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Maternal depression as a mediator for psychosocial risk factors of food insecurity among pregnant women in a South African setting.

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Keywords:	food insecurity, maternal mental health, intimate partner violence, depression mediation

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3 **Maternal depression as a mediator for psychosocial risk factors of food insecurity among pregnant**
4 **women in a South African setting.**
5

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Abstract

Purpose: Food insecurity during pregnancy is associated with lower infant birthweight and children from food insecure households have increased rates of developmental delay and poorer general health. Better understanding of psychological risk factors for food insecurity, and how they interact is crucial, given the long-term health implications for maternal and child wellbeing. This study investigated the association between psychological risk factors and food insecurity among pregnant women in a South African birth cohort, the Drakenstein Child Health Study (DCHS) and whether maternal depression mediates these relationships.

Methods: We investigated psychosocial predictors of food insecurity using multivariate regression. Mediation analyses were conducted to explore whether depression mediated the relationship between intimate partner violence (IPV) and food insecurity as well as between childhood trauma and food insecurity including disaggregation by two study communities.

Results: Among 992 pregnant women (median age 26 years), there were high rates of IPV (emotional IPV, 27%; physical IPV, 22%; sexual IPV, 7%), depression (24%), and childhood trauma (34%). In multivariate cross sectional analysis, emotional IPV (AOR 1.605; p-value<0.05), depression (AOR 1.052; p-value<0.01) and childhood trauma (AOR 1.484; p-value<0.05) predicted food insecurity. In mediation models including both communities, depression partially mediated the relationship between emotional IPV and food insecurity as well as physical IPV and food insecurity; depression partially mediated the relationship between childhood trauma and food insecurity. Differing degrees of mediation were found when applied to communities separately.

Conclusions: Antenatal maternal mental health problems were highly prevalent and associated with food insecurity. These results highlight the importance of addressing maternal depression, childhood trauma and IPV in relation to food security; screening services during antenatal care may offer an opportunity to identify and intervene in these issues. Community level differences in risk and in mediation analyses indicate that contextual tailoring of interventions may be an important consideration.

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 an African population with a large sample size.
- The findings of the current study may inform improved screening strategies in future by highlighting psychosocial risk factors linked to food insecurity during pregnancy.
- The current study included cross-sectional data; therefore further research is needed to assess the direction of causality, and if differences exist by trimester and postpartum.

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 842 million people (12%) worldwide were unable to meet their dietary requirements in 2011-2013. This is equal to 1 in 8 people with insufficient food for a healthy life, the majority from low- and middle-income countries (LMICs).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 health⁵⁻⁷ 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 and asthma.^{12,13} 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 LMICs and have been linked to food insecurity. Examining maternal 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 that 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. This ability to manage the effects of food insecurity may be adversely affected by maternal mental health.¹⁴

Maternal mental health problems such as depression,¹⁵ stressful life events and trauma¹⁶⁻¹⁹ are associated with food insecurity as well as poorer pregnancy outcomes such as low infant birth weight,²⁰ impaired foetal²¹ and infant growth and nutritional status^{3,22} as well as poorer infant cognitive development.^{8,23} Of particular interest is intimate partner violence (IPV) and maternal childhood trauma, which have been linked to food insecurity. For example, research has found maternal childhood trauma to be significantly associated with food insecurity²⁴ and that mothers of severely hungry school-aged children are more likely to have a lifetime post traumatic stress disorder (PTSD) diagnosis.²⁵ Although the relationship between maternal mental health and food insecurity has been explored, few studies have investigated depression as a mediator in the relationship between other psychosocial risk factors and food insecurity. Further, the majority of studies have focused on high-income countries^{18,26-28} or have used small sample sizes to explore associations.^{29,30} We explore depression as a mediator in the relationship between IPV as well as childhood trauma and food insecurity in a LMIC context where risk factors such as poor maternal mental health, IPV, and childhood trauma are high. This extends the evidence base to geographic regions where these issues are highly prevalent but the relationships between these variables are poorly understood and little investigated.

Given the long-term health implications of food insecurity for maternal and child wellbeing³¹⁻³³ understanding how risk factors for poor child health outcomes interact is critical to inform public policy to address the most urgent modifiable risk factors. Data from this study have shown links between psychosocial risk factors and food insecurity during pregnancy;³⁴ this paper builds upon that research by investigating the mediational effects of maternal depression on the relationship between emotional, physical and sexual IPV as well as maternal childhood trauma and food insecurity. Addressing food insecurity during pregnancy offers an opportunity to link antenatal care with nutritional programs and

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3 manage associated mental health risk factors at a time when those risk factors impact not only the
4 mother's safety and well being but also infant outcomes after birth.
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6 7 **Methods**

8 The Drakenstein Child Health Study (DCHS) is a multidisciplinary population-based birth cohort study
9 located in a peri-urban area, 60km outside of Cape Town, South Africa.³⁵ It is a stable, low
10 socioeconomic community comprising approximately 200 000 people, characterized by a high prevalence
11 of a range of health risk factors such as single-parent households, depression, childhood trauma, IPV and
12 poverty.³⁶ Maternal psychosocial health, food security and sociodemographics were measured at an
13 antenatal visit between 28 to 32 weeks' gestation, following enrollment.
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16 *Participants*

17 Pregnant women were enrolled from March 2012 to March 2015 and followed through childbirth.
18 Women were enrolled in their second trimester, between 20 to 28 weeks' gestation at two public sector
19 primary health care clinics, one serving a predominantly mixed ethnicity population (TC Newman) and
20 the other serving a predominantly Black African population (Mbekweni). Eligibility criteria were 1)
21 attendance at one of the two study clinics 2) being at least 18 years of age and 3) intending to remain in
22 the study area for at least 1 year.
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25 *Measures*

