emotionally abusive acts are more devastating than physical violence.[46] Emotional IPV, therefore, may be a critical and often overlooked risk factor for food insecurity. Further, emotional IPV may manifest differently in a LMIC setting, compared to a high-income setting, where traditional gender norms may affect women's sense of power and

identity and therefore, compounded by potential mental health sequelae, may further decrease her ability to manage household resources.[47]

Maternal childhood trauma also emerged as a critical risk factor for food insecurity during pregnancy. Sun and colleagues investigated this link in a large US-based study.[22] These authors reported that childhood trauma was linked to food insecurity during pregnancy, and found that maternal depression modified this relationship. They found a dose-response relationship between number of childhood adverse events and severity of food insecurity; when considered together with depression there was a greater impact on food insecurity. While other high-income country studies have also investigated this association, these have been limited by small sample sizes (n=44, n=31).[48,49] To our knowledge, our study is the first to investigate the link between childhood adversity and food security in a LMIC or mental health as a mediator in this relationship. Childhood trauma measured by family instability, violence exposure at a young age, food insecurity in childhood and neglect is associated with many of the known risk factors of current food insecurity such as lower levels of education, employment and poor mental health outcomes in adulthood.[50] This highlights a critical link between childhood experiences and adult outcomes and the intergenerational effects of trauma. In the context of maternal mental health, this may be particularly relevant as maternal hardship and stress may increase the likelihood of a traumatic childhood for their offspring. As noted by Sun and colleagues, there is an intergenerational transmission of disadvantage, which highlights the need for a multi-faceted approach to address food insecurity.[22] Our findings reveal important intergenerational associations between food insecurity and maternal childhood exposure to violence and suggest that future research is needed to understand how intergenerational transmission of trauma occurs between mothers and children

and what can be done to break this cycle. In high-prevalence settings in particular, intervention programs should offer more than nutrition support and should include trauma-informed mental health services to reduce the transmission of trauma from one generation to the next. Though further study is needed to determine if trauma counselling or interventions may help to alleviate the prevalence of food insecurity.

The co-occurrence of psychosocial risk factors was high (12-16%) in our study sample. In order to better understand how these risk factors influence one another, we investigated depression as a mediator in these relationships. In overall models depression partially mediated the relationship between emotional and physical IPV and food insecurity. Notably, the degree to which depression mediated this relationship differed between clinic communities. Depression fully mediated the relationship between emotional and physical IPV and food insecurity at TC Newman, but only partial mediation was found at Mbekweni. This highlights depression as important in the pathway through which IPV affects food insecurity at TC Newman. However, at Mbekweni, though depression also exacerbates this relationship, there may be other factors that explain the significant relationship between IPV and food insecurity. While maternal income was controlled for in mediation models, SES quartiles indicate that Mbekweni mothers are economically worse off than TC Newman mothers. This may be impeding the process of food management at Mbekweni, especially in the context of IPV. In overall models investigating depression as a mediator for the relationship between childhood trauma and food security, partial mediation was again seen; however, no mediation was found when models were split by community. At TC Newman, childhood trauma maintained a significant direct effect on food insecurity. It may be that social support networks are more robust at Mbekweni, thus mitigating the downstream effects of

childhood trauma in that community. A study in a similar community in South Africa found that social support buffers the effect of trauma on depression symptoms;[51] further, social support has been found to be particularly important for females, compared to males in mitigating mental health outcomes such as depression.[52] Additional research is needed to understand how or why depression mediated the effects of childhood trauma on food insecurity in overall models whereas this effect did not persist when models were split by community.

Additionally, this study indicates that community level factors should be considered when developing nutritional and mental health interventions. Many communities in South Africa are still dealing with the long-term effects of apartheid, this may have a continued effect on stress and mental health in these communities.[53] However, racial disparities exist globally affecting physical and mental health in specific communities differentially to others.[54,55] Specifically, in targeting mental health, contextual factors such as differences in stigma to accessing care, gender norms affecting agency or education levels for women, may have significant differential effects within communities. This community context may be important to understand how to best address key risk factors for food insecurity and to inform design of effective interventions.

4.6.1 Strengths and limitations

The inclusion criteria for the parent study were broad to ensure generalizability. However, recruitment was done during antenatal care visits, so mothers who did not present for antenatal care or who presented in their third trimester were excluded, which may affect overall generalizability. Further, generalizability may be limited to similar population groups, specifically pregnant mothers and similar communities. In addition, approximately 200 mothers who were

enrolled in the study were not included in the analysis due to incomplete data. While it is possible that this subset of mothers is at higher risk for many of the factors investigated; there were not significant differences in key factors investigated for mothers included versus those excluded in the current study. As the current study included cross-sectional data, we cannot assert the direction of causality. While a strength of this study was its investigation of the individual impact of different subtypes of IPV, too few mothers experienced or reported sexual IPV to allow this to be investigated fully. Finally, as all variables used were based on self-report, mothers may have underreported both risk factors and food security due to social desirability bias. Despite these limitations, the current study provides a novel quantitative analysis with a large sample size conducted in a LMIC. Our findings corroborate previous research on risk factors for food insecurity; and build on unpublished data in this cohort by investigating subtypes of IPV as well as maternal depression as a mediator for both childhood trauma and IPV.

4.6.2 Conclusions

Addressing depression during pregnancy through screening and referral services may help to alleviate the negative impact of IPV, childhood trauma and depression on food security; though direction of causality cannot be asserted by the current study, significant associations between these variables and food insecurity were found. Both IPV victimization and experiencing childhood trauma were associated with depressive symptoms in mothers, after controlling for maternal income and education. This may impact their household managerial skills by decreasing motivation to obtain food, to find and hold employment and through decreased physical and cognitive functioning. Our findings highlight the importance of comprehensive programs aimed at nutrition support or food security, as well as the importance of addressing multiple concurrent

psychosocial risk factors which may help to reduce food insecurity and alleviate its negative impact on child health. However, notably, mediation models indicate that the effects of maternal mental health issues are experienced differently at the two communities in this cohort highlighting the importance of program and policy efforts targeted to specific community profiles. Notably, though not the focus of the current study, both maternal income and maternal education were highly correlated with food insecurity – education especially is likely an important factor cross cutting all key risk and outcome variables – promoting educational opportunities represents an important intervention to improve maternal and thus child health.

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Supplementary Table 4.1 Sensitivity analysis: comparison of key sociodemographic variables between participants included in and excluded from the current study.

	Included sample	**Excluded sample**	**p-value**
Number of mothers	992	233	
Clinic			
Mbekweni	549 (55)	131 (56)	
TC Newman	443 (45)	102 (44)	0.808
Race			
Black	548 (55)	132 (57)	
Coloured	443 (45)	101 (43)	0.708
Maternal Income			
<R1,000/month	767 (77)	168 (78)	
R1000-R5000/month	212 (21)	44 (20)	0.954
R5000-R10,000/month	12 (1)	3 (1)	
Receive social assistance	491 (49)	92 (40)	0.005
Maternal education			
Some secondary	613 (62)	127 (55)	
Completed Secondary	379 (38)	103 (45)	0.066
Median number of children in household	1	1	0.911
Married/cohabiting	399 (40)	92 (40)	0.828
Employed	254 (26)	67 (29)	0.429

Chapter 5. Intimate Partner Violence and growth outcomes through infancy: a longitudinal investigation of multiple mediators in a South African birth cohort.

Preparing to submit manuscript, anticipated citation:

Barnett W, Halligan SL, Nhapi R, Pellowski J, Zar HJ, Donald KA, Stein DJ. Intimate Partner Violence and growth outcomes through infancy: a longitudinal investigation of multiple mediators in a South African birth cohort. *Lancet Child Adolesc Health*, submitted.

Relevance of this paper to the thesis:

This Chapter addresses objectives 3 & 4, investigating IPV during pregnancy and growth outcomes at birth, postnatal IPV and growth at 12 months as well as potential explanatory variables for these relationships. This chapter addresses key gaps in the literature by employing a rigorous analytical approach, using longitudinal data collection, by investigation of sub-types of IPV and their impact on growth outcomes and finally by formally investigating potential mediators in these relationships.

Contribution of student and co-authors:

I conceptualized the analysis and study aims together with supervisors and co-authors (SH, KAD, DJS). I conducted all analyses with guidance and input from RN and JP. All authors were involved in drafting and review of the manuscript.

Research in context

We searched PubMed for articles published in English through 31 Aug, 2020, using the search terms "child", "growth", "IPV", "violence" and "mediator" or "mediation". We identified multiple systematic reviews or meta-analyses reporting on the association between IPV in pregnancy and growth outcomes at birth, however, the majority were from high-income countries. We identified few studies on postnatal IPV and growth outcomes in early childhood. Only one of these formally investigated mediators. Further, a wide range of IPV definitions were used with few investigating emotional IPV or recent IPV (compared to lifetime). Lastly, few used prospectively collected data.

Added value of this study

In the current study, we investigated associations between IPV sub-types and growth at birth and 12 months as well as potential mediators underlying these relationships. Both emotional and physical IPV were found to impact growth at birth and 12 months, with alcohol and tobacco use emerging as mediators antenatally and tobacco use as a mediator in postnatal IPV-growth relationships. We address several gaps in the existing literature, specifically by using longitudinal data, considering recent rather than lifetime IPV, including emotional IPV as a separate exposure, rather than defining IPV as only physical and/or sexual and by formally investigating several potential mediators of these relationships.

Implications of all the available evidence

IPV remains a highly prevalent public health problem, impacting not only maternal health but child health outcomes, including compromised child growth. There is increasing evidence linking emotional IPV to adverse child growth outcomes and it is important that screening and referral efforts integrate support for emotional IPV alongside physical and sexual IPV. Available evidence suggests the need for intersectoral programs and interventions to address multiple co-occurring and prevalent risk factors which may be impacting child growth, particularly in high-risk settings.

5.1 Abstract

Background

Growth faltering during early childhood represents a significant indicator of short and long-term health. Intimate partner violence (IPV) has been linked to poor fetal and infant growth. However, factors underlying this relationship are not well understood, particularly in the postnatal time period. In a South African birth cohort, we investigated IPV in pregnancy and postnatally and infant growth at birth and 12 months and whether maternal depression, tobacco or alcohol use or infant hospitalization mediated IPV-growth relationships.

Methods

Mothers were enrolled in pregnancy; mother-infant pairs were followed through 12 months postpartum. Maternal IPV was measured during pregnancy and 10 weeks postpartum; depression, alcohol and tobacco use were measured during pregnancy and at 6 months postpartum. Child weight and length were measured at birth and 12 months. Linear regression and structural equation modelling were used to investigate relationships.

Findings

At birth, among 1,111 mother-infant pairs, maternal emotional and physical IPV were associated with reduced weight-for-age z-scores (WFAZ). Only physical IPV was associated with length-for-age z-scores (LFAZ) at birth. Antenatal maternal alcohol and tobacco use mediated IPV-growth relationships at birth. Postnatally, among 783 mother-infant pairs, emotional and physical IPV were associated with reduced WFAZ at 12 months. Only emotional IPV was associated with LFAZ at 12 months. Maternal tobacco use was a mediator postnatally.

Interpretation

Findings highlight the role of both physical and emotional IPV as risk factors for compromised fetal and infant growth. Further, whereas alcohol and tobacco use emerged as explanatory factors in these relationships, maternal depression and infant hospitalizations, did not. These findings underscore the importance of programs to address interrelated risk factors for compromised infant growth, specifically IPV and substance use, which are prevalent and often co-occur in high-risk settings.

Funding

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5.2 Introduction

Linear growth faltering, a slow rate of gain in a child's weight or height, is an important indicator of poor child health and is prevalent in low and middle-income country settings (LMIC). Linear growth faltering during infancy and early childhood has been linked to adverse short and long-term health outcomes, including poorer performance in school, delayed child development,[1] higher frequency and severity of infections,[2] increased risk of chronic diseases, including obesity, as well as decreased earnings in adulthood.[3] Improved understanding of the factors that impact early-life growth is necessary to develop appropriate interventions that could in turn potentially yield large economic returns and reduce adverse health outcomes through adulthood.

Increasingly, researchers are recognizing the role of intimate partner violence (IPV) in child growth outcomes. Meta-analyses have found IPV during pregnancy to increase the risk of low birth weight.[4] There is also emerging evidence linking postnatal IPV and growth outcomes in early childhood. Studies have found that IPV is associated with decreased continuous growth outcomes[5] as well as increased risk of stunting, wasting or being underweight.[5-8] Several have been multi-country studies in LMIC settings.[6,7,9] However, most studies investigated only lifetime IPV or associations using cross-sectional data. Given that IPV tends to be persistent and is known to affect birthweight, longitudinal analyses of postnatal IPV exposure are essential to further our understanding of postnatal infant growth. Moreover, the majority of studies to date have focused on physical IPV, with very few considering emotional IPV, despite evidence that the latter can be detrimental to maternal health and wellbeing.

Several potential mechanisms through which maternal IPV may impact fetal or infant growth have been proposed. IPV during pregnancy may impact fetal growth directly (e.g., through chronic psychological stress, elevating stress hormones)[10] or indirectly (e.g. impacting risky behavior, such as increasing substance use, which in turn may reduce placental blood flow[11] or compromise maternal nutrition).[10] Postnatally, IPV has been linked to increased maternal depression and substance use,[12] which may impact a woman's ability to care for her child, for instance by increasing the risk of child neglect or diverting financial resources from healthcare costs or nutritionally adequate food.[13] Maternal efficacy and financial power within a family is often impacted by abusive relationships, further exacerbating these issues.[14] Lastly, children exposed to IPV have been reported to have a higher risk of infection and hospitalizations, both of which may be associated with faltering growth, in particular diarrhoeal diseases.[15] Despite this evidence, few studies have formally investigated key mediators in the maternal IPV-infant growth relationship, especially during the sensitive early postnatal period. This is crucial, as an understanding of the underlying mechanisms, particularly where multiple co-occurring and prevalent risk factors may be impacting health outcomes, is essential in order to inform interventions that aim to prevent adverse child growth outcomes in association with maternal IPV.

Previous work in the DCHS has shown that physical IPV during pregnancy is associated with low birthweight[16] and that longitudinal postnatal IPV is associated with postnatal depression in this cohort.[17] We aimed to build upon this work by investigating associations between maternal IPV sub-types (emotional, physical or sexual) and growth outcomes at birth and at 12 months as well as whether maternal depression, alcohol use, tobacco use or infant admission to hospital mediate IPV-growth relationships.

5.3 Methods

This study is nested in the Drakenstein Child Health Study (DCHS), a multidisciplinary birth cohort investigating the early-life determinants of child health in a peri-urban area in South Africa. See chapter 2 for more detail.[18]

5.3.1 Setting

The DCHS is located in the Drakenstein subdistrict, 60 km outside Cape Town, South Africa with a population of approximately 200,000. This area has a well-established, free primary healthcare system, where more than 90% of the population access antenatal or child health services.[18,19]

5.3.2 Participants

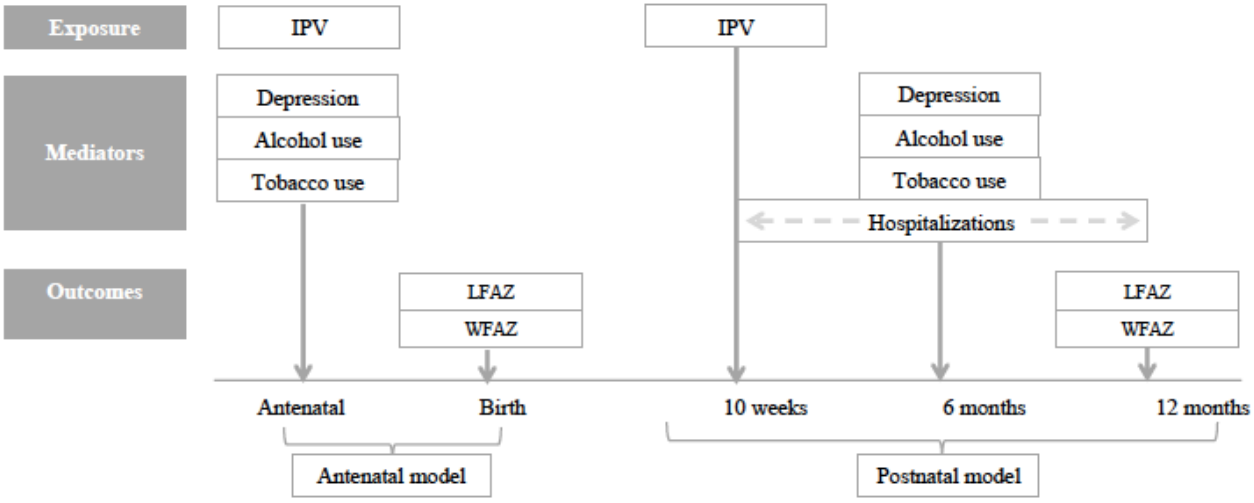
Pregnant women were recruited from two public primary healthcare clinics, Mbekweni (serving a black African community) and TC Newman (serving a mixed-ancestry community). Mothers were enrolled in their second trimester while attending routine antenatal care and have completed assessments antenatally and following birth (ongoing). Women were eligible for the study if they were 18 years or older, between 20-28 weeks gestation, planned attendance at the two recruitment clinics and intended to remain in the area. Data included in the current study were collected antenatally at 28-32 weeks' gestation, at birth, and postnatally at 10 weeks, 6 and 12 months, Figure 5.1.

5.3.3 Study population

Between March 2012 and March 2015, 1225 pregnant women were enrolled into the DCHS, as has been described.[19] Details of study attendance and loss-to-follow-up are provided in

Supplemental Figure 5.1. A total of 1,111 children had growth outcome data at birth and were included in the antenatal analysis. A total of 783 children who had growth data at 12 months were included in the postnatal analyses, Supplemental Figure 5.1.