26 Maternal sociodemographics and mental health was measured using validated questionnaires
27 administered by trained study staff at an antenatal visit at 28 to 32 weeks' gestation. Mental health
28 assessments included measures of intimate partner violence, depression, childhood trauma, stressful life
29 events and psychological distress. The Intimate Partner Violence (IPV) Questionnaire used in this study
30 was adapted from the WHO multi-country study³⁷ and the Women's Health Study in Zimbabwe³⁸.
31 Participants were dichotomized into exposed or unexposed for having experienced emotional, physical or
32 sexual IPV in the past 12 months. The Edinburgh Postnatal Depression Scale (EPDS)³⁹ was used to
33 measure depression; this scale has been validated for use with pregnant women and in a South African
34 population.^{40,41} The EPDS consists of 10 items referring to the past 7 days with each item assessed on a
35 scale from 0 to 3. A total score was obtained by summing responses for all items and was included as a
36 continuous score, with higher scores indicating more severe depressive symptoms. The Childhood
37 Trauma Questionnaire⁴³ Short-Form was used to assess abuse and neglect experienced as a child. Each
38 item was responded to on a 5 point scale ranging from 1=*never true* to 5=*very often true*. Continuous
39 scores were used with a total possible range from 28 to 140. The Modified World Mental Health Life
40 Events Questionnaire, adapted based on items used in the South African Stress and Health Study (SASH)
41 in South Africa,⁴⁴ to measure stressful or negative life events in the past year. Items were scored
42 according to whether or not the event was experienced, 0=*no*, 1=*yes*. Individual items were then summed
43 to create a total score, ranging from 0 to 17, with higher scores indicating greater exposure to stressful life
44 events. The SRQ-20 is a WHO-endorsed measure of psychological distress.⁴⁵ The SRQ-20 consists of 20
45 items, which assess non-psychotic symptoms, including symptoms of depressive and anxiety disorders,
46 scored according to whether or not the symptom was present, 0=*no*, 1=*yes*. Individual items are summed
47 to generate a total score ranging from 0 to 20, with higher scores indicating higher levels of psychological
48 distress.⁴⁶
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3 Sociodemographic variables including mother-reported paternal characteristics, household factors and
4 maternal demographics were collected using an interviewer-administered questionnaire adapted from
5 items used in the SASH Study.⁴⁴ Socioeconomic status (SES) was measured based on a composite score
6 of asset ownership, household income, employment and education.⁴⁴ Perceived food insecurity was
7 assessed using an adapted version of the U.S. Department of Agriculture (USDA) Household Food
8 Security Scale¹ which captures food hardship due to financial constraints (smaller meals, skipped meals,
9 hunger). Five items were used and an affirmative response to two or more items was coded as being food
10 insecure.
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13 14 *Ethics*

15 Ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee,
16 University of Cape Town and the Provincial Research committee. Mothers gave written informed consent
17 at enrolment.
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20 *Patient and public involvement*

21 Prior to study initiation, local stakeholders (Department of Health staff and managers) were involved in
22 the planning of the parent study, the Drakenstein Child Health birth cohort study. Patients and public
23 were not involved in conceptualisation or analysis of the specific aims reported in the current study,
24 however, study findings are routinely fed back to the study community.
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27 **Statistical Analysis**

28 All data were analysed using SPSS. Univariate logistic regression analyses were conducted to determine
29 the bivariate relationship between food insecurity and demographic and psychosocial predictors. Odds
30 ratios (ORs) with p-values were calculated to determine the strength of these associations. A hierarchical
31 multivariate logistic regression analysis was conducted to independently evaluate IPV exposure on food
32 insecurity prior to the addition of previously investigated psychosocial factors, while controlling for
33 demographic variables. Block 1 included community, maternal income, and maternal education. Block 2
34 included recent experiences of emotional, physical, and sexual IPV. Finally, Block 3 included
35 depression, childhood trauma, stressful life events, and psychological distress. To determine whether
36 depression played a mediating role on the relationship between IPV and food insecurity, mediational
37 analyses were conducted using PROCESS macro.⁴⁷ Model number 4 was used and indirect effects were
38 bootstrapped using 1000 samples. Beta coefficients and standard errors are reported for all paths and 95%
39 confidence intervals are reported for the indirect effects. Models were conducted for the full sample and
40 then for each community individually. This process was replicated for depression as a mediator of the
41 relationship between childhood trauma and food insecurity. Mediation models controlled for community,
42 maternal income, maternal education, social grants, number of children in the household and HIV status;
43 childhood trauma was controlled for in all IPV mediation models and emotional, physical, and sexual IPV
44 was controlled for in the childhood trauma mediation models.
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50 **Results**

51 A total of 1225 pregnant women were enrolled between March 2012 and February 2015; of these, 992
52 women had complete data and were included in the analysis. Missing data resulted from non-attendance
53 at one of two visits. Detailed baseline demographic characteristics, stratified by recruitment site, are
54 presented in Table 1. The median age of participants was 26.6 years [standard deviation (SD) 5.8]. The
55 sample was characterized by low SES - 77% of mothers had a monthly income of less than R1,000
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(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. HIV prevalence and SES quartiles were significantly different between clinics as were the majority of psychosocial variables. 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.

Table 1. Maternal demographic and psychological variables

	Overall	TC Newman	Mbekweni	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*	p<0.001
Race					
Black	548 (55)	6 (1)	542 (99)	943.05	<0.001
Coloured	443 (45)	437 (99)	6 (1)		
SES Quartiles					
Lowest SES	258 (26)	81 (18)	177 (32)	37.27	<0.001
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	0.049
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	0.002
Married/cohabiting	399 (40)	200 (45)	199 (36)	10.064	0.018
Employed	254 (26)	132 (30)	122 (22)	7.439	0.007
Maternal HIV	216 (22)	17 (4)	199 (36)	151.195	<0.001
Psychosocial risk factors**					
Past year IPV					
Emotional IPV	266 (27)	155 (35)	111 (20)	27.26	<0.001
Physical IPV	216 (22)	106 (24)	110 (20)	2.18	0.14
Sexual IPV	68 (7)	49 (11)	19 (3)	22.179	<0.001
Depression	242 (24)	112 (25)	130 (24)	0.341	0.559
Childhood trauma	335 (34)	179 (40)	156 (28)	15.761	<0.001
Psychological Distress	208 (21)	109 (25)	99 (18)	6.39	0.011
Stressful Life Events	449 (45)	265 (60)	184 (34)	68.467	<0.001
Co-occurrence of psychosocial risk factors					
Depression & any IPV	122 (12)	68 (15)	54 (10)	6.911	0.009
Depression & childhood trauma	124 (13)	76 (17)	48 (9)	15.864	<0.001
Childhood trauma & any IPV	154 (16)	101 (23)	53 (10)	32.304	<0.001

*t-test

**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 \geq 13; Childhood trauma above threshold where score > 36; Psychological Distress dichotomized into low and high risk categories where high risk = score \geq 8; Stressful life events presented where greater than 1.

Univariate analysis

In univariate analysis (Table 2), antenatal food insecurity was significantly more likely among participants from Mbekweni (OR 5.68; p-value <0.001), those who had not completed secondary school

(OR 0.43; p-value <0.001), mothers with lower income levels (OR 0.39; p-value <0.001), mothers who had experienced emotional IPV (OR 1.45; p-value <0.05) or physical IPV (OR 1.85; p-value <0.001) in the past twelve months and mothers with higher levels of antenatal depression (OR 1.09; p-value <0.001), childhood trauma (OR 1.49; p-value <0.01) and psychological distress (OR 1.42; p-value <0.05).

Table 2. Hierarchical logistic regression of variables associated with food insecurity.