Figure 5.1 Timing of measures



Time points of measures included in the current study. IPV= Intimate partner violence (emotional, physical and sexual); LFAZ = length-for-age z-scores; WFAZ = weight-for-age z-scores; Child hospitalizations were measured by active surveillance and included as total number of hospitalizations per child from age 10 weeks to 12 months.

5.4 Measures

5.4.1 Growth measures

Infant birth length and weight measurements were conducted by trained labor ward staff, with a subgroup of measurements checked by study staff to confirm reliability. Postnatal anthropometric measurements were done by trained study staff at 12 months. Comprehensive quality control measures were in place including regular training and assessment of staff, routine calibration of equipment and taking multiple measurements. Birth weights and lengths were converted to z-scores based on gender and gestational age using the INTERGROWTH-21st standards.[20] Postnatal weight-for-age z-scores (WFAZ) and length-for-age z-scores (LFAZ) were calculated using

weight and length measurements at 12 months, based on age and gender using Anthro software (WHO, Geneva, Switzerland).[21]

5.4.2 Intimate partner violence

The Intimate Partner Violence Questionnaire (IPVQ) is a 12-item inventory adapted from the WHO multicountry study[22] and the Women's Health Study in Zimbabwe.[23] The IPVQ assessed recent (past-year) exposure to emotional, physical, and sexual abuse. Mothers reported frequency of exposure to partner behavior ("never", "once", "a few times" or "many times".) Items were summed to create a total score for each IPV sub-type, with higher scores indicating higher frequency and severity of IPV. Mothers completed the IPVQ at the 28-32 week antenatal visit and at 10 weeks postpartum.

5.4.3 Sociodemographic and clinical variables

Sociodemographic variables were collected from an adapted questionnaire used in the South African Stress and Health (SASH) study.[19] Household income and maternal education (any secondary versus completed secondary) were self-reported antenatally at 28-32 weeks' gestation. Maternal height was measured at enrolment, using a wall-mounted stadiometer (CE stature meter).

5.4.4 Proposed mediators

Number of hospitalizations included all-cause child admissions to Paarl Hospital, the only hospital serving the study catchment area. Active surveillance was conducted by study staff at Paarl Hospital. In addition, at routine study visits, mothers were asked whether children had been hospitalized. Where admissions were reported that were missed by surveillance efforts, study staff

abstracted relevant details from hospital folders. A score for total number of hospitalizations from 10 weeks through 12 months of child age was calculated for the postnatal analyses.

Validated questionnaires were administered to mothers antenatally and at 6 months postpartum to assess maternal substance use and depression.[18] The Alcohol, Smoking and Substance Involvement Screening test (ASSIST) assessed maternal alcohol and tobacco use risk. Previously published results found that self-reported tobacco use on the ASSIST correlated well with urine cotinine measures, a biomarker of tobacco smoke.[24] Individual item responses were summed to generate total scores, with a higher score indicative of greater risk for substance-related health problems. The Edinburgh Postnatal Depression Rating Scale (EPDS) is a 10-item self-report measure of recent depressive symptoms.[25] Each item is scored on a frequency scale ranging from 0 to 3, with higher total scores indicative of more severe depressive symptoms.

5.4.5 Ethical considerations

The DCHS was approved by the Human Research Ethics Committee at the University of Cape Town (401/2009) and by the Western Cape Provincial Health Research committee. Mothers completed informed consent in their preferred language: isiXhosa, Afrikaans or English. Study staff were trained on the ethical conduct of violence research, including confidentiality, mandatory reporting and safety issues. Where substance abuse or mental health issues were identified, staff referred participants to social services or appropriate care in the Paarl area.

5.5 Statistical analysis

Linear regression models explored associations between antenatal IPV and WFAZ and LFAZ at birth as well as between postnatal IPV and WFAZ and LFAZ at 12 months. Multivariable models were run where IPV sub-types were associated in unadjusted analyses with growth at birth or 12 months. IPV sub-types were included separately in adjusted models due to collinearity. Final models considered key factors known to affect growth, namely: maternal education, household income, maternal height, maternal HIV status and child sex. Additionally, WFAZ at birth was considered in models investigating growth at 12 months. Final models were chosen based on Akaike information criterion (AIC) and were estimated using the maximum likelihood method to impute missing values. These analyses were run using STATA 15.0.

Structural equation models (SEMs) were used to investigate the role of potential mediators (maternal depression, alcohol or tobacco use) in the IPV-growth relationship at birth and at 12 months. Additionally, number of hospitalizations was considered as a potential mediator in IPV-growth relationships at 12 months. Mediators were tested concurrently[26] in final mediation models 1) where IPV sub-type and the hypothesized mediator were associated (path a) and 2) based on the hypothesized mediator's association with growth outcomes, using a cut-off level of $p<0.05$, in adjusted models (path b). Hypothesized mediators that did not meet these criteria but were associated with growth outcomes were included as covariates in final models. SEMs were used to estimate the indirect effect of IPV sub-types on growth outcomes via proposed mediators as well as the direct effect of IPV on growth outcomes (path c). SEMs were estimated using the maximum likelihood method to impute missing values. These were conducted using R version 3.6.1 (R Core Team, 2019) and the library "lavaan"[27] (version 3.5.3). Confidence intervals (95%) as well as

direct effects and casual mediation effects were calculated. Each analysis was based on 5000 bootstrapped samples.

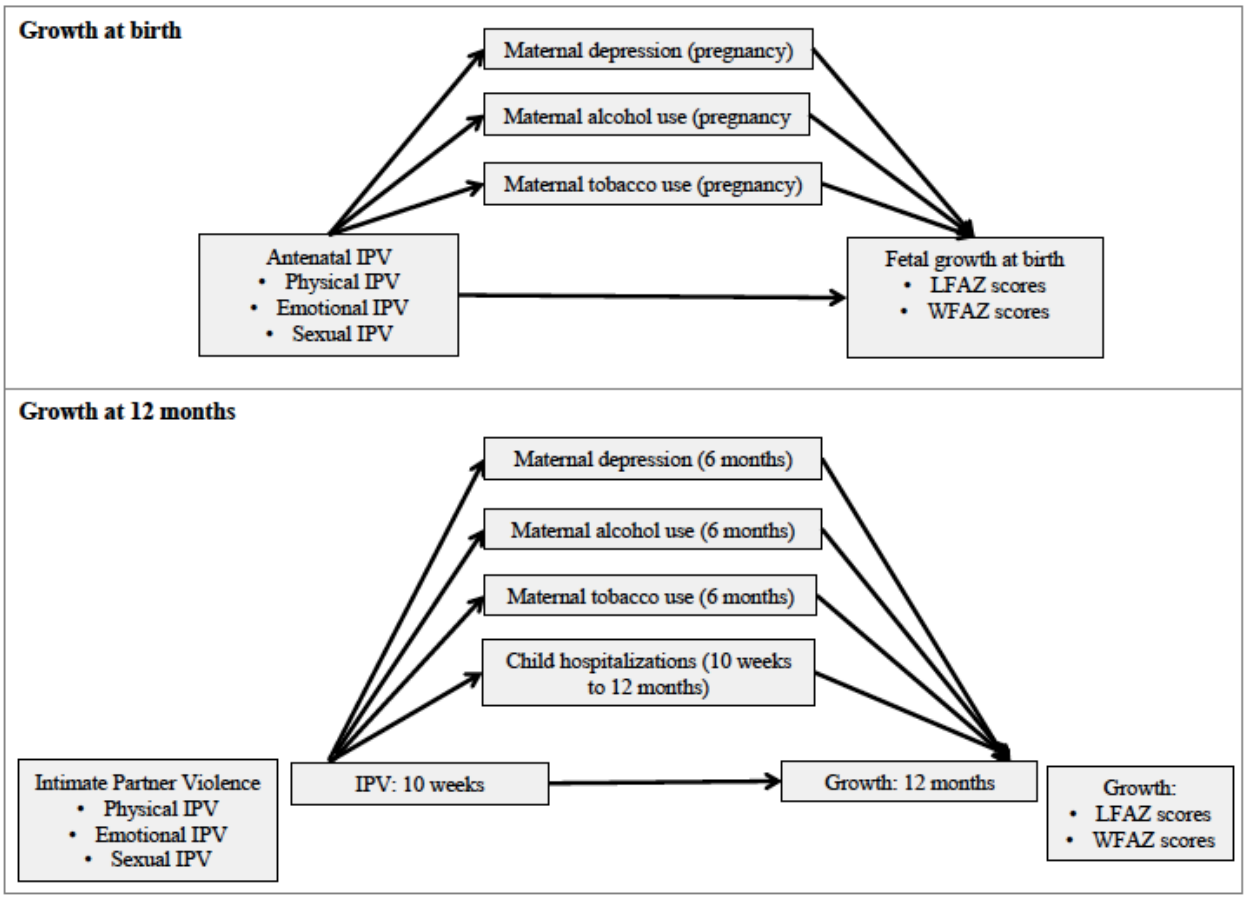


Figure 5.2 Diagram of hypothesized pathways in the association between intimate partner violence and growth at birth or 12 months.

5.6 Results

Detailed baseline characteristics are presented in Table 5.1. The sample was characterized by high levels of antenatal IPV (34%) and postnatal IPV (27%) as well as a high proportion of stunting at 12 months (15%). Antenatally, 24% of mothers were categorized as depressed, 11% were categorized as moderate or high-risk for alcohol use and 28% as moderate or high-risk for tobacco use. Similar rates of substance risk were reported postnatally (alcohol, 12%; tobacco, 30%). The majority of mothers did not complete secondary education (61%) and a large portion of households

received an income of less than R1,000 per month (USD 60, 38%). There were no differences between the group of children included in the models versus those excluded, Supplemental Table 5.1.

Table 5.1 Baseline characteristics of study population

*Sample size**	Antenatal *n=1111*	Postnatal *n=783*
Sociodemographic & clinical variables		
Maternal education (did not complete secondary/graduate highschool), n (%)	676 (61)	486 (62)
Household income, n (%)		
<R1,000/month (30 USD)	423 (38)	304 (39)
>R1,000/month	688 (62)	479 (61)
Maternal Height (cm), median (IQR)	160 (155, 164)	159 (155, 164)
Male sex, n (%)	574 (52)	396 (51)
Intimate partner violence		
Emotional IPV score, median (IQR)	4 (4, 6)	4 (4, 4)
Emotional IPV threshold, n (%)	259 (27)	104 (20)
Physical IPV score, median (IQR)	4 (4, 6)	4 (4, 4)
Physical IPV threshold, n (%)	213 (22)	99 (19)
Sexual IPV score, median (IQR)	4 (4, 4)	4 (4, 4)
Sexual IPV threshold, n (%)	68 (7)	29 (6)
Any IPV threshold, n (%)	328 (34)	141 (27)
Proposed mediators		
Depression score, median (IQR)	9 (6, 12)	8 (5, 10)
Depression threshold, n (%)	233 (24)	80 (15)
Alcohol score, median (IQR)	0 (0, 0)	0 (0, 0)
Alcohol: moderate/high risk	106 (11)	64 (12)
Tobacco score, median (IQR)	0 (0, 13)	0 (0, 12)
Tobacco: moderate/high risk	274 (28)	158 (30)
Number of hospitalizations, median (IQR)		0 (0, 0)
Any hospitalization, n (%)		94 (12)
Growth outcomes		
Weight-for-age z-score, median (IQR)	-0·55 (-1·31, 0·07)	-0·04 (-0·89, 0·79)
Length-for-age z-score, median (IQR)	0·00 (-0·86, 0·93)	-0·66 (-1·57, 0·19)

Notes: IPV= intimate partner violence, above threshold exposure defined as more than an isolated incident within each sub-type. Depression threshold defined as EPDS score of >=13. Moderate/high risk for alcohol was defined as a score of >10; moderate/high risk for tobacco was defined as a score of >3. There was missing data for IPV, depression, alcohol and tobacco use (n=134 during pregnancy; n=260 postnatally).

5.6.1 Birth outcomes

In adjusted linear regression analyses, antenatal emotional and physical IPV were inversely associated with WFAZ at birth (β=-0·04, 95%CI -0·07, -0·02 and β=-0·04, 95%CI -0·07, -0·02

respectively), Table 5.2. Only physical IPV was associated with LFAZ at birth [β=-0·04, 95%CI -0·08, -0·00), Table 5.2. Sexual IPV was not associated with either WFAZ or with LFAZ at birth.

5.6.2 Mediation models: birth size

Of proposed mediators for antenatal IPV-growth at birth relationships, only alcohol and tobacco use during pregnancy were associated with WFAZ and LFAZ at birth (in both emotional and physical IPV analyses), Table 5.3. These were therefore formally investigated as mediators. Maternal antenatal depression was not associated with birth size (path b). Both emotional and physical IPV were associated with maternal alcohol and tobacco use during pregnancy (path a). Details about variable selection for model building appear in supplemental tables.

We examined alcohol and tobacco use as mediators of the physical IPV-WFAZ association at birth (model 1), the emotional IPV-WFAZ association at birth (model 2), and the physical IPV-LFAZ association at birth (model 3). In model 1, the relationship between antenatal physical IPV and WFAZ was partially mediated by tobacco and alcohol use (total proportion mediated = 39%). The direct effect of physical IPV on WFAZ remained significant after including potential mediators and confounders. In model 2, the relationship between antenatal emotional IPV and WFAZ at birth was fully mediated by tobacco and alcohol use (total proportion mediated = 51%). In model 3, the relationship between antenatal physical IPV and LFAZ at birth was fully mediated by alcohol use in pregnancy (proportion mediated = 36%). Tobacco use did not mediate this relationship. Results are summarized in Figure 5.3.

Table 5.2 Adjusted associations between intimate partner violence and growth outcomes at birth and through 12 months.

	Birth^		12 months#	
	Weight-for-age z-score Coef (95% CI)	Length-for-age z-score Coef (95% CI)	Weight-for-age z-score Coef (95% CI)	Length-for-age z-score Coef (95% CI)
Emotional IPV Score	-0·04 (-0·07, -0·02)**	-0·03 (-0·07, 0·01)	-0·07 (-0·11, -0·04)**	-0·07 (-0·10, -0·04)**
Physical IPV Score	-0·04 (-0·07, -0·02)*	-0·04 (-0·08, -0·00)*	-0·03 (-0·05, -0·00)*	-0·03 (-0·06, 0·01)
Sexual IPV Score	-0·05 (-0·13, 0·03)	-0·10 (-0·22, 0·01)	-0·08 (-0·22, 0·07)	-0·10 (-0·31, 0·10)

Notes: Due to collinearity, each IPV sub-type was run in a separate multivariable model. The weight-for-age model at birth was adjusted for recruitment site, maternal height and child sex; length-for-age model at birth was adjusted for maternal height. Models investigating length-for-age and weight-for-age at 12 months were adjusted for recruitment site, maternal education, household income, maternal height, child sex and weight-for-age z-scores at birth). IPV sub-types were included as continuous variables in all models.
*p<0·05; **p<0·001
^Sample size at birth, n=972; #Sample size at 12 months, n=783

Table 5.3 Mediator adjusted associations between intimate partner violence and growth outcomes at birth and through 12 months.

Emotional IPV Models				
	Birth^		**Through 12 months#**	
	Weight-for-age z-scores Coef (95% CI)	Length-for-age z-scores Coef (95% CI)	Weight-for-age z-scores Coef (95% CI)	Length-for-age z-scores Coef (95% CI)
Intimate Partner Violence				
Emotional IPV Score	-0·02 (-0·05, 0·00)	-0·01 (-0·04, 0·03)	-0·06 (-0·09, -0·03)**	-0·05 (-0·10, -0·00)*
Proposed Mediators				
Alcohol abuse score	-0·02 (-0·03, -0·01)**	-0·03 (-0·04, -0·01)*	0·00 (-0·01, 0·01)	-0·01 (-0·03, 0·01)
Tobacco abuse score	-0·01 (-0·02, -0·00)*	-0·01 (-0·02, -0·00)*	-0·02 (-0·03, -0·01)*	-0·02 (-0·03, -0·00)*
Physical IPV Models				
	Birth^		**Through 12 months#**	
	Weight-for-age z-scores Coef (95% CI)	Length-for-age z-scores Coef (95% CI)	Weight-for-age z-scores Coef (95% CI)	Length-for-age z-scores Coef (95% CI)
Intimate Partner Violence				
Physical IPV Score	-0·03 (-0·05, -0·00)*	-0·02 (-0·04, -0·01)*	-0·01 (-0·05, 0·03)	-0·01 (-0·04, 0·03)
Proposed Mediators				
Alcohol risk score	-0·02 (-0·03, -0·01)**	-0·02 (-0·04, -0·01)*	-0·00 (-0·01, 0·02)	-0·01 (-0·02, 0·00)
Tobacco abuse score	-0·01 (-0·02, -0·00)*	-0·01 (-0·02, -0·00)*	-0·02 (-0·04, -0·01)*	-0·02 (-0·03, -0·01)*

Notes: Mediator adjusted models were run to confirm association (p<0·05) between proposed mediator and growth outcome prior to running formal mediation models. Due to collinearity, emotional and physical IPV were run in separate multivariable models. Weight-for-age model at birth was adjusted for recruitment site, maternal height and child sex; length-for-age model at birth was adjusted for maternal height. Models investigating length-for-age and weight-for-age at 12 months were adjusted for recruitment site, maternal education, household income, maternal height, child sex and weight-for-age z-scores at birth). IPV sub-types, alcohol and tobacco use are included as continuous variables.
*p<0·05; **p<0·001
^Sample size at birth, n=972; #Sample size at 12 months, n=783