Variables	Univariate Regressions		Block 1		Block 2		Block 3	
	Unadjusted OR	p-value	Adjusted OR	p-value	Adjusted OR	p-value	Adjusted OR	p-value
<i>Demographic variables</i>								
Community	5.679	***	6.015	***	7.751	***	7.876	***
Maternal Income	0.394	***	0.421	***	0.422	***	0.449	***
Maternal Education	0.427	***	0.421	***	0.431	***	0.452	***
<i>Intimate Partner Violence</i>								
Emotional IPV	1.445	*			1.707	*	1.605	*
Physical IPV	1.853	***			1.433	0.102	1.315	0.220
Sexual IPV	1.624	0.059			1.882	0.05	1.463	0.253
<i>Psychological Variables ****</i>								
Depression (EPDS)	1.087	***					1.052	**
Childhood Trauma	1.491	**					1.484	*
Stressful Life Events	0.780	0.074					0.937	0.708
Psychological Distress	1.416	*					1.138	0.547
			Block X2(df)	p-value	Block X2(df)	p-value	Block X2(df)	p-value
			188.93 (3)	***	29.76 (3)	***	20.04 (4)	***

*p<0.05, **p<0.01, ***p<0.001

**** Psychological variables were included as continuous scores in regression analyses.

Hierarchical regression

A hierarchical logistic regression was done to investigate the additive impact of risk factor groups on food security (Table 2). Throughout all blocks, community, maternal education and maternal income remained significantly associated with food insecurity. In block 2 among additional IPV risk factors, adjusting for maternal sociodemographic factors and community, only physical IPV was a significant predictor. In the final model (block 3), which incorporated all psychological variables, IPV and demographic variables, mothers from Mbekweni were almost eight times (OR 7.88; p-value <0.001) as likely as TC Newman mothers to experience antenatal food insecurity. Mothers who completed secondary school were 55% less likely to experience food insecurity (OR 0.45; p-value <0.001) compared to mothers who did not complete secondary school. Similarly, mothers with higher incomes were 55% (OR 0.45; p-value <0.001) less likely to experience food insecurity. Mothers who experienced emotional IPV in the past twelve months were 60% more likely (OR 1.60; p-value <0.05), mothers with higher depression scores on EPDS were 5% more likely (OR 1.05; p-value <0.01) and mothers with a history of childhood trauma were 48% more likely (OR 1.48; p-value <0.05) than mothers without these psychological risk factors to experience food insecurity.

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

In mediation models including both communities (figure 1), 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

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3 model because the bivariate relationship between sexual IPV and food insecurity was not significant (OR
4 1.62; $p=0.06$). Mediation models were split by community due to the high significance of recruitment
5 community as an independent predictor of food insecurity; when split by community differing degrees of
6 mediation were found. At TC Newman (figure 2), depression fully mediated the relationship between
7 emotional IPV and food insecurity (direct effect p -value = 0.13; indirect effect = 0.24, 95% CI 0.05, 0.50)
8 as well as between physical IPV and food insecurity (indirect effect = 0.23, 95% CI 0.06, 0.46). At
9 Mbekweni (figure 3), depression partially mediated the relationship between emotional IPV and food
10 insecurity (direct effect p -value = 0.0004; indirect effect = 0.11, 95% CI 0.03, 0.25) and partially
11 mediated the relationship between physical IPV and food insecurity (direct effect p -value = 0.008;
12 indirect effect = 0.13, 95% CI 0.04, 0.29).
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Depression as a mediator of the relationship between childhood trauma and food insecurity

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17 In mediation models including both communities (figure 4), depression partially mediated the relationship
18 between childhood trauma and food insecurity (direct effect p -value = 0.025; indirect effect = 0.127, 95%
19 CI 0.05, 0.23). These mediation models were also split by community, due to the high significance of
20 community as a risk factor for food insecurity. When applying mediation models to childhood trauma at
21 TC Newman, depression did not mediate the relationship between childhood trauma and food insecurity
22 (direct effect p -value = 0.0009; indirect effect 0.12, 95% CI -0.12, 0.35). Additionally, at Mbekweni,
23 depression did not mediate the relationship between childhood trauma and food insecurity (direct effect p -
24 value = 0.63; indirect effect 0.04, 95% CI -0.02, 0.13).
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Discussion

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31 Our goal was to investigate the association between IPV and other psychosocial risk factors with food
32 insecurity during pregnancy, as well as to investigate maternal depression as a mediator for these
33 relationships in a LMIC country, South Africa. We found significant effects of emotional IPV and
34 maternal childhood trauma on antenatal food insecurity, after adjusting for community, maternal income
35 and education. Mothers experiencing emotional IPV or with a history of childhood trauma were 60% and
36 52% more likely, respectively, to live in food insecure households while pregnant. Though previous
37 studies have investigated links between IPV or childhood trauma and food insecurity, the majority were in
38 high-income countries,^{18,26,27} where programs and support networks addressing these risk factors are more
39 robust. Others utilized relatively small sample sizes^{29,30} and the vast majority do not differentiate between
40 subtypes of IPV,¹⁸ which may differ in their impact on food insecurity and maternal mental health,
41 employment capabilities or maternal household managerial capacity.
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46 Hernandez and colleagues found that IPV was a significant predictor of food insecurity and that this was
47 mediated by depression.⁴⁸ However, this US-based study did not find significant associations between
48 subtypes of IPV and food insecurity - only a composite measure of IPV was found to be significant. Our
49 research extends this to a LMIC setting and found that sub-types of IPV differentially predicted food
50 insecurity, with emotional IPV the only significant predictor in the final model. While mediation models
51 split by site found a mediational effect of depression on this relationship at both clinics; emotional IPV
52 did maintain a direct effect on food insecurity at Mbekweni. This may be an important distinction when
53 planning effective interventions that consider community contexts; qualitative research has found that
54 women feel emotionally abusive acts are more devastating than physical violence.⁴⁹ Emotional IPV,
55 therefore, may be a critical and often overlooked risk factor for food insecurity; and may manifest
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3 differently in a LMIC setting compared to a high-income setting possibly linked to traditional gender
4 norms affecting women's sense of power and identity and therefore ability to manage household
5 resources.⁵⁰
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8 Maternal childhood trauma also emerged as a critical risk factor for food insecurity during pregnancy.
9 Sun and colleagues investigated this link in a large US-based study.^{24 29,30} These authors reported that
10 childhood trauma was linked to food insecurity during pregnancy,³⁴ but did not include maternal
11 depression as a potential mediator in this relationship. While other high-income country studies have also
12 investigated this association, these have been limited by small sample sizes (n=44, n=31). To our
13 knowledge, our study is the first to investigate this link in a LMIC. Childhood trauma measured by
14 family instability, violence exposure at a young age, food insecurity in childhood and neglect is
15 associated with many of the known risk factors of current food insecurity such as lower levels of
16 education, employment and poor mental health outcomes in adulthood.⁵¹ This highlights a critical link
17 between childhood experiences and adult outcomes and the intergenerational effects of trauma. In the
18 context of maternal mental health, this may be particularly relevant as maternal hardship and stress may
19 increase the likelihood of a traumatic childhood for their offspring. As noted by Sun and colleagues,
20 there is an intergenerational transmission of disadvantage, which highlights the need for a multi-faceted
21 approach to address food insecurity. Our findings reveal important intergenerational risks for food
22 insecurity via maternal childhood exposure to violence and suggest that future research is needed to
23 understand how intergenerational transmission of trauma occurs between mothers and children and what
24 can be done to break this cycle. In high-prevalence settings in particular, intervention programs should
25 offer more than nutrition support and should include trauma-informed mental health services to reduce the
26 transmission of trauma from one generation to the next.⁵²
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32 The co-occurrence of psychosocial risk factors was high (12-16%) in our study sample. In order to better
33 understand how these risk factors influence one another, we investigated depression as a mediator in the
34 these relationships. In overall models depression partially mediated the relationship between emotional
35 and physical IPV and food insecurity. Notably, the degree to which depression mediated this relationship
36 differed between clinics. Depression fully mediated the relationship between emotional and physical IPV
37 and food insecurity at TC Newman, but only partial mediation was found at Mbekweni. This highlights
38 depression as important in the pathway through which IPV affects food insecurity at TC Newman.
39 However, at Mbekweni, though depression also exacerbates this relationship, there may be other factors
40 that explain the significant relationship between IPV and food insecurity. While maternal income was
41 controlled for in mediation models, SES quartiles indicate that Mbekweni mothers are economically
42 worse off than TC Newman mothers. This may be impeding the process of food management at
43 Mbekweni, especially in the context of IPV. In overall models investigating depression as a mediator for
44 the relationship between childhood trauma and food security, partial mediation was again seen; however,
45 no mediation was found when models were split by community. At TC Newman, childhood trauma
46 maintained a significant direct effect on food insecurity. It may be that social support networks are more
47 robust at Mbekweni, thus mitigating the downstream effects of childhood trauma in that community.
48 Further research is needed to understand why depression mediated the effects of childhood trauma on
49 food insecurity in overall models whereas this effect did not persist when models were split by
50 community.
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Strengths & 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. 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.