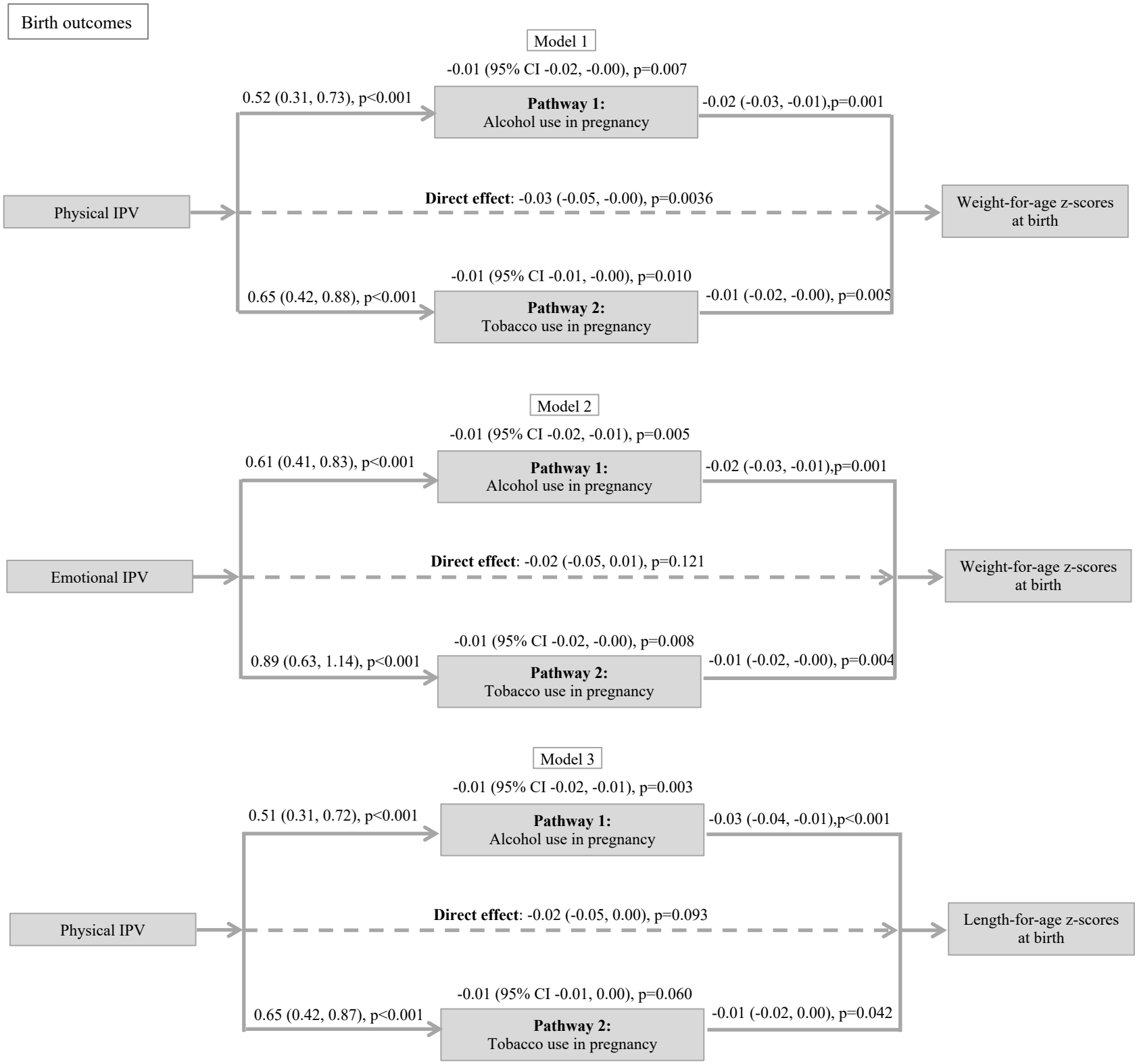


Figure 5.3 Results of structural equation models investigating mediators of intimate partner violence and growth at birth

The figure shows results (regression path coefficients, 95% confidence intervals and p-values) for each direct and indirect association. Structural equation models were used to investigate potential mediators in the relationship between antenatal IPV and growth at birth. Model 1 and 2: Adjusted for maternal height and child sex. Model 3: Adjusted for maternal height.

5.6.3 Growth at 12 months

In adjusted analyses, emotional and physical IPV were inversely associated with reduced WFAZ at 12 months (β=-0·07, 95%CI -0·11, -0·04; β=-0·03, 95%CI, -0·05, -0·00, respectively), Table 5.2. Only emotional IPV was associated with reduced LFAZ at 12 months (β=-0·07, 95%CI, -0·10, -0·04).

5.6.4 Mediation models: growth at 12 months

Of proposed mediators for postnatal IPV-growth relationships, only postnatal tobacco use was associated with WFAZ as well as with LFAZ at 12 months (in both emotional and physical IPV analyses), Table 5.3. Therefore, postnatal tobacco use was formally investigated as a mediator. Details about modelling building and variable selection appear in supplemental tables. Postnatal alcohol use was associated with WFAZ and LFAZ in unadjusted analyses (path b), however maternal depression and child hospitalizations were not. Therefore, alcohol use was included as a covariate but not investigated as a mediator. Both postnatal emotional and physical IPV were associated with maternal depression, alcohol use and tobacco use but not child hospitalizations (path a).

We examined postnatal tobacco use as a mediator of the physical IPV-WFAZ association at 12 months (model 4), the emotional IPV-WFAZ association (model 5), and the emotional IPV-LFAZ association at 12 months (model 6). In model 4, the relationship between postnatal physical IPV and WFAZ was fully mediated by tobacco use (proportion mediated = 62%). In model 5, the relationship between postnatal emotional IPV and WFAZ at 12 months was partially mediated by tobacco use (proportion mediated = 23%). In model 6, the relationship between postnatal emotional IPV and LFAZ at 12 months was partially mediated by tobacco use (proportion mediated = 24%). Emotional IPV maintained a direct effect on WFAZ and LFAZ at 12 months. Results are summarized in Figure 5.4.

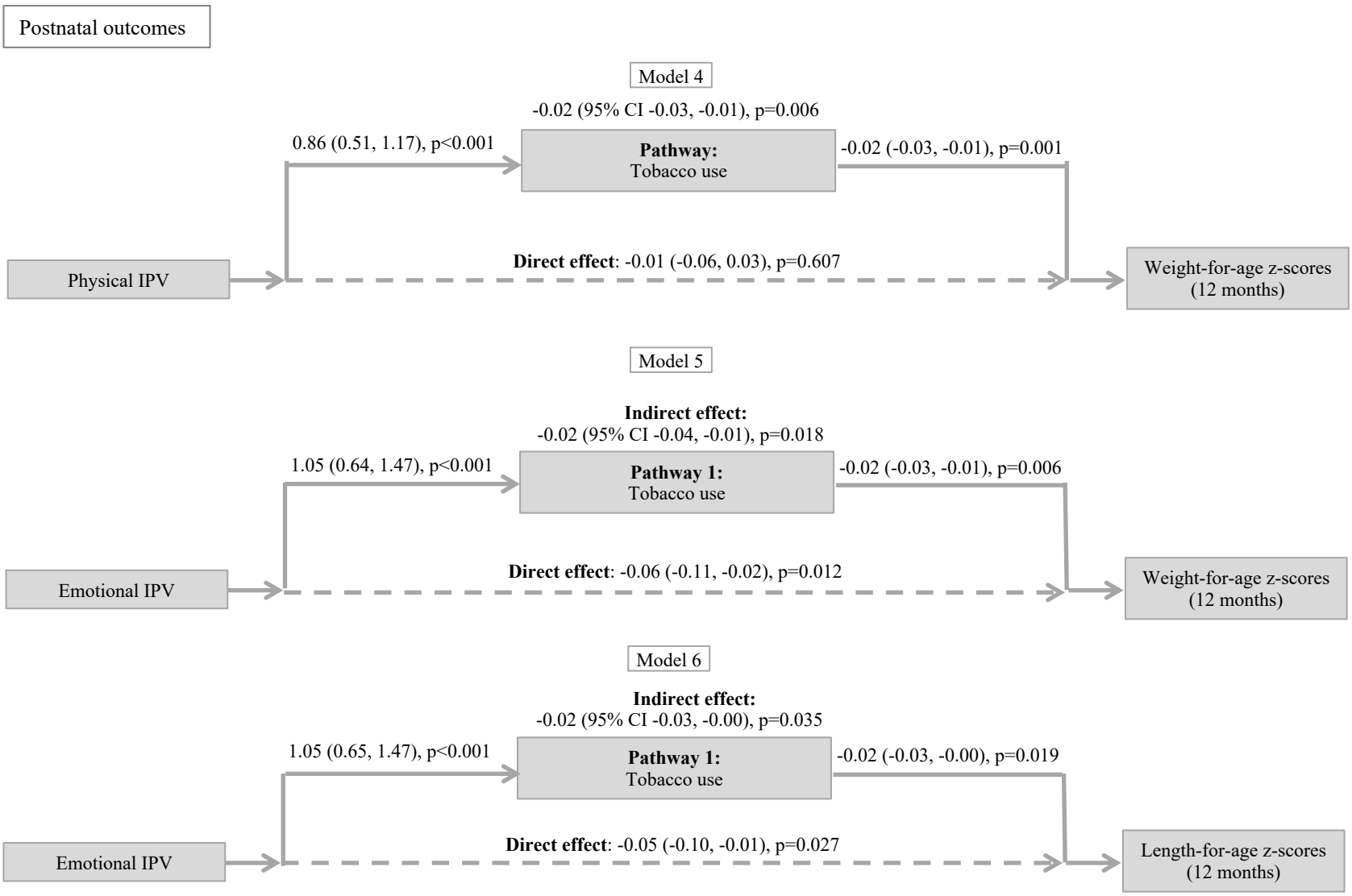


Figure 5.4 Results of structural equation models investigating mediators of intimate partner violence and growth at 12 months

The figure shows results (regression path coefficients, 95% confidence intervals and p-values) for each direct and indirect association. Structural equation models were used to investigate potential mediators in the relationship between postnatal IPV and growth at 12 months. All models adjusted for maternal height, child sex, household income, weight for age z-score at birth, maternal education and alcohol use.

5.7 Discussion

In this study, investigating maternal IPV and infant growth outcomes in a South African birth cohort, we describe high prevalence of both maternal antenatal and postnatal IPV. At birth, both maternal emotional and physical IPV were associated with lower WFAZ. Only physical IPV was associated with lower LFAZ at birth. Maternal alcohol use and tobacco use during pregnancy were key mediators of the relationship between maternal IPV and WFAZ, alcohol use was a mediator for the relationship between physical IPV and LFAZ at birth. Postnatally, both maternal emotional and physical IPV were associated with lower infant WFAZ at 12 months of age. Only emotional IPV was associated with lower child LFAZ at 12 months of age. Postnatal maternal tobacco use emerged as a mediator in these relationships. Findings build on previous research by investigating IPV's impact on child growth through infancy and by formally testing multiple mediators collected in a birth cohort study.

These results linking IPV during pregnancy with growth at birth are consistent with previous literature, specifically associations with low birth weight are well-established.[4] Both smoking and hazardous alcohol use during pregnancy have also been well-documented as factors impacting fetal growth.[28,29] Though many studies have investigated IPV, substance use and intrauterine growth, few have formally tested mediation. A US study investigating mediators of emotional or physical IPV and birthweight found that both forms of IPV were associated with lower birthweight and that tobacco use mediated this relationship.[30] Tobacco and alcohol use often co-occur, increasing the potential impact on pregnancy outcomes. Importantly, pregnant women who smoke often sustain similar rates of tobacco use postnatally,[31] which may continue to impact child health and nutritional outcomes. Our findings support research linking IPV to substance use during pregnancy as well as growth restriction in utero; they also extend

this research to an LMIC context and formally investigate substance use as a mediator in this relationship, which has been proposed but not often formally tested.

In the postnatal period, the association between emotional IPV and compromised infant growth is novel as few studies have investigated sub-types of IPV and infant growth. We found that both maternal physical and emotional IPV are associated with reduced child WFAZ at 12 months as well as an association between recent emotional but not physical IPV and child LFAZ at 12 months. One study, in Brazil, investigated past-year maternal verbal or physical abuse, finding only severe physical and not verbal or less severe physical abuse to be associated with child WFAZ in the first 2 years of life.[32] Another study investigated emotional IPV and linear growth, finding no association.[5] The existing literature investigating postnatal associations between IPV and growth are relatively few and use a wide range of definitions for IPV exposure with the majority investigating lifetime IPV rather than recent exposure. These novel findings, specifically related to postnatal maternal emotional IPV and early child growth outcomes, require replication in additional cohorts.

An aim of the current study was to investigate potential mediators in the relationship between IPV and growth. This is a key gap in the existing literature, only one study investigating IPV and postnatal growth has formally investigated potential mediators.[8] This study examined multiple potential mediators including alcohol use, positive–negative cognitive stimulation, depression and number of adults and/or children in the IPV-stunting relationship did not find evidence of mediation for any factors investigated. Other studies have adjusted for potential mediators, though did not formally investigate mediation. For example, one study included recent child illness as a potential confounder, finding that physical and sexual IPV were significantly associated with child stunting and underweight, after adjusting for childhood

illness.[33] Another study proposed maternal care seeking behaviour but found that this did not substantially change the association between maternal IPV and infant growth outcomes in the adjusted model.[6]

Maternal smoking mediated the IPV-growth relationship at 12 months of age, after adjusting for clinical and sociodemographic variables. Exposure to tobacco smoke has been linked to poor child growth, in particular, reduced linear height as well as stunting.[34] It can be difficult to distinguish causal effects in the presence of potential unmeasured environmental and socioeconomic factors. For instance, women who smoke postnatally are more likely to have smoked during pregnancy, a known risk factor for fetal growth restriction, which is known to impact subsequent growth; we were therefore careful to adjust for birthweight in final models. Additional potential reasons for the association between smoke exposure and poor infant growth include family income diverted from the purchase of nutritious food to cigarettes[35] and that smoke exposure has been shown to cause frequent health problems in children, which may additionally impact growth.[36] Given the relatively low household incomes in the current study, it is feasible that diverted income has an impact on child nutrition in this study; previous work in this cohort found several dietary deficits as well as a rising trend in the consumption of inappropriate and nutritionally poor foods through infancy.[37]

5.7.1 Policy implications

The majority of women in South Africa as well as worldwide attend antenatal care, offering an opportunity to screen for maternal IPV as well as substance use and refer for help. Public health efforts have made huge strides in informing mothers of the potential negative child health sequelae of alcohol and tobacco use, specifically during pregnancy. However, this has also created stigma, establishing a barrier to disclosure. Existing programs have also tended to focus

on educating mothers about the dangers of alcohol or tobacco smoke exposure antenatally rather than in the postnatal period. Further, it is important that screening and referral efforts integrate support for emotional IPV alongside physical and sexual IPV, given its potential impact on both substance use as well as child growth.

5.7.2 Strengths & Limitations

Inclusion criteria for the parent study were broad, however, study recruitment was done during routine antenatal care and mothers who did not present or presented very late for antenatal care were not included. This may have resulted in the highest risk mothers being underrepresented. Key mediators were also self-reported, specifically maternal depression, alcohol and tobacco use, which may have been underreported, particularly in pregnancy given the stigma linked to substance use. Postnatal IPV was measured at 10 weeks and may therefore overlap antenatal IPV exposure, however, postnatal IPV was measured at multiple points postnatally and found to be correlated with stable intensity profiles through 2 years postpartum.[38] In addition, there were children who were not included in analyses due to incomplete data, although there was no evidence that these excluded children differed from the wider sample on key risk factors. Lastly, IPV sub-types were analyzed separately due to collinearity; however, these co-occur to a large degree and disentangling sub-type specific effects is difficult and should be interpreted with caution. Despite these limitations, the current study adds to a small growing literature investigating IPV and growth outcomes postnatally. Further, we address several methodological gaps in the existing literature, specifically by using longitudinal data, considering recent rather than lifetime IPV and including emotional IPV as a key exposure, rather than defining IPV as only physical and/or sexual.

5.8 References

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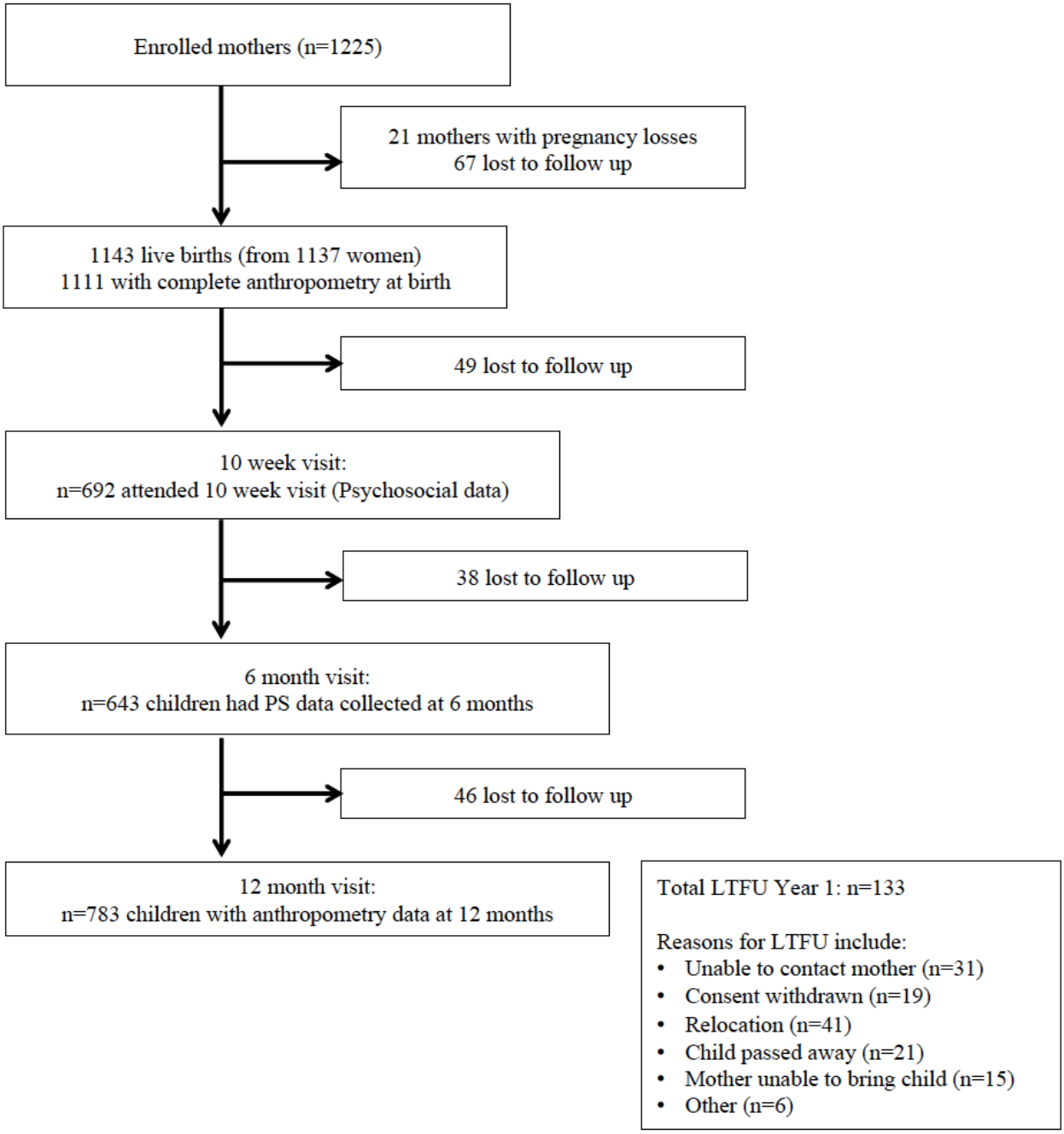
Supplemental Figure 5.1 Flow diagram of attendance and loss to follow up from enrolment through the first year of life.



Supplemental Table 5.1 Comparison of psychosocial, demographic and clinical data between child observations included in final models and those not included.

	In model	Not in model	p-value
Sociodemographic & clinical variables			
Sample	*n=783*	*n=352*	
Education: did not complete secondary education	486 (62)	205 (58)	0·204
Household income:			
<R1,000	479 (61)	226 (64)	0·33
Maternal Height (cm)	159·1 (155, 164)	159 (155, 164)	0·616
Gender: Male	396 (51)	186 (53)	0·502
WAZ at birth	-0·55 (-1·32, 0·11)	-0·53 (-1·19, -0·01)	0·712
Intimate Partner Violence (antenatal)			
Sample	*n=977*	*n=15*	
Emotional IPV Score, median (IQR)	4 (4, 6)	4 (4, 7)	0·472
Physical IPV Score, median (IQR)	4 (4, 6)	4 (4, 6)	0·947
Sexual IPV Score, median (IQR)	4 (4, 4)	4 (4, 4)	0·548
Intimate Partner Violence (10 weeks)			
Sample	*n=523*	*n=169*	
Emotional IPV Score	4 (4, 4)	4 (4, 4)	0·922
Physical IPV Score	4 (4, 4)	4 (4, 4)	0·544
Sexual IPV Score	4 (4, 4)	4 (4, 4)	0·694
Mediator variables (Antenatal)			
Sample	*n=977*	*n=15*	
Depression Score	9 (6, 12)	8 (7, 10)	0·762
Alcohol use	0 (0, 0)	0 (0, 6)	0·507
Tobacco use	0 (0, 13)	0 (0, 9)	0·817
Mediator variables (6 months)			
Sample	*n=523*	*n=118*	
Depression Score	8 (5, 10)	7 (5, 10)	0·976
Alcohol use	0 (0, 0)	0 (0, 2)	0·580
Tobacco use	0 (0, 12)	0 (0, 0)	0·059
Sample	*n=783*	*n=352*	
Hospitalizations (10 weeks to 12 months)	0 (0, 0)	0 (0, 0)	0·175

Supplemental Table 5.2 Unadjusted associations between intimate partner violence and proposed mediators.

	Antenatal		Postnatal	
	Emotional IPV Coefficient (95% CI)	Physical IPV Coefficient (95% CI)	Emotional IPV Coefficient (95% CI)	Physical IPV Coefficient (95% CI)
Depression score	0·12 (0·06, 0·18)**	0·14 (0·10, 0·19)**	0·26 (0·15, 0·56)*	0·24 (0·06, 0·41)*
Alcohol use	0·09 (0·06, 0·13)**	0·10 (0·05, 0·15)**	0·73 (0·42, 1·04)**	0·77 (0·52, 1·03)**
Tobacco use	0·07 (0·05, 0·09)**	0·06 (0·04, 0·08)**	0·98 (0·61, 1·35)**	0·78 (0·47, 1·09)**
Child Hospitalizations			-0·00 (-0·01, 0·01)	0·00 (-0·01, 0·01)

Associations explored by linear regression. IPV sub-types, depression, alcohol and tobacco use are included as continuous variables.
*p<0·05; **p<0·001

Supplemental Table 5.3 Unadjusted associations between covariates, intimate partner violence and mediators and infant weight-for-age z-scores and length-for-age z-scores at birth.

	Weight-for-age z-scores Unadjusted Coef (95% CI)	Length-for-age z-scores Unadjusted Coef (95% CI)
Intimate Partner Violence (antenatal)		
Emotional IPV Score	-0·04 (-0·06, -0·02)*	-0·03 (-0·07, -0·00)*
Physical IPV Score	-0·04 (-0·06, -0·02)**	-0·04 (-0·07, -0·01)*
Sexual IPV Score	-0·06 (-0·14, 0·01)	-0·12 (-0·22, 0·02)
Sociodemographic & clinical variables		
Education: did not complete secondary education	-0·10 (-0·24, 0·03)	-0·17 (-0·34, 0·01)
Household income:		
<R1,000	0·03 (-0·11, 0·17)	0·07 (-0·11, 0·25)
Maternal Height (cm)	0·02 (0·01, 0·03)**	0·02 (0·01, 0·03)*
Gender: Male	-0·17 (-0·31, -0·04)*	-0·17 (-0·34, 0·01)
Mediator variables (antenatal)		
Depression Score	-0·01 (-0·02, 0·00)	-0·00 (-0·02, 0·01)
Alcohol use	-0·02 (-0·03, -0·02)**	-0·03 (-0·04, -0·02)**
Tobacco use	-0·02 (-0·02, -0·01)**	-0·02 (-0·02, -0·01)**

Associations explored by linear regression. IPV sub-types, depression, alcohol and tobacco use are included as continuous variables.
*p<0·05; **p<0·001

Supplemental Table 5.4 Unadjusted associations between covariates, intimate partner violence, proposed mediators and infant growth at 12 months

	Weight-for-age z-scores (12 months) Unadjusted Coef (95% CI)	Length-for-age z-scores (12 months) Unadjusted Coef (95% CI)
Intimate Partner Violence (10 weeks)		
Emotional IPV Score	-0·10 (-0·14, -0·06)**	-0·10 (-0·14, -0·05)**
Physical IPV Score	-0·05 (-0·09, -0·01)*	-0·05 (-0·09, -0·01)*
Sexual IPV Score	-0·14 (-0·31, 0·04)	-0·15 (-0·33, 0·03)
Sociodemographic & clinical variables		
Education: did not complete secondary education	-0·48 (-0·66, -0·29)**	-0·50 (-0·69, -0·31)**
Household income:		
<R1,000	-0·19 (-0·37, 0·00)	-0·26 (-0·45, -0·07)*
Maternal Height (cm)	0·04 (0·03, 0·05)**	0·04 (-0·02, 0·05)**
Gender: Male	-0·32 (-0·50, -0·14)*	-0·45 (-0·64, -0·27)**
WAZ at birth	0·33 (0·26, 0·41)**	0·27 (0·19, 0·35)**
Mediator variables (6 months)		
Hospitalizations	-0·09 (-0·40, 0·23)	-0·07 (-0·39, 0·25)
Depression Score	-0·00 (-0·02, 0·02)	0·00 (-0·02, 0·02)
Alcohol use	-0·02 (-0·03, -0·00)*	-0·02 (-0·04, -0·01)*
Tobacco use	-0·03 (-0·04, -0·02)**	-0·03 (-0·04, -0·01)**

Associations explored by linear regression. IPV sub-types, depression, alcohol and tobacco use are included as continuous variables.
*p<0·05; **p<0·001

Chapter 6. Maternal emotional and physical intimate partner violence and early child development: investigating mediators in a cross sectional study in a South African birth cohort.

Final submitted version:

Barnett W, Halligan SL, Wedderburn CJ, MacGinty R, Hoffman N, Zar HJ, Stein DJ, Donald KA. Maternal emotional and physical intimate partner violence and early child development: investigating mediators in a cross sectional study in a South African birth cohort. *BMJ Open,* submitted.

Relevance of this paper to the thesis:

This Chapter addresses objective five of this thesis, investigating recent IPV and child developmental outcomes at 2 years of child age. There is relatively little research examining associations between IPV exposure and adverse developmental outcomes in infancy and early childhood, though this is a critical developmental period that can have significant implications for long-term health. Further, few studies incorporate a broad definition of IPV inclusive of emotional IPV in addition to physical or sexual IPV and few studies formally investigate potential mediators in these relationships.

Contribution of student and co-authors:

I conceptualized the study aims and methodology together with my supervisors. I conducted all analyses, however, statistical advice and guidance was provided by RM. CW and KD are coinvestigators and were responsible for implementation, training and quality control of developmental assessments. All authors provided intellectual input and reviewed and approved the final manuscript.

6.1 Abstract

Objectives: This study investigated associations between recent maternal intimate partner violence (emotional, physical and sexual) and child development at 2 years as well as whether maternal depression or alcohol use mediated these relationships.

Design: Cross sectional study nested in a South African birth cohort.

Setting: Two primary care clinics in Paarl, South Africa.

Participants: 626 mother-child pairs; inclusion criteria for maternal antenatal enrolment were clinic attendance and remaining in the study area for at least 1 year; women were excluded if a minor.

Primary outcome measures: Child cognitive, language and motor development composite scores. These were assessed using the Bayley Scales of Infant and Toddler Development, 3rd edition (BSID-III).

Results: Emotional IPV was associated with lower cognitive (β=-0.32; 95% CI -0.60,-0.04), language (β=-0.36; 95% CI -0.69,-0.01) or motor composite scores (β=-0.58; 95% CI -0.95,-0.20) in children at 2 years of age. Physical IPV was associated with lower motor scores (β=-0.42; 95% CI -0.75,-0.09) at 2 years. Sexual IPV was unrelated to developmental outcomes, possibly due to low prevalence. Neither recent maternal depression nor alcohol use were shown to mediate the relationship between IPV and developmental outcomes.

Conclusions: Interventions to reduce maternal IPV, including emotional IPV, and early-life interventions for infants and toddlers are needed to promote optimal child development.

6.2 Background

Intimate partner violence (IPV) is one of the most common forms of violence against women. The World Health Organization's multicountry study on violence against women found high lifetime prevalence of physical IPV (up to 61%), sexual IPV (up to 59%) and emotional IPV (up to 75%).[1] The epidemic of IPV is particularly marked in low-and-middle-income countries (LMICs), including South Africa, where prevalence is amongst the highest globally.[2,3] Children in households with IPV are often witnesses and are at increased risk for abuse or neglect.[4] The United Nations estimates that each year between 133–275 million children witness violence between primary caregivers.[5] Exposure to violence in the home is linked to many adverse health outcomes in children, including developmental, psychological and behavioural impairments.[6-8] Importantly, these often impact health and development beyond childhood, having negative effects that extend into adolescence and adulthood.[6,9,10] However, there remain several gaps in the existing literature.

Relatively little research has examined associations between the presence of IPV and poorer cognitive, language and motor development in infancy and very early childhood[11-13] though it is a critical developmental period that can have significant implications for long-term health.[14] Where data are available, exposure to IPV in the first two years of life has been associated with increased risk of developmental delay.[12,13] Healthy development during the first years of life is vital, given its impact on academic performance and mental health across the lifespan.[10,14] Indeed, a longitudinal study through 8 years found that exposure to interpersonal trauma (maltreatment and/or witnessing IPV) in the first two years of life was associated with the poorest cognitive outcomes compared to other periods in childhood.[15]

Research focusing on child development and IPV often narrowly defines IPV as only physical or sexual abuse, though emotional IPV has been linked to similar or increased rates of ill-health, both physical and mental, compared to physical IPV.[16-19] Additionally, the majority of studies, particularly in school-aged children, have been done in high income countries (HICs), though LMICs have a higher burden of IPV-associated risk factors, such as community violence, trauma, substance use disorders and mental illness and limited support networks. South Africa in particular has among the highest burdens of interpersonal violence in the world.[20] The roots of high levels of violence can be linked to South Africa's colonial and apartheid past, including the impacts of systemic racism, impoverishment, migrant labour, gender norms and constructions of masculinity.[21] Zembe and colleagues investigated social risk factors and relationship power inequity and IPV in a South African sample, finding high acceptability of violence in intimate relationships as well as gender norms supporting aggressive masculinity and subservient femininity, particularly in historically marginalized groups such as those included in the present study.[22]

Lastly, a key gap in the existing literature examining associations between IPV exposure and early life child developmental outcomes is investigation of potential mediators in this relationship, particularly in LMIC settings. Several potential mechanisms underlying the relationship between IPV and child development have been proposed. For instance, maternal depression as well as alcohol use have been separately linked to both IPV and development outcomes,[13,19] potentially compromising maternal-child attachment, impacting maternal autonomy and caregiving, diverting financial resources in the home and may increase the risk of child maltreatment or abuse.[23] Alcohol is one of the most commonly misused substances, with extremely high prevalence of alcohol use disorders in South Africa,[24] and maternal use postnatally is associated with poorer child development and academic performance.[25-27]

Maternal depression has been linked to insecure mother-child attachment;[28] less sensitive and responsive caregiving,[29] and reduced health care service utilization[30] adversely impacting care and stimulation needed for healthy development. Although there is evidence linking proposed mediators to both IPV and early-life development, extremely few have formally investigated potential explanatory factors.[31]

This study aims to explore associations between IPV sub-types (emotional, physical and sexual) and child development (cognitive, language and motor) at two years of age and to investigate potential mechanisms underlying this relationship. The current study addresses three key gaps in the literature, specifically by (i) investigating associations between IPV and development in very young children (ii) investigating the differential impact of sub-types of IPV and (iii) investigating maternal depression or alcohol use as potential mediators in these relationships. Given the high prevalence of IPV in low resource settings, understanding the significant impact IPV exposure may have on young children during this developmentally sensitive period and improved understanding of possible pathways underlying these relationships is important for improving child potential globally.[11]

6.3 Methods

The Drakenstein Child Health Study (DCHS) is a longitudinal, population-based birth cohort study following mother–child dyads from pregnancy through childhood.[32-34] The study is located in a periurban area in South Africa, characterised by low socioeconomic status (SES) and psychosocial risk factors. There is a free primary health care system, that includes antenatal and child health services. The current cross sectional analysis uses data from three study visits occurring at or near 2 years of child age.

6.3.1 Participants

Pregnant women were enrolled from March 2012 to March 2015. Women were enrolled in their second trimester, between 20 and 28 weeks' gestation at two public sector primary healthcare clinics, one serving a predominantly mixed-ancestry population and the other serving a predominantly Black African population. Our intention in using the historic terms of *Black African* and *mixed ancestry* is not meant to reify these terms, but to contribute to the literature on ongoing health disparities. Inclusion criteria were: (1) pregnant women attending one of the two study clinics; (2) aged 18 years or older; and (3) intending to remain in the study area for at least 1 year.

6.3.2 Ethical considerations

The Faculty of Health Sciences Research Ethics Committee, University of Cape Town (401/2009) and the Provincial Research Committee for the Western Cape provided ethical approval. Pregnant women provided written informed consent at enrolment and were re-consented annually thereafter. Study staff were trained in ethical conduct of violence and mental health research, including confidentiality, and identification and management of risk. Interviews were conducted privately, data were de-identified and only accessible to study staff to ensure confidentiality. Where significant mental health issues or safety concerns were identified, staff referred participants to appropriate care or social services (including support services for IPV, substance abuse and mental health issues).