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. Both IPV victimization and experiencing childhood trauma may lead to depressive symptoms in mothers, impacting 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, also addressing multiple concurrent risk factors to reduce food insecurity and alleviate its negative impact on child health. However, notably, mediation models indicate that the effects of multiple 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.

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Declaration of interest

The authors have no conflicts of interest to declare.

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Author contributions:

WB & JP conceptualized the analysis and wrote the first draft of the manuscript. HJZ is principal

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3 investigator of the parent study; DS leads the psychosocial study aspects; NK and KD are co-investigators
4 and contributed to the study design and implementation. JP conducted the data analysis. CK, JP and DS
5 provided critical inputs on the manuscript. All authors read and approved the final manuscript.
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8 Data sharing statement: No additional data are available.
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Figure legends

Fig 1. Mediation models for both communities investigating depression as a mediator; depression **partially** mediates the relationship between emotional IPV and food insecurity as well as the relationship between physical IPV and food insecurity. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

Fig 2. Mediation models for TC Newman investigating depression as a mediator; depression **fully** mediates the relationship between emotional IPV and food insecurity as well as physical IPV and food insecurity. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

Fig 3. Mediation models at Mbekweni investigating depression as a mediator; depression **partially** mediates the relationship between emotional IPV and food insecurity as well as the relationship between

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2
3 physical IPV and food insecurity. Covariates included in the model are: community, maternal income,
4 maternal education, social grants, number of children in the household, HIV status and childhood trauma.
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6 **Fig 4.** Mediation models for both communities, TC Newman and Mbekweni investigating depression as a
7 mediator for childhood trauma and food insecurity. Depression **partially** mediated the overall relationship
8 between childhood trauma and food insecurity, but **did not mediate** the relationship at TC Newman and **did**
9 **not** mediate the relationship at Mbekweni. Covariates included in the model are: community, maternal
10 income, maternal education, social grants, number of children in the household, HIV status and emotional,
11 physical and sexual forms of IPV.
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Figure 1. Combined community Meditational Models: emotional IPV & physical IPV and food insecurity

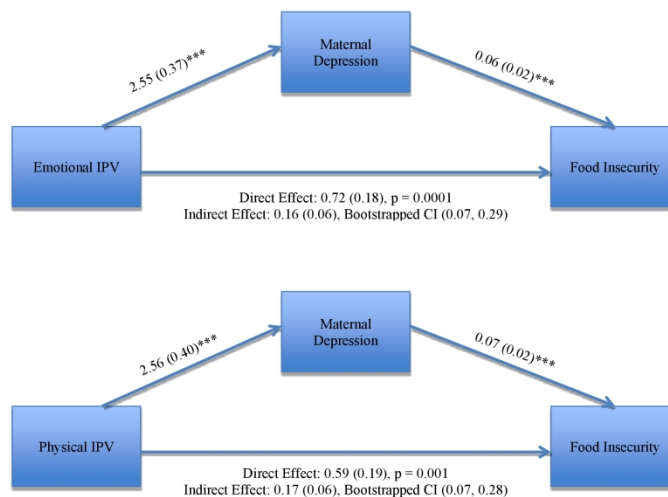


Fig 1. Mediation models for both communities investigating depression as a mediator; depression partially mediates the relationship between emotional IPV and food insecurity as well as the relationship between physical IPV and food insecurity. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

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Figure 2. TC Newman Mediation Models: relationship between emotional & physical IPV and food insecurity

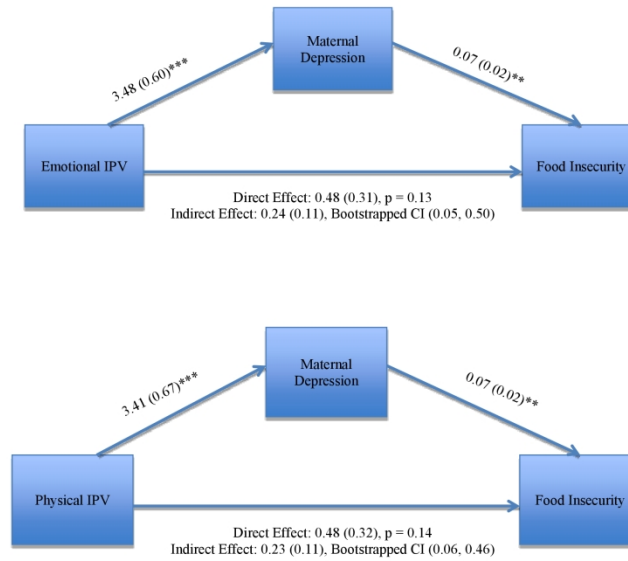


Fig 2. Mediation models for TC Newman investigating depression as a mediator; depression fully mediates the relationship between emotional IPV and food insecurity as well as physical IPV and food insecurity. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

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Figure 3. Mbekweni Mediation Models: relationship between emotional & physical IPV and food insecurity