6.3.3 Clinical and sociodemographic data

Sociodemographic information was collected from the mother at a visit two years after their child's birth, using a standardized questionnaire adapted from items included in the South African Stress and Health Study.[35] Maternal education (any secondary versus completed

secondary), employment and partnership status (single or married/marriage-like relationship) and household income [<R,1000/month (60USD), R1,000 to R5000 (350USD) or > R5,000/month] were self-reported at 2 years postpartum. Maternal HIV status during pregnancy was confirmed by routine testing during antenatal care. All HIV-exposed children were tested per the Western Cape prevention of mother-to-child transmission guidelines.[36] Birthweight and postnatal anthropometric measurements were collected by trained staff at birth and 2 years, as has been described.[37]

6.3.4 Intimate partner violence

Recent maternal IPV was measured at 2 years postpartum using the Intimate Partner Violence Questionnaire (IPVQ), a 12-item inventory adapted from the WHO multicountry study[38] and the Women's Health Study in Zimbabwe.[39] The IPVQ assessed recent (past-year) exposure to emotional (4 of 12 questionnaire items), physical (5 of 12 items), and sexual abuse (3 of 12 items). Partner behavior indicating emotional IPV included having been insulted or made to feel bad, having been humiliated in front of others, intentionally scared or intimidated or threatened with physical harm. Physical IPV included being slapped, pushed, shoved, hit with an object, beaten or choked. Sexual IPV exposure was classified based on having been forced to have sex, afraid not to have sex or forced to do something sexual which was degrading or humiliating. Mothers were asked about frequency of exposure to partner behavior ("never", "once", "a few times" or "many times"). Items were then summed to create scores for each IPV sub-type with higher scores indicating greater severity and frequency of exposure; exposure was defined as a score >1 indicating more than an isolated incident within each subtype. Scoring guidelines were devised for the purposes of this study, and were based on prior work in South Africa.[40]

6.3.5 Proposed mediating variables

Recent maternal depression was measured using the Beck Depression Inventory (BDI), a validated and reliable screening tool for depressive symptoms at 2 years post-partum.[41,42] The BDI-II comprises 21 items, which assesses severity of symptoms of major depression on a severity scale from 0 (absence of symptoms) to 3 (severe). Individual items are summed to obtain a total score, with higher scores indicating more severe depressive symptoms. A cut off score of ≥20 was used to indicate participants with probable depression.[43] The Alcohol, Smoking and Substance Involvement Screen Test (ASSIST) was used to measure current maternal alcohol-related risk at 2 years of child age.[44] Alcohol related items were summed to create a score for alcohol-related problems with higher scores indicating greater substance-related risk. We used published guidelines for the ASSIST to classify alcohol scores into three categories for descriptive purposes: low/no risk (0-10), moderate risk (11-26) and high risk (>26), with the likelihood of alcohol dependence.[45]

6.3.6 Bayley scales of infant and toddler development, 3rd edition (BSID-III)

The Bayley Scales of Infant and Toddler Development, third edition (BSID-III)[46] was used to measure toddler neurodevelopment. It is widely used to assess development in children ages 2 to 42 months and has been validated for use in South Africa.[47] Assessments for neurodevelopment were done at 2 years of child age by trained physiotherapists and occupational therapists supervised by a paediatric neurodevelopmental specialist.[34] Quality control and monitoring processes were implemented to ensure accuracy. Assessments were conducted with language prompts in the child's preferred language and assessors alternated between sites and assessed a similar number of children. In the current study, composite scores for cognition, language and motor development were used. The composite scores are calculated using a normal US population, and are standardised to have a mean of 100 and standard

deviation of 15. Composite scores are strongly correlated to raw scores in the current study and allow comparison across domains. Continuous composite scores as well as categorical outcomes are reported. Categories were defined as 'delay' (<2 standard deviations below mean), 'suboptimal development' (<1 standard deviation below mean) and 'no delay'.

Patient and public involvement

Investigators have established close relationships with key stakeholders including Western Cape Government Health Department and community members. Participants were not involved in the design or recruitment of the DCHS. However, participant experience and satisfaction have been assessed at multiple time points.[48] Participant feedback about study experience, information provided and study procedures have been used ongoing to reassess study protocols and to make alternations to improve study experience and participant satisfaction. Study findings are routinely fed back to the community and the Department of Health clinical and administrative staff.

6.4 Data analysis

The analyses were conducted using STATA 15 (StataCorp Inc., College Station, Texas, USA). Demographic, clinical, psychosocial and child development data were described using median (interquartile range (IQR)) for continuous data or number (%) for categorical data. Developmental data were compared by child sex using Pearson's Chi-square test for categorical data and the Wilcoxon Rank Sum test for continuous data.

Mean composite scores were calculated for the Bayley-III for cognitive, language and motor domains. Birthweight was converted to z-scores based on child sex and gestational age using the INTERGROWTH-21st standards [49]. Postnatal weight-for-age z-scores (WFAZ), length-for-

age z-scores (LFAZ) and weight-for-length z-scores (WFHZ) were calculated using weight and length measurements at 24 months, using Anthro software (WHO, Geneva, Switzerland) [50]. These as well as emotional, physical and sexual IPV and proposed mediator variables were included as continuous scores in all analyses.

We examined associations using a complete case analysis sample. Bivariate linear regression analyses were used to investigate the relationship between developmental domains, clinical and demographic variables, proposed mediators and IPV sub-types. Regression coefficients with 95% confidence intervals (CIs) are reported. Multivariable linear regression models were then run for each of the developmental (composite cognitive, language and motor scores) outcomes, including significant univariable coefficients ($p<0.05$). Continuous scores were used for exposure, mediator and outcome data in multivariable models. Where multiple IPV sub-types were significant in bivariate regression, adjusted models were run for each separately, as these were highly correlated. Hypothesized mediators of the relationship between IPV and early life development (current maternal depression and alcohol use) were investigated. Criteria for formal investigation of potential mediators were 1) their association with developmental outcomes, using a cut-off level of $p<0.05$, in final adjusted models (path b) and 2) where associations between IPV and the hypothesized mediator were significant (path a).

In addition to the analysis of observations with complete data, we examined associations after imputing missing data for covariates and developmental outcomes using multiple imputation with chained equations (MICE). We assumed covariate data were missing at random and performed 30 imputations. Results from complete case and imputed datasets produced similar conclusions. Results based on imputed data are presented in Supplemental Tables. To explore potential selection bias, we assessed the characteristics of mother-child dyads with complete

and missing data, using Pearson's Chi-squared and Wilcoxon Rank Sum tests to compare covariate distributions between groups.

6.5 Results

Of 1143 study births, 154 (13.5%) children were lost to follow up before reaching two years of age. A further 255 (25.8%) did not complete a BSID-III assessment due to non-attendance on the day or moving out of the study area. Data for the current study was collected across three visits at approximately 2 years of child age: a clinical visit for growth and sociodemographic data collection; a psychosocial visit for maternal depression and substance use data and a visit assessing child development. A total of 626 children who completed the BSID-III assessment and had IPV exposure and covariate data were included in the final complete case dataset. Comparing the characteristics of dyads with complete and missing exposure or outcome data, mothers with missing data were less likely to be HIV infected (p=0.01) and less likely to be employed (p=0.02, Supplemental Table 6.1).

Clinical, demographic, and psychosocial characteristics at two years are presented in Table 6.1. This sample was characterized by low maternal employment (41%), low maternal education (37% completed secondary education), low household income (only 27% earning more than R5,000 per month [approximately USD 350]). Almost half of mothers were married or cohabiting (49%) and 24% of children were HIV exposed with only 2 children HIV-infected. A minority of mothers experienced psychosocial risk factors or substance use, including emotional IPV (16%), physical IPV (17%) and sexual IPV (4%), alcohol (10% moderate/high risk), and depression (11%), Table 6.1.

Table 6.1 Sample maternal and child psychosocial, demographic and clinical characteristics, n=626*

	Total *n=626*
Intimate Partner Violence (24 months)	
Emotional score, median (IQR)	0 (0, 0)
Emotional (above threshold)	102 (16)
Physical score, median (IQR)	0 (0, 0)
Physical (above threshold)	107 (17)
Sexual score, median (IQR)	0 (0, 0)
Sexual (above threshold)	25 (4)
Any sub-type score, median (IQR)	0 (0,0)
Any sub-type (above threshold)	138 (22)
Sociodemographics (24 months)	
Maternal education (secondary not completed)	233 (37)
Mother employed	225 (41)
Mother married/partnered	268 (49)
Household Income	
<R5,000 (approximately 300 USD)	445 (73)
>R5,000	164 (27)
Recruitment site: TC Newman	274 (440)
Physical variables	
Birth weight z-score, median (IQR)**	-0.59 (-1.34, 0.16)
Child age at assessment (months), median (IQR)	24.05 (23.79, 24.31)
HIV exposed**	153 (24)
Length for age z-score at 24 months, median (IQR)	-1.16 (-1.89, -0.52)
Weight for age z-score at 24 months, median (IQR)	-0.31 (-1.10, 0.43)
Weight for length z-score at 24 months, median (IQR)	0.28 (-0.48, 1.21)
Psychosocial variables (24 months)	
Depression score, median (IQR)	0 (0, 3)
Depression (above threshold)	64 (11)
Alcohol dependence score, median (IQR)	0 (0, 0)
Alcohol dependence (categories)	
Low dependence, n (%)	160 (27)
Moderate dependence, n (%)	33 (6)
High dependence, n (%)	22 (4)

Notes: Median (IQR ranges reported for anthropometry data, intimate partner violence scores as well as depression and alcohol scores. Frequencies (percentages) reported for all other variables.
*Includes data from mothers or children included in complete case dataset.
**Birthweight and HIV exposure collected at birth; all other variables collected at 2 years of child age.

6.5.1 Developmental outcomes

A total of 28/625 (4%) children were categorized as having cognitive delay (<2 standard deviations below mean), 48/598 (8%) with language delay and 7/592 (1%) with motor delay. Only language differed significantly by child sex, with males having a higher prevalence of delay compared to females (10% versus 5%; p value=0.001) and lower composite scores (p<0.001), Table 6.2.

Table 6.2 Developmental outcomes of children at 2 years of age by child sex

	Total	Female	Male	p-value
Sample	*n=625*	*n=303*	*n=322*	
Cognitive scores, mean (SD)	85.74 (8.84)	86.44 (8.56)	85.08 (9.06)	0.035
Cognitive categories				
No delay, n (%)	425 (68)	218 (72)	207 (64)	
Suboptimal development, n (%)	173 (28)	75 (25)	98 (30)	
Delayed, n (%)	28 (4)	10 (3)	18 (6)	0.082
Sample	*n=598*	*n=289*	*n=309*	
Language scores, mean (SD)	84.45 (11.39)	86.57 (11.35)	82.47 (11.08)	<0.001
Language categories				
No delay, n (%)	325 (52)	178 (59)	147 (46)	
Suboptimal development, n (%)	253 (40)	110 (36)	143 (44)	
Delayed, n (%)	48 (8)	15 (5)	33 (10)	0.001
Sample	*n=592*	*n=289*	*n=303*	
Motor scores, mean (SD)	93.62 (11.89)	94.40 (12.12)	92.86 (11.63)	0.111
Motor categories				
No delay, n (%)	524 (84)	257 (85)	267 (83)	
Suboptimal development, n (%)	95 (15)	41 (14)	54 (17)	
Delayed, n (%)	7 (1)	5 (2)	2 (1)	0.270

Continuous composite scores are presented as mean (SD). Categorical data presented as frequencies (percentages). Categories were defined as 'delay' (<2 standard deviations below mean), 'suboptimal development' (<1 standard deviation below mean) and 'no delay'. P-values presented are comparing sex differences.

6.5.2 Intimate partner violence and developmental outcomes

At 24 months, bivariate analysis showed that emotional IPV was associated with lower composite cognitive scores (β=-0.32; 95% CI -0.58,-0.06), lower composite language scores (β=-0.35; 95% CI -0.69,-0.01) and lower composite motor scores (β=-0.58; 95% CI -0.93,-0.24). Physical IPV was associated with lower composite motor scores (β=-0.42; 95% CI -0.73,-0.11). Sexual IPV was not associated with any composite developmental outcomes, Table 6.3.

Multivariable regression models were run to examine associations between IPV and child developmental outcomes, adjusting for key potential confounding factors. IPV sub-types were run separately in adjusted models due to collinearity and only where significant in bivariate analyses. In adjusted models, the results held, recent emotional IPV was associated with reduced

Table 6.3 Univariate associations between intimate partner violence, covariates and proposed mediators and composite scores for developmental domains in complete case analysis.

	Composite Cognitive (n=549)	**Composite Language (n=598)**	**Composite Motor (n=521)**
	Unadjusted	Unadjusted	Unadjusted
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Intimate Partner Violence (IPV)			
Emotional IPV score	-0.32 (-0.58, -0.06)*	-0.35 (-0.69, -0.01)*	-0.58 (-0.93, -0.24)*
Physical IPV score	-0.18 (-0.42, 0.05)	-0.23 (-0.54, 0.08)	-0.42 (-0.73, -0.11)*
Sexual IPV score	-0.15 (-0.97, 0.67)	-0.16 (-1.29, 0.97)	-0.49 (-1.63, 0.65)
Sociodemographics			
Maternal education (not completed secondary)	-1.31 (-2.70, 0.08)	-2.86 (-4.61, -1.11)*	-0.93 (-2.78, 0.92)
Mother employed	0.60 (-0.87, 2.08)	0.34 (-1.57, 2.27)	0.68 (-1.29, 2.65)
Mother married/partnered	-0.52 (-1.98, 0.93)	0.47 (-1.43, 2.37)	0.01 (-1.94, 1.95)
Household Income			
>R5000	0.73 (-0.92, 2.38)	0.32 (-1.80, 2.45)	1.63 (-0.55, 3.82)
Recruitment site: TC Newman	1.19 (-0.16, 2.53)	3.05 (1.35, 4.76)**	1.13 (-0.66, 2.93)
Physical variables			
Birth weight z-score	0.42 (-0.17, 1.01)	0.84 (0.09, 1.58)*	0.62 (-0.17, 1.39)
Male	-1.66 (-3.01, -0.32)*	-4.27 (-5.96, -2.59)**	-1.52 (-3.31, 0.27)
Child age (months)	-0.94 (-2.23, 0.34)	-0.10 (-1.74, 1.53)	-2.81 (-4.49, -1.12)*
HIV exposed	-1.71 (-3.30, -0.11)*	-3.90 (-5.93, -1.87)**	-0.76 (-2.89, 1.38)
Length for age z-score	0.97 (0.36, 1.58)*	0.77 (-0.01, 1.55)	0.13 (-0.70, 0.97)
Weight for age z-score	0.92 (0.32, 1.51)*	0.64 (-0.12, 1.40)	0.68 (-0.19, 1.47)
Weight for length z-score	0.61 (0.02, 1.19)*	-0.34 (-0.41, 1.09)	0.84 (0.05, 1.63)*
Proposed Psychosocial mediators			
Depression score	-0.02 (-0.11, 0.08)	-0.06 (-0.18, 0.06)	-0.12 (-0.25, 0.01)
Alcohol dependence score	-0.07 (-0.17, 0.03)	-0.03 (-0.16, 0.11)	0.01 (-0.13, 0.15)

Notes: All variables measured at 2 years of child age except birth weight, sex and HIV-exposure which were captured at birth.
Abbreviations: IPV=intimate partner violence.
*p<0.05; **p<0.001

Table 6.4 Multivariable linear regression demonstrating the adjusted association of intimate partner violence and composite scores for developmental domains in complete case analysis sample.

	Composite Cognitive (n=549)	**Composite Language (n=598)**	**Composite Motor (n=521)**	
	Adjusted#	Adjusted^	Adjusted+	Adjusted+
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Emotional IPV score	-0.32 (-0.60, -0.04)*	-0.35 (-0.69, -0.01)*	-0.58 (-0.95, -0.20)*	
Physical IPV score				-0.42 (-0.75, -0.09)*

Adjusted models were run only where IPV sub-type was associated with outcome explored (p<0.05) in bivariate analyses. For cognitive and language scores, only emotional IPV was associated in bivariate analyses and therefore run in multivariable models. Due to collinearity, emotional and physical IPV were run in separate multivariable models for motor development. Abbreviations: IPV=intimate partner violence.
*p<0.05; **p<0.001
#Adjusted for child sex, HIV exposure, length-for-age z-scores, weight-for-age z-scores and weight-for-length z-scores at 24 months.
^Adjusted for maternal education, recruitment site, weight-for-age z-score at birth, child sex and HIV exposure.
+Adjusted for child age at assessment and weight-for-length z-scores at 24 months.

scores across all developmental outcomes, specifically with lower composite cognitive scores (β -0.32; 95% CI -0.60,-0.04), language (β -0.35; 95% CI -0.69, -0.01) and motor scores (β -0.58; 95% CI -0.95, -0.20). Physical IPV was associated with lower motor scores (β -0.42; 95% CI -0.75, -0.09), Table 6.4. Associations using the imputed dataset were similar for key exposures (IPV) and outcomes (developmental), Supplemental Table 6.4 & 6.5.

6.5.3 Hypothesized mediators

Current maternal depression and alcohol use were explored as potential mediators in the relationship between recent IPV sub-types and developmental outcomes. In correlational analyses, both maternal depression and alcohol use were positively associated with emotional as well as physical IPV (Supplemental Table 6.2). However, when linear regressions were run investigating associations between mediators and developmental outcomes, adjusted for potential confounding factors, we found no evidence of associations between proposed mediators and each developmental outcome (cognitive, language, motor), Supplemental Table 6.3. Therefore, formal mediation analyses were not done.

6.6 Discussion

Our results show that recent maternal emotional IPV was associated with lower cognitive, language and motor scores and physical IPV with lower motor scores in children at 24 months. Further, we investigated the potential role of current maternal depression or alcohol use in this relationship. There was insufficient evidence that current maternal depression or alcohol use were explanatory factors in the relationship between IPV and child development at 2 years of age.

We found associations between emotional IPV and each developmental outcome investigated, which are novel findings in such young children. Though there is limited research in this age group, and existing studies use differing definitions of IPV, a recent study pooling data from 11 LMICs investigating pre-school development (36-59 months) found associations between all IPV sub-types and developmental outcomes.[51] Where investigated in a younger sample, studies have found a link between IPV and early life development. However, few investigated IPV sub-types as separate risk factors for poor development. For example, a US study, investigating the impact of IPV on developmental outcomes at two years reported an increased risk of language and neurological delay in infants and toddlers, however this was not analysed by IPV sub-type but rather a composite measure of emotional, physical and sexual IPV.[12] A Tanzanian study through three years of age found both maternal lifetime physical and lifetime sexual IPV to be associated with reduced motor skills, expressive and receptive communication and cognitive development.[13] Emotional IPV was not included in their IPV measure. One study that did investigate emotional IPV separately as a risk factor for cognitive and language delay, only found associations with postnatal physical IPV and only in unadjusted analyses. The limited sample size (n=72) may have reduced statistical power to detect an association.[52] In the current study, sexual IPV was not associated in unadjusted or adjusted analyses with the outcomes investigated, but this is likely due to insufficient power to detect an association given the relatively low prevalence of recent sexual IPV in our study population (4%). In the current study, maternal emotional IPV as compared to physical IPV was more consistently associated with poorer developmental outcomes. These results indicate that emotional IPV may carry a unique risk for poor child developmental outcomes in early life in our setting.

Given the high prevalence of emotional IPV and that it is often not as readily recognised or included in research, intervention or policy efforts aimed at prevention of IPV, it is critical to

better understand its distinct impact on child health outcomes. Our findings suggest that adverse outcomes and their association with maternal IPV may be underestimated when IPV exposure is not considered broadly and inclusive of emotional IPV, a potentially significant gap in the literature. Emotional abuse in a current or past intimate relationships is increasingly being recognized as a unique contributing factor to maternal ill-health outcomes.[17-19] Specifically, emotional IPV has been linked to poor mental health, post traumatic stress disorder and poorer physical health, sometimes above that of physical IPV.[18,53] Psychological control or abuse by a partner may uniquely impact maternal efficacy, independence and diminish maternal power within the family, which may affect her ability to provide nutritious food, a secure environment or to have positive parenting practices, all of which could lead to increased risk of negative outcomes for her children. These factors may be particularly influential for health outcomes in settings such as South Africa where entrenched gender norms and a high acceptability of violence contribute to high levels of IPV.[22]

Our investigation of potential mediators found little evidence to support that current maternal depression symptoms or reported alcohol use were explanatory factors for the impact of IPV on child development at two years. In the parent study we have previously found that IPV is linked to longitudinal maternal depression[19] as well as hazardous alcohol use in pregnancy.[54] In the current study, we found that IPV was associated with depression and alcohol use at 2 years. However, these did not appear to be associated with development at 2 years. Recent maternal depression or alcohol use may compromise the quality of parenting or parent-child attachment, may divert household financial resources and decrease maternal care-seeking behaviours, which in turn may compromise child development. Though there is much literature linking maternal substance use to adverse child outcomes, some studies that have investigated its impact on parenting or secure attachment have found mixed results.[55,56] For example, a

study assessing maternal substance use and quality of caregiving found no differences between substance abusing and non-substance abusing mothers and caregiving or maternal-child attachment at 12 months.[55] Similarly, studies investigating maternal depression and child development have shown mixed findings.[13,57,58] A Tanzanian study investigating depression and toddler development, found that depression was associated with receptive language and motor development but not cognitive or expressive language.[13] Another study found that maternal depression at 7 weeks postpartum impacted development at 3 months but this relationship attenuated by 6 months.[57] Our findings may be influenced by relatively low levels of probable clinical depression (11%) or moderate-high alcohol-related risk (10%), diluting possible associations. We found no evidence that recent maternal depression or alcohol use influenced the relationship between IPV and early life development; these findings may illustrate the complexity of the relationship between the factors explored and other adverse environmental risks which often co-occur and may be underlying these relationships.

The prospective nature of the parent study, including measurement of a broad range of risk factors and robust measurement of developmental outcomes in an LMIC setting, is a strength of this study. However, there are several limitations. The current study used cross sectional data, therefore we cannot assert causality. Maternal sexual IPV prevalence was very low in our sample (4%) and this likely affected power to discern potential associations. We also did not investigate longitudinal exposures or cumulative impact of maternal depression or alcohol use; these were only investigated as recent exposures. Further, although the BSID-III is a well recognised tool, further standardisation in sub-Saharan African settings is required. For example, the categorisation of delay is based on scaled scores using normative US data that might not be generalisable to a South African population. However, our data from the parent study has shown that raw scores have similar patterns to the results based on delay

categorisation. There were some differences in characteristics of those included versus excluded in the present study, namely HIV exposure and maternal employment. Maternal employment was lower in the included sub-sample (41% vs 51%), however, household income was similar across groups. Furthermore, maternal employment was not associated with any outcomes investigated in bivariate analyses and adjustment for this did not alter any of the key associations. HIV exposure was higher in the included sub-sample (24% versus 18%), however, this would likely bolster potential associations. In addition, approximately one-third of children who were still active in the study at two years were not included in the analysis due to incomplete data. However, results were similar when associations were explored in the imputed dataset.

6.6.1 Conclusions

In summary, our results highlight the need for programs that aim to reduce IPV as well as early life prevention efforts to mitigate the impact of maternal IPV on children. Maternal IPV was a consistent predictor of poor child developmental outcomes; furthermore, emotional IPV emerged as a uniquely deleterious risk factor for child developmental outcomes. Further work is needed to understand the mechanisms underlying this relationship, exploring maternal depression and alcohol use in other samples as well as additional potential mechanisms. Given our findings, it is important for public health professionals and policy makers to ensure that maternal emotional IPV is included in training programs for health care staff as well as in screening and referral efforts. Lastly, more research investigating emotional or psychological IPV and adverse health outcomes is needed. Critically, in our setting, the majority of pregnant and early postpartum women access healthcare, providing an important, potentially under-utilized opportunity to intervene early to attempt to shield children from the negative effects of IPV.

6.7 References

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Supplemental Table 6.1 Comparison of psychosocial, demographic and clinical data between children included in complete case developmental models and those who are not.

	In Development models	Not in Development model	p-value
Intimate Partner Violence (IPV)			
Emotional IPV score, median (IQR)	0 (0, 0)	0 (0, 0)	0.669
Physical IPV score, median (IQR)	0 (0, 0)	0 (0, 0)	0.213
Sexual IPV score, median (IQR)	0 (0, 0)	0 (0, 0)	0.160.
Sociodemographics			
Maternal education (did not complete secondary)	393 (63)	302 (58)	0.132
Mother employed	225 (41)	99 (51)	0.022*
Mother married/partnered	268 (49)	99 (51)	0.718
Household Income			
<R5000	445 (73)	122 (63)	0.671
>R5000	164 (27)	47 (24)	
Recruitment site: TC Newman	274 (44)	235 (45)	0.586
Physical variables			
Birth weight z-score, median (IQR)	-0.59 (-1.34, 0.16)	-0.51 (-1.22, -0.00)	0.744
Male sex	321 (51)	269 (52)	0.774
HIV exposed	153 (24)	94 (18)	0.010*
Length for age z-scores, median (IQR)	-1.10 (-1.80, -0.34)	-1.03 (-1.85, -0.28)	0.846
Weight for age z-scores, median (IQR)	-0.31 (-1.10, 0.43)	-0.24 (-1.01, 0.40)	0.6682
Weight for length z-scores, median (IQR)	0.28 (-0.48, 1.13)	0.43 (-0.40, 1.09)	0.7542
Psychosocial factors			
Depression score, median (IQR)	0 (0, 3)	0 (0, 5)	0.415
Alcohol dependence score, median (IQR)	0 (0,0)	0 (0,0)	0.068

Data are presented as n(%) or median IQR). Birthweight and HIV exposure collected at birth; all other variables collected at 2 years of child age. Abbreviation: IPV=intimate partner violence.
*p<0.05; **p<0.001

Supplemental Table 6.2 Univariate associations between proposed mediators and intimate partner violence in complete case sample.

	Emotional IPV Coefficient (95% CI)	**Physical IPV** Coefficient (95% CI)
Depression score	1.01 (0.80, 1.22)**	0.68 (0.49, 0.87)**
Alcohol dependence score	0.34 (0.13, 0.56)*	0.30 (0.12, 0.49)*

Abbreviation: IPV = intimate partner violence.
*p<0.05, **p<0.001

Supplemental Table 6.3 Univariate and adjusted associations between proposed mediators and developmental outcomes in complete case sample.

		Cognitive scores[#] Coefficient (95% CI)	**Language scores**^ Coefficient (95% CI)	**Motor scores**[+] Coefficient (95% CI)
Univariate	Depression	-0.02 (-0.11, 0.08)	-0.06 (-0.18, 0.06)	-0.12 (-0.25, 0.01)
	Alcohol	-0.07 (-0.17, 0.03)	-0.03 (-0.16, 0.11)	0.01 (-0.13, 0.15)
Adjusted	Depression	0.02 (-0.08, 0.13)	-0.05 (-0.18, 0.07)	-0.04 (-0.19, 0.10)
	Alcohol	-0.06 (-0.17, 0.05)	0.01 (-0.12, 0.14)	0.05 (-0.10, 0.20)

Notes: Adjusted associations between proposed mediators and developmental domains were run using linear regression. Depression and alcohol were run separately in adjusted regression models. Abbreviation: IPV = intimate partner violence.
#Adjusted for intimate partner violence, child sex, HIV exposure, length-for-age z-scores, weight-for-age z-scores and weight-for-length z-scores at 24 months.
^Adjusted for intimate partner violence, maternal education, recruitment site, weight-for-age z-score at birth, child sex and HIV exposure.
+Adjusted for intimate partner violence, child age at assessment and weight-for-length z-scores at 24 months.

Supplemental Table 6.4 Univariate associations between intimate partner violence, covariates and proposed mediators and composite scores for developmental domains in the multiple-imputation analysis sample

	Composite Cognitive	**Composite Language**	**Composite Motor**
	Unadjusted	Unadjusted	Unadjusted
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Intimate Partner Violence (IPV)			
Emotional IPV score	-0.33 (-0.60, -0.06)*	-0.34 (-0.68, -0.01)*	-0.51 (-0.86, -0.16)*
Physical IPV score	-0.19 (-0.43, 0.05)	-0.20 (-0.50, 0.11)	-0.39 (-0.70, -0.09)*
Sexual IPV score	-0.13 (-0.98, 0.71)	-0.16 (-1.36, 1.04)	-0.41 (-1.58, 0.75)
Sociodemographics			
Maternal education (not completed secondary)	-1.31 (-2.69, 0.07)	-3.20 (-4.94, -1.45)**	-1.45 (-3.30, 0.40)
Mother employed	0.48 (-1.02, 1.99)	0.13 (-1.81, 2.07)	0.41 (-1.55, 2.38)
Mother married/partnered	-0.59 (-2.07, 0.89)	0.26 (-1.64, 2.16)	0.15 (-1.88, 2.18)
Household Income			
>R5000	0.73 (-0.92, 2.38)	1.00 (-1.14, 3.13)	1.96 (-0.28, 4.20)
TC Newman	1.20 (-0.15, 2.54)	3.12 (1.41, 4.84)**	0.89 (-0.91, 2.68)
Physical variables			
Birth weight z-score	0.44 (-0.15, 1.03)	0.68 (-0.07, 1.42)	0.58 (-0.21, 1.36)
Male	-1.67 (-3.01, -0.33)*	-4.07 (-5.77, -2.37)**	-1.70 (-3.49, 0.09)
Child age (months)	-0.95 (-2.24, 0.33)	-0.12 (-1.77, 1.53)	-2.81 (-4.50, -1.11)*
HIV exposed	-1.70 (-3.29, -0.10)*	-3.77 (-5.82, -1.72)**	-0.59 (-2.72, 1.54)
Length for age z-score	0.92 (0.33, 1.52)*	0.67 (-0.09, 1.42)	0.26 (-0.54, 1.06)
Weight for age z-score	0.84 (0.26, 1.43)*	0.64 (-0.10, 1.37)	0.82 (0.04, 1.60)*
Weight for length z-score	0.50 (-0.08, 1.08)	0.39 (-0.34, 1.11)	0.88 (0.10, 1.66)*
Proposed Psychosocial mediators			
Depression score	-0.02 (-0.12, 0.08)	-0.06 (-0.18, 0.07)	-0.11 (-0.24, 0.02)
Alcohol dependence score	-0.08 (-0.19, 0.03)	-0.03 (-0.17, 0.11)	0.03 (-0.11, 0.16)

Birthweight and HIV exposure collected at birth; all other variables collected at 2 years of child age. Abbreviation: IPV= intimate partner violence.
*p<0.05, **p<0.001

Supplemental Table 6.5 Multivariable linear regression demonstrating the association of intimate partner violence with composite scores for developmental domains in the multiple-imputation analysis sample.

	Cognitive scores	**Language scores**	**Motor scores**	
	Adjusted# Coefficient (95% CI)	Adjusted^ Coefficient (95% CI)	Adjusted+ Coefficient (95% CI)	Adjusted+ Coefficient (95% CI)
Emotional IPV score	-0.30 (-0.57, -0.03)*	-0.35 (-0.68, -0.01)	-0.52 (-0.87, -0.17)*	
Physical IPV score				-0.39 (-0.70, -0.09)*

Adjusted models were run only where IPV sub-type was associated ($p<0.05$) with outcome explored in bivariate analyses. For cognitive and language scores, only emotional IPV was associated in bivariate analyses and therefore run in multivariable models. Due to collinearity, emotional and physical IPV were run in separate multivariable models for motor development. Adjusted models were run including same covariates as the complete case analysis, as noted below. Abbreviations: IPV=intimate partner violence.

*$p<0.05$; **$p<0.001$

#Adjusted for child sex, HIV exposure, length-for-age z-scores, weight-for-age z-scores and weight-for-length z-scores at 24 months.

^Adjusted for maternal education, recruitment site, weight-for-age z-score at birth, child sex and HIV exposure.

+Adjusted for child age at assessment and weight-for-length z-scores at 24 months.

Chapter 7: Discussion and recommendations

As discussed in more detail in Chapter 1, Intimate partner violence (IPV) constitutes a major global health problem, affecting one in three women worldwide at some point during their lifetime.[1] IPV exposure during pregnancy and early life may pose a significant risk for child health and has been linked to increased risk of physical and mental health problems that extend beyond childhood into adolescence and adulthood.[2-4] This thesis sought to provide insight into patterns and type of IPV exposure in mothers and children from pregnancy through early life and the impact of IPV exposure on food security during pregnancy, growth at birth and through infancy as well as child development at 2 years. Key gaps in the literature this thesis sought to address include i) investigating relationships between IPV and child health outcomes in the first two years of life, a critical and under-studied period ii) investigating the unique impact of emotional, physical and sexual IPV on child growth or developmental outcomes and iii) investigation of potential mechanisms underlying these relationships. This final chapter provides a synopsis of key findings in relation to the objectives of this thesis, a discussion of the limitations of this work and recommendations for policy and future research based on the combined results presented.

7.1 Synopsis of findings

A summary of chapters, analytic approach and findings are presented in Table 7.1 below. **Chapter 3** investigated associations between maternal childhood trauma and longitudinal patterns of IPV exposure from pregnancy through 24 months postpartum. This chapter demonstrated stable IPV intensity profiles for mothers during this period, indicating chronic and sustained IPV exposure through pregnancy and the postpartum period. Membership in high or moderate exposure groups was associated with maternal childhood maltreatment.

Table 7.1 Summary of thesis results chapters including methodology and findings.

Chapter/ Objective	Publication title	Exposure	Mediator	Outcome	Methodology	Findings
3 / 1	Maltreatment in childhood and intimate partner violence: A latent class growth analysis in a South African pregnancy cohort.	Maternal childhood maltreatment	N/A	Longitudinal patterns of IPV (by sub-type & combined)	Longitudinal latent class analysis describing IPV exposure patterns across 6 time points from pregnancy through two years postpartum. Linear regression investigating associations between maltreatment and IPV latent classes.	High levels of maternal maltreatment were seen during childhood (34%) and IPV during pregnancy (33%). Two latent classes of no/low and moderate sexual IPV and three classes of low, moderate, and high emotional and physical IPV (separately) were detected. Moderate and high classes for all IPV sub-types and combined analysis showed stable intensity profiles. Maternal maltreatment in childhood was associated with increased probability of experiencing high or moderate intensity IPV during and around pregnancy.
4 / 2	Food-insecure pregnant women in South Africa: a cross-sectional exploration of maternal depression as a mediator of violence and trauma risk factors.	IPV during pregnancy & maternal childhood maltreatment	Depression	Food insecurity in pregnancy	Cross sectional analysis during pregnancy; multivariable regression and mediation analysis.	Emotional IPV, depression and childhood trauma predicted food insecurity (FI). In mediation models, depression partially mediated the relationship between emotional IPV and FI as well as physical IPV and FI; depression partially mediated the relationship between childhood trauma and FI. Differing degrees of mediation were found when applied to communities.
5 / 3&4	Intimate Partner Violence and growth outcomes through infancy: a longitudinal investigation of multiple mediators in a South African birth cohort.	IPV during pregnancy and postnatal IPV	Maternal depression, alcohol, tobacco dependence; child hospitalizations	WFAZ and LFAZ at birth; WFAZ and LFAZ at 12 months.	Cross sectional linear regression for growth at birth and 12 months; structural equation models for mediation.	At birth, both maternal emotional and physical IPV were associated with reduced WFAZ. Only physical IPV was associated with LFAZ at birth. Maternal alcohol use and tobacco use during pregnancy were key contributors to the relationship between IPV and birth WFAZ, with alcohol use being an explanatory variable for the relationship between physical IPV and LFAZ at birth. Postnatally, both emotional and physical IPV were associated with reduced WFAZ at 12 months, Only emotional IPV was associated with LFAZ at 12 months. Postnatal maternal tobacco use emerged as the key explanatory variable in these relationships.
6 / 5	Maternal emotional and physical intimate partner violence and toddler development: a cross sectional study in a South African birth cohort.	IPV at 24 months	Maternal depression and alcohol dependence	Developmental outcomes (24 months)	Cross sectional analysis at 24 months postpartum; linear regression.	Emotional IPV was associated with lower cognitive, language or motor composite scores in children at 2 years of age. Physical IPV was associated with lower motor scores. Recent maternal depression and alcohol use were investigated as mediators; neither were shown to mediate the relationship between IPV and developmental outcomes.

Subsequent chapters built upon these findings of sustained risk of IPV during and following pregnancy by exploring associations with food security in pregnancy, child growth and early-life child development. **Chapter 4** presented evidence that emotional IPV, maternal depression and childhood trauma were associated with food insecurity during pregnancy and that depression partially explained these relationships in this cohort. Building upon this, **Chapter 5** explored whether maternal IPV is associated with growth outcomes at birth and through infancy as well as potential pathways for this impact. Findings presented in this chapter highlight the role of emotional IPV in addition to physical IPV as a risk factor for compromised fetal and infant growth, and identified maternal alcohol and tobacco use as explanatory factors antenatally and tobacco use as an explanatory factor postnatally.

Chapter 6 explored whether IPV sub-types are associated with child cognitive, language or motor development at 2 years of age and whether maternal depression or alcohol use mediated these relationships. Findings again highlight the role of emotional IPV in child developmental outcomes in addition to physical IPV but found that neither depression nor alcohol use were explanatory factors in these relationships.