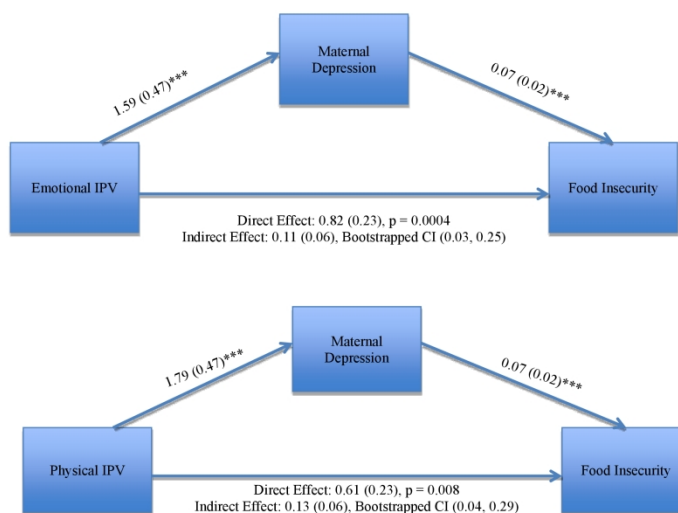
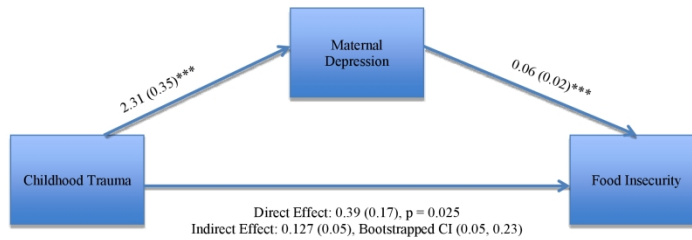


Fig 3. Mediation models at Mbekweni investigating depression as a mediator; depression partially mediates the relationship between emotional IPV and food insecurity as well as the relationship between physical IPV and food insecurity. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

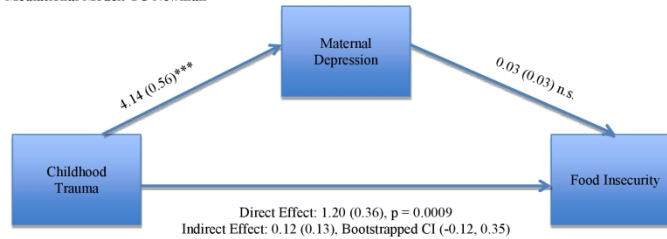
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Figure 4. Mediation Models for both communities, TC Newman and Mbekweni investigating the relationship between childhood trauma and food insecurity

Mediation Model: Overall



Mediation Model: TC Newman



Mediation Model: Mbekweni

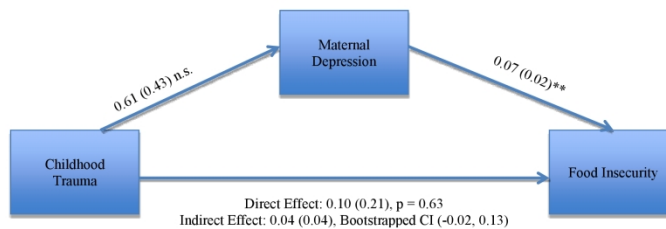


Fig 4. Mediation models for both communities, TC Newman and Mbekweni investigating depression as a mediator for childhood trauma and food insecurity. Depression partially mediated the overall relationship between childhood trauma and food insecurity, but did not mediate the relationship at TC Newman 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.

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STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4,5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4,5
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
Statistical methods		(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5,7
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	
	<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	n/a	
	12	<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	10

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	5
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	n/a
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8,10
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8,9,10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

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

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Nutrition and metabolism, Mental health
Keywords:	food insecurity, maternal mental health, intimate partner violence, depression mediation

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3 Food insecure pregnant women in South Africa: Maternal depression mediates violence and trauma risk
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30 **Key words:** food insecurity, maternal mental health, intimate partner violence, depression, mediation
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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.

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 health⁵⁻⁷ 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 as 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 depression¹³ and psychosocial risk factors such as stressful life events, intimate partner violence and trauma¹⁴⁻¹⁷ are associated with food insecurity as well as poorer pregnancy outcomes such as low infant birth weight,¹⁸ impaired foetal¹⁹ 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

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3 food insecurity, disaggregated by two communities with different risk profiles and community level
4 factors. We investigate whether depression acts as a mediator in the relationship between IPV or
5 childhood trauma and food insecurity in a LMIC context,(see figure 1: conceptual framework). This
6 extends the evidence base to geographic regions where these issues are highly prevalent but the
7 relationships between these variables are poorly understood and rarely investigated.
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10 Given the long-term health implications of food insecurity for child development as well as maternal and
11 child mental and physical health,¹²⁻¹⁵ understanding how risk factors for poor child health outcomes
12 interact is critical to inform public policy to address the most urgent modifiable risk factors. Previous
13 published findings from this cohort have shown links between psychosocial risk factors and food
14 insecurity during pregnancy;²⁸ this paper builds upon that research by investigating the mediational
15 effects of maternal depression on the relationship between emotional, physical and sexual IPV and food
16 insecurity as well as maternal childhood trauma and food insecurity. Addressing food insecurity during
17 pregnancy offers an opportunity to link antenatal care with nutritional programs and manage associated
18 mental health risk factors at a time when those risk factors impact not only the mother's safety and well
19 being but also infant outcomes after birth.
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24 **Methods**

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

39 Pregnant women were enrolled from March 2012 to March 2015. Women were enrolled in their second
40 trimester, between 20 to 28 weeks' gestation at two public sector primary health care clinics, one serving
41 a predominantly mixed-ancestry population (TC Newman) and the other serving a predominantly Black
42 African population (Mbekweni). Inclusion criteria were 1) attendance at one of the two study clinics 2)
43 and 2) intending to remain in the study area for at least 1 year. Mothers were excluded if they were under
44 18 years of age at enrolment or were not pregnant.
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48 *Measures*

49 Maternal sociodemographics and mental health was measured using validated questionnaires
50 administered by trained study staff across two antenatal visits. Mental health assessments included
51 measures of intimate partner violence, depression, childhood trauma, stressful life events and
52 psychological distress. The Intimate Partner Violence (IPV) Questionnaire used in this study was adapted
53 from the WHO multi-country study³² and the Women's Health Study in Zimbabwe.³³ Participants were
54 dichotomized into exposed or unexposed for having experienced emotional, physical or sexual IPV in the
55 past 12 months; exposure was defined as a score >1 indicating more than an isolated incident within each
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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 dichotomised. A cut of score of ≥ 13 was used to classify women as depressed.³⁴ The Childhood Trauma Questionnaire³⁷ 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 dichotomised, 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 Scale¹ 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 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.

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.

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 conceptualisation or analysis of the specific aims reported in the current study, however, study findings are routinely fed back to the study community.

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, mediational 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.

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 versus the whole cohort differed significantly only regarding whether mothers received social grants (Supplementary Table 1). Detailed baseline demographic characteristics, stratified by recruitment site, are presented in Table 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.

Table 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.

In bivariate analysis (Table 2), antenatal food insecurity was significantly more likely among participants from Mbekweni (aOR 5.82; 95% CI 4.20, 8.07), those who had not completed secondary school (aOR 0.43; 95% CI 0.32, 0.57), mothers with lower income levels (aOR 0.39; 95% CI 0.27, 0.56), mothers who had experienced emotional IPV (aOR 1.44; 95% CI 1.07, 1.94) or physical IPV (aOR 1.84; 95% CI 1.35,

Table 2. Hierarchical logistic regression of variables associated with food insecurity

Variables	Block 1		Block 2		Block 3			
	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value		
<i>Demographic variables</i>								
Community	5.82 (4.20, 8.07)	***	6.02 (4.30, 8.41)	***	8.22 (5.60, 12.06)	***		
Maternal Income	0.39 (0.27, 0.56)	***	0.42 (0.28, 0.62)	***	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)	***		
<i>Intimate Partner Violence</i>								
Emotional IPV	1.44 (1.07, 1.94)	*			1.67 (1.09, 2.56)	*		
Physical IPV	1.84 (1.35, 2.52)	***			1.41 (0.91, 2.18)	0.121		
Sexual IPV	1.62 (0.98, 2.68)	0.061			1.77 (0.92, 3.39)	0.085		
<i>Trauma/Stress+</i>								
Childhood Trauma	1.49 (1.13, 1.97)	**			1.66 (1.18, 2.33)	**		
Stressful Life Events	0.96 (0.90, 1.02)	0.157			0.98 (0.91, 1.06)	0.585		
<i>Mental Health+</i>								
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.

2.52) in the past twelve months and mothers with higher levels of antenatal depression (aOR 1.09; 95% CI 1.06, 1.12), childhood trauma (aOR 1.49; 95% CI 1.13, 1.97) and psychological distress (aOR 1.04; 95% CI 1.01, 1.08).

Hierarchical regression

A hierarchical logistic regression was done to investigate the additive impact of risk factor groups on food security (Table 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 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.

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3 Mothers who experienced emotional IPV in the past twelve months were 60% more likely (aOR 1.60;
4 95% CI 1.04, 2.46), mothers with higher depression scores on EPDS were 5% more likely (aOR 1.05;
5 95% CI 1.01, 1.08) and mothers with a history of childhood trauma were 52% more likely (aOR 1.52;
6 95% CI 1.08, 2.15) than mothers without these psychological risk factors to experience food insecurity.
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9 *Depression as a mediator of the relationship between IPV and food insecurity*

10 In mediation models including both communities (figure 2a), depression partially mediated the
11 relationship between emotional IPV and food insecurity (direct effect p-value = 0.0001; indirect effect =
12 0.16, 95% CI 0.07, 0.29) and partially mediated the relationship between physical IPV and food insecurity
13 (direct effect p-value=0.001; indirect effect = 0.17, 95% CI 0.07, 0.28). Sexual IPV was not tested in a
14 mediation model because the bivariate relationship between sexual IPV and food insecurity was not
15 significant (OR 1.62; p=0.06). Mediation models were split by community due to the high significance of
16 recruitment community as an independent predictor of food insecurity; when split by community differing
17 degrees of mediation were found. At TC Newman (figure 2b), depression fully mediated the relationship
18 between emotional IPV and food insecurity (direct effect p-value = 0.13; indirect effect = 0.24, 95% CI
19 0.05, 0.50) as well as between physical IPV and food insecurity (indirect effect = 0.23, 95% CI 0.06,
20 0.46). At Mbekweni (figure 2c), depression partially mediated the relationship between emotional IPV
21 and food insecurity (direct effect p-value = 0.0004; indirect effect = 0.11, 95% CI 0.03, 0.25) and partially
22 mediated the relationship between physical IPV and food insecurity (direct effect p-value = 0.008;
23 indirect effect = 0.13, 95% CI 0.04, 0.29).
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29 *Depression as a mediator of the relationship between childhood trauma and food insecurity*

30 In mediation models including both communities (figure 3), depression partially mediated the relationship
31 between childhood trauma and food insecurity (direct effect p-value = 0.025; indirect effect = 0.13, 95%
32 CI 0.05, 0.23). These mediation models were also split by community, due to the high significance of
33 community as a risk factor for food insecurity. When applying mediation models to childhood trauma at
34 TC Newman, depression did not mediate the relationship between childhood trauma and food insecurity
35 (direct effect p-value = 0.0009; indirect effect 0.12, 95% CI -0.12, 0.35). Additionally, at Mbekweni,
36 depression did not mediate the relationship between childhood trauma and food insecurity (direct effect p-
37 value = 0.63; indirect effect 0.04, 95% CI -0.02, 0.13).
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41 **Discussion**

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43 Our goal was to investigate the association between IPV or maternal childhood trauma and food
44 insecurity during pregnancy, as well as to investigate maternal depression as a mediator for these
45 relationships in a LMIC country, South Africa. We found significant effects of emotional IPV and
46 maternal childhood trauma on antenatal food insecurity, after adjusting for community, maternal income
47 and education. Mothers experiencing emotional IPV or with a history of childhood trauma were 60% and
48 52% more likely, respectively, to live in food insecure households while pregnant. Though previous
49 studies have investigated links between IPV or childhood trauma and food insecurity, the current study
50 extends this research to a low resource setting with a large sample size.
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54 Hernandez and colleagues found that IPV was a significant predictor of food insecurity and that this was
55 mediated by depression.²⁴ However, this US-based study did not find significant associations between
56 subtypes of IPV and food insecurity - only a composite measure of IPV was found to be significant. Our
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3 research found that sub-types of IPV were differentially associated with food insecurity, with emotional
4 IPV the only significant predictor in the final model. While mediation models split by site found a
5 mediational effect of depression on this relationship at both clinics; emotional IPV did maintain a direct
6 effect on food insecurity at Mbekweni. This may be an important distinction when planning effective
7 interventions that consider community contexts; qualitative research has found that women feel
8 emotionally abusive acts are more devastating than physical violence.⁴⁶ Emotional IPV, therefore, may be
9 a critical and often overlooked risk factor for food insecurity. Further, emotional IPV may manifest
10 differently in a LMIC setting, compared to a high-income setting, where traditional gender norms may
11 affect women's sense of power and identity and therefore, compounded by potential mental health
12 sequelae, may further decrease her ability to manage household resources.⁴⁷
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17 Maternal childhood trauma also emerged as a critical risk factor for food insecurity during pregnancy.
18 Sun and colleagues investigated this link in a large US-based study.²² These authors reported that
19 childhood trauma was linked to food insecurity during pregnancy, and found that maternal depression
20 modified this relationship. They found a dose-response relationship between number of childhood
21 adverse events and severity of food insecurity; when considered together with depression there was a
22 greater impact on food insecurity. While other high-income country studies have also investigated this
23 association, these have been limited by small sample sizes (n=44, n=31).^{48,49} To our knowledge, our
24 study is the first to investigate the link between childhood adversity and food security in a LMIC or
25 mental health as a mediator in this relationship. Childhood trauma measured by family instability,
26 violence exposure at a young age, food insecurity in childhood and neglect is associated with many of the
27 known risk factors of current food insecurity such as lower levels of education, employment and poor
28 mental health outcomes in adulthood.⁵⁰ This highlights a critical link between childhood experiences and
29 adult outcomes and the intergenerational effects of trauma. In the context of maternal mental health, this
30 may be particularly relevant as maternal hardship and stress may increase the likelihood of a traumatic
31 childhood for their offspring. As noted by Sun and colleagues, there is an intergenerational transmission
32 of disadvantage, which highlights the need for a multi-faceted approach to address food insecurity.²² Our
33 findings reveal important intergenerational associations between food insecurity and maternal childhood
34 exposure to violence and suggest that future research is needed to understand how intergenerational
35 transmission of trauma occurs between mothers and children and what can be done to break this cycle. In
36 high-prevalence settings in particular, intervention programs should offer more than nutrition support and
37 should include trauma-informed mental health services to reduce the transmission of trauma from one
38 generation to the next. Though further study is needed to determine if trauma counselling or interventions
39 may help to alleviate the prevalence of food insecurity.
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46 The co-occurrence of psychosocial risk factors was high (12-16%) in our study sample. In order to better
47 understand how these risk factors influence one another, we investigated depression as a mediator in these
48 relationships. In overall models depression partially mediated the relationship between emotional and
49 physical IPV and food insecurity. Notably, the degree to which depression mediated this relationship
50 differed between clinic communities. Depression fully mediated the relationship between emotional and
51 physical IPV and food insecurity at TC Newman, but only partial mediation was found at Mbekweni.
52 This highlights depression as important in the pathway through which IPV affects food insecurity at TC
53 Newman. However, at Mbekweni, though depression also exacerbates this relationship, there may be
54 other factors that explain the significant relationship between IPV and food insecurity. While maternal
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3 income was controlled for in mediation models, SES quartiles indicate that Mbekweni mothers are
4 economically worse off than TC Newman mothers. This may be impeding the process of food
5 management at Mbekweni, especially in the context of IPV. In overall models investigating depression as
6 a mediator for the relationship between childhood trauma and food security, partial mediation was again
7 seen; however, no mediation was found when models were split by community. At TC Newman,
8 childhood trauma maintained a significant direct effect on food insecurity. It may be that social support
9 networks are more robust at Mbekweni, thus mitigating the downstream effects of childhood trauma in
10 that community. A study in a similar community in South Africa found that social support buffers the
11 effect of trauma on depression symptoms;⁵¹ further, social support has been found to be particularly
12 important for females, compared to males in mitigating mental health outcomes such as depression.⁵²
13 Additional research is needed to understand how or why depression mediated the effects of childhood
14 trauma on food insecurity in overall models whereas this effect did not persist when models were split by
15 community.
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20 Additionally, this study indicates that community level factors should be considered when developing
21 nutritional and mental health interventions. Many communities in South Africa are still dealing with the
22 long-term effects of apartheid, this may have a continued effect on stress and mental health in these
23 communities.⁵³ However, racial disparities exist globally affecting physical and mental health in specific
24 communities differentially to others.^{54,55} Specifically, in targeting mental health, contextual factors such
25 as differences in stigma to accessing care, gender norms affecting agency or education levels for women,
26 may have significant differential effects within communities. This community context may be important
27 to understand how to best address key risk factors for food insecurity and to inform design of effective
28 interventions.
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32 *Strengths & Limitations*