Together, these results highlight core themes emerging from the analyses presented, namely that: 1) a substantial proportion of mothers were exposed to chronic and sustained high or moderate IPV during pregnancy continuing into the postnatal period; 2) maternal IPV in a peri-urban South African setting is associated with outcomes including food insecurity, growth at birth and through infancy, and child development at 2 years; 3) emotional IPV, which is common and often not considered separately in the literature, is an important risk factor for child outcomes and may have

a more consistent relationship with some outcomes explored compared to physical or sexual IPV; and finally, 4) mechanisms underlying these relationships are complex, potentially community specific, and not consistent across outcomes reported here. These findings are discussed in more detail below.

7.2 Discussion of key findings

This section presents a discussion of key findings prior to making recommendations for policy and future research. This discussion focuses on three broad themes emerging from the results chapters: i) there was a substantial prevalence of IPV exposure during pregnancy and pattern of sustained moderate or high exposure in the early postnatal period; ii) emotional IPV in addition to physical IPV emerged as a key risk factor for outcomes investigated and iii) explored mediators were found to differentially contribute to IPV-outcome relationships, depending on the timing (antenatal versus postnatal), the community and the IPV-outcome relationship explored.

7.2.1 Patterns and prevalence of IPV during pregnancy and postpartum

The findings of this thesis are consistent with a large body of work documenting the high burden of IPV in LMIC countries such as South Africa. Across results chapters, prevalence of IPV was high (33-34% antenatally and 22-29% postnatally), with emotional IPV occurring most often followed by physical and then sexual IPV. Overall, these prevalence estimates are similar to other studies reporting any-type IPV during pregnancy (30% for physical + sexual IPV)[5] and postnatal prevalence is within ranges reported by others (15-31%).[6,7]

Chapter 3 aimed to characterize patterns and intensity profiles of IPV from pregnancy through 24 months postpartum by identifying classes of women based on longitudinal IPV exposure. For the largest class (no/low exposure), pregnancy seemed to be a time of increased risk; for these women, there was an increased probability of experiencing IPV during pregnancy compared to postnatal time points. Few studies have utilized longitudinal data to investigate IPV exposure during and following pregnancy. Where investigated, some have found an increase during pregnancy[8,9] while others have cited a reduction in IPV prevalence during pregnancy, specifically compared to pre-pregnancy prevalence.[10,11] Increased risk during pregnancy has been linked to financial strain,[12] conflict arising from unwanted pregnancy, substance use[13] or traditional gender norms.[14] Further, few studies have attempted to group women based on IPV exposure patterns. Similar to our findings, one review of patterns and prevalence of IPV during and around pregnancy noted that some women are at increased risk while, for others, pregnancy seems to offer protection from or a decrease in IPV exposure.[15] Further work delineating sub-groups for whom IPV prevalence peri-natally differs may help to better understand what differentiates women who may be at increased risk of IPV exposure during pregnancy versus those for whom this is a protective period. Additionally, mothers that have lower risk following pregnancy may represent women who have successfully exited abusive relationships and may provide insight into how to tailor interventions to support other women in similar situations.

Critically, Chapter 3 also described a large degree of stability in the frequency and intensity of IPV exposure over time, specifically for moderate and high IPV exposure classes. This indicates a consistent and repeated pattern of IPV exposure for mothers that extends well beyond pregnancy. Mothers grouped into high or moderate classes for emotional or physical IPV represented a

significant proportion of the cohort (30-40% of women). These women may be key to identify early through screening conducted during routine antenatal care, given the adverse child health sequelae associated with both in utero and postnatal exposure. Further, especially in resource limited settings, identifying these mothers early may provide a way to triage care for those most at risk. Identified patterns of sustained exposure may represent an important risk to not only the mental and physical well-being of these mothers, but also to that of their children across their lifespan.

Lastly, Chapter 3 highlighted the fact that maternal maltreatment in childhood was associated with increased probability of experiencing high or moderate intensity IPV during and around pregnancy, substantiating existing research showing an increased risk of adult IPV exposure following abuse or neglect during childhood.[16,17] Though the majority of this thesis focuses on relationships between maternal IPV and child health outcomes, this finding underscores the cyclical nature of abuse in our setting. Further, given the high prevalence of maternal IPV presented in this cohort and established links with child abuse or neglect from other studies,[18-20] these patterns of sustained IPV during and following pregnancy may place children at increased risk of multiple adverse childhood exposures.

7.2.2 Emotional IPV as a key risk factor

As discussed in the introduction, the majority of extant research focuses on physical and/or sexual IPV as a risk factor in relation to child growth and developmental outcomes. Although there is an emerging literature investigating emotional IPV as a unique risk factor, there remains limited evidence examining the impact of emotional IPV on these outcomes. The results of this thesis

consistently found that emotional IPV was a key risk factor for outcomes investigated. Specifically finding unique associations between emotional IPV and food insecurity in pregnancy, postnatal emotional IPV and LFAZ at 12 months as well as multiple developmental domains (cognitive and language); associations that were not found with physical IPV. Emerging evidence suggests that emotional IPV may have a unique and sometimes greater impact on maternal mental and physical health compared to physical IPV.[21-24] Others have found increased psychological issues associated with emotional IPV, including increased suicidal ideation and suicide attempts,[25] psychosomatic conditions,[26] and increased risk of postnatal depression independent of other forms of IPV.[27,28] This potential for the differential impact of emotional IPV on maternal mental health or risky behaviors may underlie the unique association between emotional IPV and child outcomes found. Findings from this thesis highlight that emotional IPV may carry distinct or additive risk and it is critical to consider when investigating the impact of IPV on maternal or child health.

Chapter 4 found that only emotional IPV, and not physical IPV, was significantly associated with food insecurity in pregnancy, after adjusting for other forms of IPV as well as sociodemographic and psychosocial factors. Few studies have investigated sub-types of IPV and food insecurity. One study, from Nepal, found that both emotional and physical IPV were separately associated with food insecurity.[29] Another study found an association between food insecurity and emotional IPV but not a combined category of emotional plus physical IPV, citing that emotional IPV may have distinct drivers that may impact food insecurity differently than physical IPV.[30] Emotional IPV may manifest differently in a LMIC setting, compared to a high-income setting, where traditional gender norms may affect women's efficacy or access to support systems, compounded by potential

mental health sequelae, this may further decrease her ability to manage household resources.[31] Emotional IPV, therefore, may be a critical and often overlooked risk factor for food insecurity.

Chapter 5 found that both antenatal emotional and physical IPV independently predicted reduced growth at birth and at 12 months. However, antenatally physical IPV was more consistently associated with outcomes at birth (WFAZ and LFAZ) and postnatally, emotional IPV was more consistently associated with reduced growth at 12 months (WFAZ and LFAZ), indicating that there may be unique drivers for these relationships dependent on timing of exposure. Few studies have investigated associations between distinct IPV sub-types and growth at birth or in early life. Where investigated, some studies have found an association between emotional IPV in pregnancy and birth weight,[32] while others have only found physical IPV and not emotional IPV to be associated with birth weight.[33] Further, multiple studies investigating sub-types of IPV as well as a composite category have seen associations only between composite measures of IPV and growth.[34,35] Associations between physical IPV and growth outcomes have been relatively robustly studied, however, few have considered the separate impact of emotional IPV, though it is highly prevalent and may be an important risk factor for compromised child growth. One such study, in Brazil, investigated past year verbal or physical abuse, finding only severe physical and not verbal or less severe physical abuse to be associated with WFAZ in the first 2 years of life.[36] Therefore, the findings presented in this thesis, specifically related to postnatal emotional IPV and growth outcomes is novel and requires replication in other studies and other settings.

Lastly, Chapter 6 found that emotional IPV was associated with all developmental domains investigated (cognitive, language and motor outcomes), whereas physical IPV was only associated

with composite motor scores. In similar age groups, there are few studies that have separately investigated emotional IPV and child development; where done, these studies have shown mixed findings. One of these studies, a multi-country study, found that emotional IPV was associated with child development in pooled analyses.[37] Other studies that included measures of emotional IPV either only investigated the combined IPV measure (emotional, physical and sexual IPV)[38] or did not find that emotional IPV was separately associated with developmental outcomes.[39] However, these were done in relatively small sample sizes (n<80), which may have impacted findings. Further, each of these studies used a different measure to assess child development. Given the limited available literature investigating the unique impact of IPV subtypes on developmental outcomes (cognitive, language and motor development) in this age group, findings presented in this thesis are relatively novel and require replication.

These results indicate that emotional IPV may have a unique impact on both child health outcomes as well as exposed mothers, affecting potential maternal mental health or parental caregiving mechanisms underlying these relationships. Previous analyses, also conducted within the DCHS, have found that emotional as well as sexual IPV, but not physical IPV, was associated with depression in mothers from pregnancy through 18 months postpartum.[24] As mentioned, others have found increased psychological or mental health issues associated with emotional IPV,[26,27,28] in some cases independent of other forms of IPV.[27,28] These findings highlight that emotional IPV may carry distinct or additive risk. Given the high prevalence of emotional IPV and that it is often not as readily recognised or included in research, intervention or policy efforts aimed at prevention of IPV, it is critical to better understand its distinct impact on health outcomes. Lastly, given the

lack of investigation of emotional IPV as a separate construct, replication of these findings in other studies and settings is critical.

7.2.3 Mechanisms underlying relationships between IPV and outcomes explored

A key aim of this thesis was to explore potential explanatory variables underlying the relationship between IPV and investigated outcomes. Multiple potential mediators were investigated, with mixed findings reported in the results chapters. Results from Chapter 4 indicate that antenatal maternal depression may have partially explained the relationship between antenatal emotional and physical IPV and household food insecurity during pregnancy. Further, there was evidence that antenatal depression partially explained the association between maternal childhood trauma and food insecurity during pregnancy. Few studies have investigated depression as an explanatory variable in these relationships. However, where investigated, our study corroborates others' findings. For example, two US based studies independently investigated depression as an explanatory variable between childhood trauma or IPV and food insecurity respectively, finding that depression did mediate these relationships.[40,41] We investigated these relationships in the overall cohort as well as disaggregated by community and found different levels of mediation by recruitment community.

Food security is a managed process and community level factors such as poverty, social support networks and stigma may affect maternal agency within the family or maternal mental health, thus impacting how food insecurity is experienced.[42,43] The inability to cope with or manage the effects of food insecurity may be exacerbated by poorer mental health, affecting a woman's ability to obtain or prepare food and intensifying feelings of being fatigued or overwhelmed by the

responsibility.[44,45] Taken together these findings suggest that interventions aimed at reducing food insecurity should incorporate IPV and mental health screening and treatment services as well as consider tailoring interventions to account for community-level differences. This may be most feasible in pregnancy, given the high proportion of women who access antenatal care and may be particularly important given the chronicity of IPV and associations with food insecurity.

Chapter 5 investigated maternal depression, alcohol or tobacco use and child hospitalizations as potential explanatory variables in the relationship between IPV and growth. Findings indicated that maternal alcohol use in pregnancy contributed to relationships between physical as well as emotional IPV and growth at birth. Additionally, tobacco use during pregnancy emerged as an important explanatory variable between emotional IPV and growth at birth. Antenatal associations between IPV and growth restriction at birth are well-established as are relationships between substance use and growth restriction at birth. Though few studies have formally tested mediation, where done, these substantiate our findings.[46] IPV has been shown to impact lifestyle habits, including substance use, which in turn may reduce placental blood flow[47] or compromise maternal nutrition in pregnancy[48] which may lead to restricted uterine growth. Other potential pathways have been proposed including associations between IPV and compromised maternal nutrition or antenatal care,[49] as well as increased psychological stress, elevating stress hormones, which impact maternal and fetal weight gain during pregnancy.[50,51] Future work should consider maternal mental health or behavior in conjunction with potential biological pathways to more fully explain associations between IPV and growth at birth. Given the complex relationships between potential mediators as well as differential associations between IPV sub-types, mediators and growth

outcomes at birth, it is also important to more fully explore whether underlying mechanisms are different based on type of IPV experienced by mothers.

As noted in the introduction (Table 1.1), very few studies have investigated potential explanatory variables underlying the relationship between postnatal IPV and growth. Where explored, mediators investigated have included alcohol use, depression, parental stimulation[52] or maternal care-seeking behavior.[53] These studies have not found evidence that these factors mediate the postnatal IPV-growth relationships explored. Similarly, we found that, of our hypothesized mediators, only maternal tobacco use, and not maternal alcohol use, depression or child hospitalizations contributed to the relationship between IPV and linear growth. Further, tobacco use appeared to explain only a very small portion of this relationship and emotional IPV maintained a direct effect on growth outcomes at 12 months after adjusting for mediators, suggesting other factors underlie these relationships. Exposure to tobacco smoke has been linked to reduced child growth, for example, stunting.[54] Underlying reasons for this association may include indirect mechanisms such as adults diverting family income from the purchase of nutritious food to buy cigarettes.[55,56] Or via direct mechanisms, for example smoke exposure has been shown to cause frequent health problems in children, including impacting growth.[57] Though we did explore child hospitalizations as a mediator, it is possible that less severe illness or infections linked to tobacco smoke exposure or IPV were impacting growth. It can be difficult to parse out causal effects in the presence of potential unmeasured environmental and socioeconomic factors. Though work investigating substance exposure on growth in animal models can be helpful in elucidating these associations, investigating the interaction between biological, behavioural and environmental factors in clinical studies is important to meaningfully explore these relationships.

Given the limited literature and novelty of the findings reported here, further work to replicate these findings is needed.

The final results chapter investigated maternal depression and alcohol use as explanatory variables in the relationship between IPV and child development at 2 years, finding no evidence of mediation in this cohort. Though both physical and emotional IPV were associated with mediators explored; neither current maternal depression nor alcohol use were associated with child development in adjusted models; though previous investigations in the DCHS cohort have found associations between these exposures in pregnancy and poorer child development at 2 years.[58] These results were unexpected; literature suggests that recent maternal depression[59,60] or alcohol use[61,62] may compromise the quality of parenting or parent-child attachment,[59] increase harsh punishment,[63] and may adversely impact maternal care-seeking behaviors, which in turn may compromise child development. Studies investigating maternal depression and child development have reported results which are not consistent across different groups.[52,64,65] A Tanzanian study found that maternal depression was associated with toddler receptive language and motor development but not cognitive outcomes or expressive language.[52] Another study found that maternal depression at 7 weeks postpartum impacted development at 3 months but this relationship attenuated by 6 months.[64] Additionally, few studies have investigated associations between parental postnatal drinking and child development in the South African context, though the Western Cape in particular has some of the highest rates of hazardous drinking globally.[66] Where investigated, two South African studies found that children of mothers who engaged in hazardous drinking postnatally had lower cognitive scores and increased behavioral problems, though sub-clinical levels were not investigated.[67,68] Analyses presented in Chapter 6 did not investigate hazardous

drinking as a distinct exposure but rather included an alcohol score indicating alcohol-related problems, with the majority of mothers categorized as low risk, therefore statistical power to detect associations may have been compromised and may have impacted findings. Findings presented that maternal depression or alcohol use did not mediate the IPV-child development relationship may illustrate the complexity of the relationship between the factors explored and other adverse environmental risks, which often co-occur and may be underlying these relationships.

Taken together, these results add important findings to a growing but small literature that seeks to understand pathways between IPV and child growth or development in early life. Similar hypothesized mediators were explored in relation to outcomes investigated, though results from this thesis indicate that there may be unique drivers underlying relationships based on i) type of IPV 2) timing of IPV 3) community context and 4) child health outcome explored. More work is needed to substantiate findings and to understand differences in underlying pathways for specific types of IPV and how these may differently impact adverse child health outcomes. Further, explored mediators investigated potential maternal behavioral pathways and not biological pathways such as children's stress responsive biological regulatory systems, which may play a role in relationships between postnatal IPV and child nutrition or development.[69,70] Lastly, LMICs have a high burden of co-occurring and often chronic risk factors, specifically high levels of community violence, trauma, substance use disorders and mental disorders. These risk factors are likely exacerbated by limited support networks and treatment gaps as well as community level factors affecting women's autonomy, efficacy, health seeking behavior and acceptability of violence. This represents a complex web of interrelated factors that should be considered where possible in future

research as well as when interpreting presented findings. It is important to consider the presented findings within the context of the strengths and limitations of this thesis; these are discussed below.

7.3 Strengths and limitations

Limitations and strengths for presented analyses were included in each of the results chapters. However, there are overarching limitations that should be considered.

7.3.1 Study sample

Both a strength and limitation of this work is the cohort from which the data are drawn.

These data arise from a single population, pregnant and postpartum women and their children from Paarl, a peri-urban town in South Africa. Though research aims required investigation of key questions in a pregnant and postpartum sample, women were recruited while attending antenatal care clinics during their first or second trimester. Therefore, mothers who did not present for antenatal care or who presented in their third trimester were excluded, which may affect overall generalizability. Though the vast majority of South African women in the public sector (96-97%)[71,72] present for antenatal care at some point in their pregnancy, characteristics may differ based on time of presentation. For example, younger women and women whose pregnancy was unplanned, were more likely to present late for antenatal care.[72] Conversely, women with supportive partners and first time mothers were more likely to present earlier in pregnancy for antenatal care.[73] Lastly, this population was restricted to pregnant women 18 years and older, though younger pregnant women may be more vulnerable, face increased stigma and have fewer support systems.[74,75] Recruitment methods and criteria for the parent study should be taken into consideration when interpreting results as these may have impacted generalizability of findings to

all pregnant and early postpartum women and their children. Despite these considerations, recruitment into the parent study was intentionally broad with few exclusion criteria to facilitate generalizability.