33 The inclusion criteria for the parent study were broad to ensure generalizability. However, recruitment
34 was done during antenatal care visits, so mothers who did not present for antenatal care or who presented
35 in their third trimester were excluded, which may affect overall generalizability. Further, generalizability
36 may be limited to similar population groups, specifically pregnant mothers and similar communities. In
37 addition, approximately 200 mothers who were enrolled in the study were not included in the analysis due
38 to incomplete data. While it is possible that this subset of mothers is at higher risk for many of the factors
39 investigated; there were not significant differences in key factors investigated for mothers included versus
40 those excluded in the current study. As the current study included cross-sectional data, we cannot assert
41 the direction of causality. While a strength of this study was its investigation of the individual impact of
42 different subtypes of IPV, too few mothers experienced or reported sexual IPV to allow this to be
43 investigated fully. Finally, as all variables used were based on self-report, mothers may have
44 underreported both risk factors and food security due to social desirability bias. Despite these limitations,
45 the current study provides a novel quantitative analysis with a large sample size conducted in a LMIC.
46 Our findings corroborate previous research on risk factors for food insecurity; and build on unpublished
47 data in this cohort by investigating subtypes of IPV as well as maternal depression as a mediator for both
48 childhood trauma and IPV.
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54 *Conclusions*

55 Addressing depression during pregnancy through screening and referral services may help to alleviate the
56 negative impact of IPV, childhood trauma and depression on food security; though direction of causality
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3 cannot be asserted by the current study, significant associations between these variables and food
4 insecurity were found. Both IPV victimization and experiencing childhood trauma were associated with
5 depressive symptoms in mothers, after controlling for maternal income and education. This may impact
6 their household managerial skills by decreasing motivation to obtain food, to find and hold employment
7 and through decreased physical and cognitive functioning. Our findings highlight the importance of
8 comprehensive programs aimed at nutrition support or food security, as well as the importance of
9 addressing multiple concurrent psychosocial risk factors which may help to reduce food insecurity and
10 alleviate its negative impact on child health. However, notably, mediation models indicate that the effects
11 of maternal mental health issues are experienced differently at the two communities in this cohort
12 highlighting the importance of program and policy efforts targeted to specific community profiles.
13 Notably, though not the focus of the current study, both maternal income and maternal education were
14 highly correlated with food insecurity – education especially is likely an important factor cross cutting all
15 key risk and outcome variables – promoting educational opportunities represents an important
16 intervention to improve maternal and thus child health.
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27

28 *Declaration of interest*

29 The authors have no conflicts of interest to declare.
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31

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39 represent the official views of the SAMRC.
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43 *Author contributions:*

44 WB & JP conceptualized the analysis and wrote the first draft of the manuscript. HJZ is principal
45 investigator of the parent study; DS leads the psychosocial study aspects; NK and KD are co-investigators
46 and contributed to the study design and implementation. JP conducted the data analysis. CK, JP and DS
47 provided critical inputs on the manuscript. All authors read and approved the final manuscript.
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50 *Data sharing statement:* No additional data are available. All study instruments used in this analysis are
51 available to requesting researchers.
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Figure legends

Fig 2a-2c. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

Fig 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.

Figure 1. Conceptual framework for study

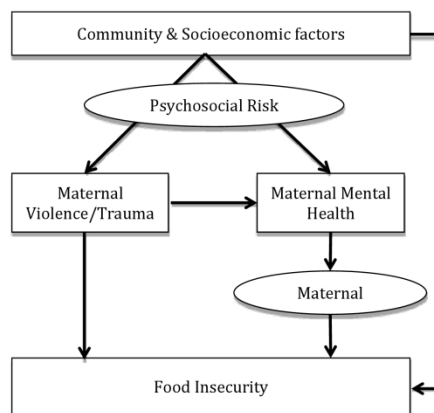


Figure 1. Conceptual framework for study.