Further, specific community-level factors may have impacted the prevalence of IPV, reported here, and its impact on maternal psychosocial health, for example differences in gender norms, normalization of violence, community and family support networks and stigma may differ between community settings.[30,76,77] A strength of the presented work is the inclusion of participants recruited from multiple community samples, specifically from both a Black African population and a mixed ancestry population. However, community-level differences were only evaluated in Chapter 4, which found different degrees of mediation when applied to these communities separately. Specifically, at TC Newman, depression fully mediated IPV-food insecurity relationships, whereas at Mbekweni, depression only partially mediated this relationship and IPV maintained a direct effect on food insecurity. More work is needed to better understand how and why community-level differences may impact associations. Nevertheless, the majority of research in South Africa has focused on Black African communities and our additional inclusion of a mixed ancestry population is likely to make our findings more widely representative of South Africa as a whole. Findings presented herein should be extrapolated to other settings with consideration of the communities from which the data arose.

7.3.2 Data sources and type

Key factors explored, namely IPV, depression and substance use were self-reported by mothers. In particular, given the high rates of alcohol use antenatally and associated stigma in the Western

Cape and ongoing established programs aimed at reducing alcohol use,[78] particularly during pregnancy, this may have resulted in underreporting. IPV was also self-reported by mothers and may have been impacted by individual and community level factors; disclosure of violence in a relationships, in particular during pregnancy, is impacted by a number of factors and subject to stigma, confidentiality concerns, unwillingness to disclose to healthcare workers and fear that disclosure may result in children being removed from the home.[79-81] This may have affected rates of reporting. However, as discussed below, our prevalence estimates during pregnancy are similar or higher than those reported by other studies in South Africa. A similar trend was seen with postnatal prevalence rates suggesting that concerns about possible under-reporting are less likely to have been an issue in this study. Further, multiple key outcomes were rigorously assessed by trained study staff. Specifically developmental assessments were done by direct observation, assessors were trained and monitored by a pediatric neurodevelopmental specialist and inter-assessor reliability was monitored throughout to ensure standardised data collection and accuracy.[82] Growth was also rigorously assessed across visits; measurements were performed twice in each child, equipment was calibrated and checked weekly and study staff underwent regular training and assessment to ensure accuracy of growth measurements.[83]

7.3.3 Methodology

A further limitation is that Chapter 4 and Chapter 6 use cross-sectional analysis strategy, therefore limiting opportunity to draw conclusions about the direction of causality. Conversely, a strength of Chapter 3 and Chapter 5 is the use of longitudinal, prospectively collected data to estimate associations, for the former this allowed detailed description of patterns over time and for the latter it enabled preservation of the timing of exposure/outcome relationships, strengthening

conclusions. Overall, the data included comes from an observational study and there is the potential for unmeasured confounding. However, in all analyses, potential confounders were included in models estimating exposure-outcome relationships of interest. Furthermore, though the analyses were restricted to measured variables as well as the schedule of measures from the parent study, the Drakenstein Child Health Study collected data on a comprehensive set of exposures and outcomes and key sociodemographic and clinical data were available. Missing data is an important limitation of this work, given the prospective nature of data collection, missed visits impacted completeness of datasets available. However, strategies to mitigate this issue included the use of sensitivity analyses as part of each chapter and imputation of missing data in Chapters 5 and 6 to ensure analysis samples were as representative as possible of the overall cohort.

Lastly, the majority of results chapters considered IPV sub-types separately as risk factors, examining the unique associations of each with outcomes investigated. Though considering different forms of IPV and their effect on child health outcomes addresses an important gap in the literature, this approach limits our ability to address how the co-occurrence of different forms of IPV may have affected child growth and development in this study.

Despite the above limitations, this thesis has a number of key strengths and extends the literature in several areas. Presented results are strengthened by prospectively collected data, arising from a birth cohort in a LMIC setting, the use of longitudinal data with repeated measures, investigation of multiple sub-types of IPV and the use of validated measures and robust measurement of key outcomes by trained study staff, specifically growth and child development. Key extensions to the literature include i) investigation of the impact of IPV on early life child growth and development,

a critical but understudied period ii) exploration of the unique impact of emotional, physical and sexual IPV on outcomes explored and iii) investigation of potential mechanisms underlying these relationships. However, as discussed below, further work is needed to replicate these findings in different settings.

7.4 Recommendations for future research

The discussion above leads to several recommendations for future research. Although alluded to in various parts of this thesis, they are summarised here in order to provide overarching recommendations.

As discussed in the introduction, there is not a consensus in the research community on how to measure or define emotional IPV. As noted by Mason and colleagues, there is a need for future research to clearly and consistently define emotional IPV to facilitate comparison across studies.[84] Thus, emotional IPV is often not considered in reviews, representing a critical gap. Indeed, the Global Burden of Disease study in 2010 excluded emotional IPV in estimations of disease burden because of the lack of research separately examining emotional IPV and health impacts.[85] Similarly, the WHO's 2013 review of the health effects of IPV excluded emotional IPV, citing the differing operational definitions used in research and a lack of research on emotional IPV as a separate construct.[86] This represents a significant gap in the existing literature as overwhelmingly research to date has focused on physical and/or sexual IPV or a composite category of multiple types of IPV, yet research indicates that the consequences of violence experienced by women may vary according to type of violence experienced.[15] Further, emotional IPV is pervasive. In a WHO multi-country study, prevalence of past year emotional IPV across 10 LMIC countries ranged from

20-75%, representing a significant burden to women's health. Prevalence of emotional IPV across time points investigated in this thesis was consistently higher than physical or sexual IPV.

Emerging evidence suggests that emotional IPV may carry unique or additive risk for exposed women, above physical or sexual IPV.[21-24] Given the growing body of literature showing the detrimental effects of emotional IPV on women's physical and mental health and wellbeing, it is critical that research seeks to understand the potential unique influence of emotional IPV on child health outcomes. Emotional IPV may play a key role in maternal mental health and risky behavior, which in turn may differentially impact child health outcomes through these maternal psychosocial mechanisms. Results from this thesis, specifically associations between emotional IPV and food insecurity, reduced child growth at birth and through infancy as well as poorer early life developmental outcomes highlight the breadth of impact emotional IPV may have on child health and the need to ensure future research considers emotional IPV. More work is needed to examine potential unique effects of emotional IPV on maternal as well as child health outcomes to better understand potential unique drivers of health outcomes related to emotional IPV. This is particularly important given the high prevalence of emotional IPV not only in resource limited settings but in high income settings as well. It is therefore critical that future research continues to investigate the impact emotional IPV may have on child health outcomes, given the chronicity of IPV and the long-term effects of adversity or ill health in childhood.

Similarly, there is a growing literature on mechanisms underlying IPV exposure and child health outcomes, however, more work is needed to unpack the complex and interrelated factors that may contribute to these relationships. Specifically, results from this thesis suggest that further work is

needed to 1) understand how behavioral and biological pathways may relate or interact 2) investigate how and why pathways may differ based on timing and type of exposure and outcome and 3) explore how community level factors may impact relationships between exposures, mediators and outcomes.

Firstly, there is a need to explore both behavioral and biological pathways, incorporating interdisciplinary research to fully capture the effects and pathways of impact. For example, Chapter 6 found that neither alcohol use nor depression mediated the IPV-development relationship, though previous research has suggested both are potential contributors to this relationship. This may point to biological rather than behavioral mechanisms underlying associations in this cohort, for example that maternal IPV may impact a child's stress responsive biological regulatory systems, which in turn impacts child development. Secondly, results from this thesis focused primarily on maternal psychosocial and risky behaviors as mechanisms (e.g. depression, alcohol, tobacco use), finding differing degrees of mediation depending on the exposure/outcome relationship explored, timing of exposure and setting. For example, maternal depression emerged as a mediator in Chapter 4 related to food insecurity but not in Chapters 5 or 6 for growth and developmental outcomes and maternal alcohol use was only found to mediate relationships between antenatal IPV and growth at birth but not through infancy. It is critical that results are replicated in other communities and settings. However, these findings imply that the relationships between IPV and health outcomes as well as the factors underlying explored associations are highly complex; that there may not be universal mechanisms underlying relationships between IPV and child health outcomes, that mediators may differ based on setting, health outcome and timing of exposure. Thirdly, there is a need to better understand whether there

are common direct and indirect effects across diverse settings and communities. For example, results from Chapter 4 showed differing degrees of mediation between community samples. Further research is needed to better understand what community level factors may impact relationships between exposures, outcomes and explanatory variables. This community context may be important to understand how to best address key risk factors for child growth and development and to inform design of effective interventions. Lastly, this thesis presents novel findings, specifically in relation to postnatal emotional IPV and growth as well as child development; it is important that these findings are replicated in other settings and studies.

7.5 Recommendations for practice

In addition to recommendations for research, several recommendations for practice and policy arise from this work.

Findings from this study and others indicate that, at least for some women, pregnancy is a time of increased risk for IPV compared to postnatal time points. Considering this and the considerable proportion of women exposed to IPV and attending antenatal care, routine screening for IPV during pregnancy should be implemented. Additionally, studies have noted that pregnancy can be a period where IPV occurs for the first time or escalates.[9,15,87] Findings from this thesis, consistent with other studies show a high prevalence of IPV during pregnancy – representing a substantial at-risk population. Further, the antenatal and early postpartum period represent a period where the majority of mothers have multiple points of contact with healthcare providers, offering an opportunity to develop trust and continuity of care for identifying IPV exposure and referring mothers for care related to associated mental health and substance use issues identified. Given the

sustained risk over time and the likelihood for engagement in healthcare services for pregnant women; antenatal care represents a unique opportunity to identify and refer women exposed to IPV for support services. Importantly, given the results of this thesis, screening and referral efforts should incorporate identification of emotional IPV alongside physical and sexual IPV.

However, it is important to consider the healthcare context and availability of resources for treatment or counseling prior to implementing routine IPV screening in pregnancy. For example, the WHO only recommends routine screening in antenatal care settings where healthcare workers are well trained on first-line response and a set of minimum requirements are in place, specifically standard operating procedures, training on how to discuss IPV, that confidentiality can be ensured, there is time for appropriate disclosure and a system for referrals is in place.[88] Other research has similarly shown that IPV screening is only beneficial if done alongside services or interventions that can support victims following disclosure.[89]

A systematic review of health-sector responses to IPV in LMICs found a number of critical facilitators when implementing IPV interventions – specifically the availability of clear guidelines and policies, support from management, intersectoral coordination with clear referral options, well-trained staff with empathetic attitudes towards women affected by IPV and a supportive supervised environment in which to enact protocols.[90] Contextual barriers are important. For instance, guidelines on care of women exposed to domestic violence in South Africa and the Western Cape are available. However, existing guidelines are not universally adopted and the implementation is often lacking in continuity and poorly coordinated.[91] Universal screening of women for IPV during antenatal care should make sure that evidence based approaches are

integrated into healthcare sector responses, ensuring that adequate staff training and referral networks are in place.

Finally, results from this thesis underscore the complexity of factors related to IPV that may be impacting health outcomes. IPV is a complex issue, requiring a multi-sectorial approach to provide support to women affected. Findings from this thesis indicate that IPV is associated with multiple health outcomes (food security, child growth and development) as well as maternal depression and substance use. However, public health services often screen for these issues separately or do not have adequate referral options to address issues where found. This may greatly reduce the health system's ability to adequately address or attempt to mitigate adverse child health outcomes. Additionally, given the chronicity of these risk factors and that maternal IPV, mental health and risky behavior are highly correlated, addressing these concurrently and providing ongoing care is critical for improving both maternal and child health. Given the complexity of these relationships, interventions for IPV or associated health outcomes must be broad, intersectoral and multidisciplinary. In high-prevalence settings in particular, intervention programmes aimed at reducing child malnutrition or delayed development should include trauma-informed services and adequate referral for care where issues are identified. Regionally, Sub-Saharan Africa bears a disproportionate burden of global child malnutrition and poor development, representing a significant burden for families, economies and health systems.[92,93] Addressing IPV and associated risk factors as part of comprehensive intervention efforts may improve targeted health outcomes.

7.6 Conclusion

This thesis aimed to investigate IPV in a South African birth cohort, the Drakenstein Child Health Cohort, to better understand the patterns of IPV amongst pregnant and postpartum women, the impact antenatal and postnatal IPV exposure may have on their child's growth and development and the pathways by which IPV may impact child health sequelae.

Overall the findings highlight that emotional IPV in addition to physical IPV is a key risk factor for child growth and development and identifies potential pathways underlying explored relationships. Maternal depression and substance use emerged as partial explanatory variables for food security and growth outcomes in this population. Violence against women is a significant public health problem and is associated with far ranging physical and psychological health consequences for both women as well as their children. These findings underscore the intergenerational impact of IPV, not only impacting maternal health and well-being but that of their children as well.

Findings presented in this thesis suggest that comprehensive and intersectoral programs are needed to address IPV inclusive of efforts to address maternal mental health and substance use. Comprehensive programs may be critical for successful policies which aim to improve child growth and development. Further, it is also vital to ensure emotional IPV is included in training and intervention efforts. This is particularly critical given the high prevalence of malnutrition and poor development in Sub-Saharan Africa, which bears some of the highest burdens in young children.

7.7 References

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Chapter 8. Appendices

8.1 Ethics approval documents

8.1.1 University of Cape Town Human Research Ethics Committee for the Drakenstein Child Health Study

UNIVERSITY OF CAPE TOWN

HUMAN RESEARCH ETHICS COMMITTEE
07 JUL 2020
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938)			
This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30-08-2021
☐ Not approved	See attached comments		
Signature Chairperson of the HREC/ Designee		Date Signed	8/7/2020

Note: Please note that incomplete submissions will not be reviewed.
Please email this form and supporting documents (if applicable) in a combined pdf-file to hrec-enquiries@uct.ac.za.
Please clarify your plan for research-related activities during COVID-19 lockdown

Comments to PI from the HREC
Thank you for the comprehensive report

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	6 July 2020		
HREC REF Number	401/2009	Current Ethics Approval was granted until	August 30 2020
Protocol title	Drakenstein Child Health Study		
Protocol number (if applicable)	Protocol v1.18		
Are there any sub-studies linked to this study?		☑ Yes ☐ No	
If yes, could you please provide the HREC Ref's for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study		Details included in appendix.	
Principal Investigator	Prof Heather Zar		

8.1.2 University of Cape Town Human Research Ethics Committee for this thesis

UNIVERSITY OF CAPE TOWN

HUMAN RESEARCH ETHICS COMMITTEE
0 6 AUG 2020
HEALTH SCIENCES
UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938) This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30-08-2021
☐ Not approved	See attached comments		
Signature Chairperson of the HREC		Date Signed	6/8/2020

Comments to PI from the HREC
Please could you expand on the loss to follow ups. Especially those that are unable to attend visits and you are unable to contact. Especially as the study is looking at intimate partner violence Thankyou

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	5 Aug 2020		
HREC REF Number	171/2017	Current Ethics Approval was granted until	30 Aug 2020
Protocol title	Intergenerational effects: child and maternal outcomes related to exposure to intimate partner violence and trauma in a South African community (linked to Drakenstein Child Health Study, HREC Ref: 401/2009).		
Protocol number (if applicable)			
Are there any sub-studies linked to this study?	☐ Yes ✓ No		
If yes, could you please provide the HREC Ref's for all sub-studies? **Note: A separate FHS016 must be submitted for each sub-study.**			
Principal Investigator	Prof Dan Stein		
Department / Office Internal Mail Address	Groote Schuur Hospital, Anzio Rd, Observatory 7925, Cape Town, South Africa		

1.1 Does this protocol receive US Federal funding?	☐ Yes	✓ No

8.2 Intimate partner violence questionnaire

Introduction

In any relationship there are good times and bad times. This questionnaire asks you about some of the bad times you might have had in relationships because we want to learn more about what women experience in their lives. There are no right or wrong answers and anything you say will be kept strictly confidential. Your husband/partner will not be informed that we have asked you these specific questions about your relationship. He will not be asked these same questions, and will not see any of your answers to these questions. Any conversations you might want to have with a study staff member after you have completed this questionnaire - now or at a future clinic visit - will be private.

EMOTIONAL ABUSE		
Tick the most appropriate answer.		
1	Has your husband or boyfriend ever insulted you or made you feel bad about yourself? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
2	Has your husband or boyfriend ever belittled or humiliated you in front of other people? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
3	Has your husband or boyfriend ever done things to scare or intimidate you on purpose for example by the way he looked at you, by yelling and smashing things? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
4	Has your husband or boyfriend ever threatened to hurt you? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
5	Have any of these things happened in the past 12 months?	☐ Yes ☐ No

PHYSICAL ABUSE		
6	Has your husband or boyfriend ever slapped you or thrown something at you which could hurt you? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
7	Has your husband or boyfriend ever pushed or shoved you? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
8	Has your husband or boyfriend ever hit you with a fist or with something else which could hurt you? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
9	Has your husband or boyfriend ever kicked, dragged, beaten, choked or burnt you? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
10	Has your husband or boyfriend ever threatened to use or actually used a gun, knife or other weapon against you? Did this happen many times, a few times, once or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
11	Have any of these things happened <u>in the past 12 months?</u>	☐ Yes ☐ No

SEXUAL ABUSE		
12	Has your husband or boyfriend ever physically forced you to have sex when you did not want to? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
13	Have you ever had sex with your husband or boyfriend when you did not want to because you were afraid of what he might do? Did this happen many times, a few times, once, or did it not happen?	☐ Never ☐ Once ☐ Few ☐ Many
14	Has your husband or boyfriend ever forced you to do something sexual that you found degrading or humiliating?	☐ Never ☐ Once ☐ Few ☐ Many
15	Have any of these things happened <u>in the past 12 months?</u>	☐ Yes ☐ No

COMPLETION OF QUESTIONNAIRE
We know these were difficult questions to answer, but it is only by hearing from women themselves that we can really understand about their health and experiences of intimate partner violence. Thank you for helping us, and for taking the time to complete this questionnaire.
A study staff member will be providing you with a list of organisations that provide support, legal advice and counselling services to women in your area. You can take the information home with you, or leave it at the clinic if you prefer. Please do contact these services if you would like to talk with anyone about your situation. The services are free, and they will keep anything that you say to them private. You can go whenever you feel ready to.

CRF Completed by: _____ Date: __ / __ / ____
DD MM YYYY