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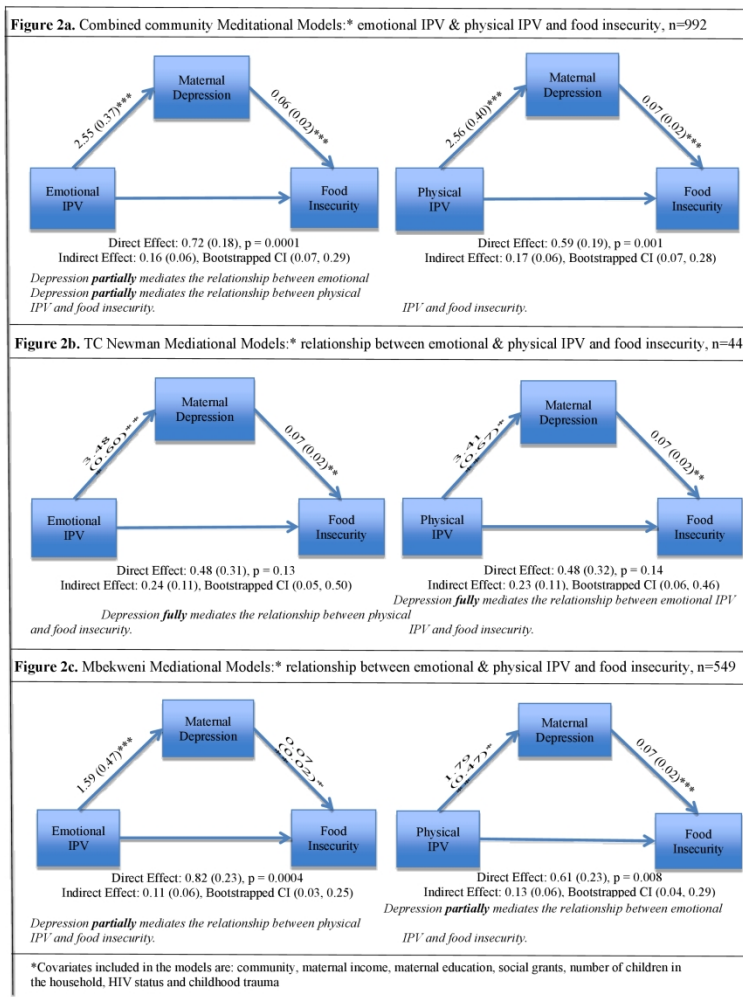


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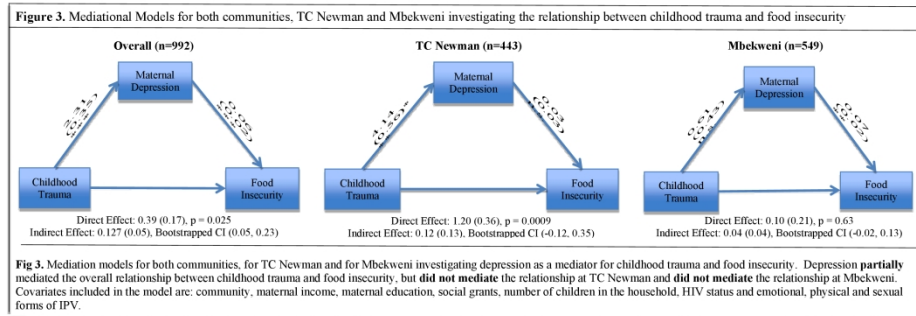


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Supplemental Table 1. Sensitivity analysis: comparison of key sociodemographic variables between participants included in and excluded from the current study.

	Included sample	Excluded sample	p-value
Number of mothers	992	233	
Clinic			
Mbekweni	549 (55)	131 (56)	0.808
TC Newman	443 (45)	102 (44)	
Race			
Black	548 (55)	132 (57)	0.708
Coloured	443 (45)	101 (43)	
Maternal Income			
<R1,000/month	767 (77)	168 (78)	0.954
R1000-R5000/month	212 (21)	44 (20)	
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)	0.066
Completed Secondary	379 (38)	103 (45)	
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

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4,5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4,5
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
		(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5,7
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	
Statistical methods	12	<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	n/a
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	10

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	5
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	n/a
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8,10
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8,9,10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Food insecure pregnant women in South Africa: A cross-sectional exploration of maternal depression as a mediator of violence and trauma risk factors.

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Nutrition and metabolism, Mental health
Keywords:	food insecurity, maternal mental health, intimate partner violence, depression mediation

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3 Food insecure pregnant women in South Africa: A cross-sectional exploration of maternal depression as a
4 mediator of violence and trauma risk factors.
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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.

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 health⁵⁻⁷ 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 as 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 depression¹³ and psychosocial risk factors such as stressful life events, intimate partner violence and trauma¹⁴⁻¹⁷ are associated with food insecurity as well as poorer pregnancy outcomes such as low infant birth weight,¹⁸ impaired foetal¹⁹ 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.

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3 We therefore aim to explore associations between maternal psychosocial risk factors or mental health and
4 food insecurity, disaggregated by two communities with different risk profiles and community level
5 factors. We investigate whether depression acts as a mediator in the relationship between IPV or
6 childhood trauma and food insecurity in a LMIC context,(see figure 1: conceptual framework). This
7 extends the evidence base to geographic regions where these issues are highly prevalent but the
8 relationships between these variables are poorly understood and rarely investigated.
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11 Given the long-term health implications of food insecurity for child development as well as maternal and
12 child mental and physical health,¹²⁻¹⁵ understanding how risk factors for poor child health outcomes
13 interact is critical to inform public policy to address the most urgent modifiable risk factors. Previous
14 published findings from this cohort have shown links between psychosocial risk factors and food
15 insecurity during pregnancy;²⁸ this paper builds upon that research by investigating the mediational
16 effects of maternal depression on the relationship between emotional, physical and sexual IPV and food
17 insecurity as well as maternal childhood trauma and food insecurity. Addressing food insecurity during
18 pregnancy offers an opportunity to link antenatal care with nutritional programs and manage associated
19 mental health risk factors at a time when those risk factors impact not only the mother's safety and well
20 being but also infant outcomes after birth.
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25 **Methods**

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

41 Pregnant women were enrolled from March 2012 to March 2015. Women were enrolled in their second
42 trimester, between 20 to 28 weeks' gestation at two public sector primary health care clinics, one serving
43 a predominantly mixed-ancestry population (TC Newman) and the other serving a predominantly Black
44 African population (Mbekweni). Inclusion criteria were 1) attendance at one of the two study clinics 2)
45 and 2) intending to remain in the study area for at least 1 year. Mothers were excluded if they were under
46 18 years of age at enrolment or were not pregnant.
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49 *Measures*

50 Maternal sociodemographics and mental health was measured using validated questionnaires
51 administered by trained study staff across two antenatal visits. Mental health assessments included
52 measures of intimate partner violence, depression, childhood trauma, stressful life events and
53 psychological distress. The Intimate Partner Violence (IPV) Questionnaire used in this study was adapted
54 from the WHO multi-country study³² and the Women's Health Study in Zimbabwe.³³ Participants were
55 dichotomized into exposed or unexposed for having experienced emotional, physical or sexual IPV in the
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3 past 12 months; exposure was defined as a score >1 indicating more than an isolated incident within each
4 sub-type. The Edinburgh Postnatal Depression Scale (EPDS)³⁴ was used to measure depression; this scale
5 has been validated for use with pregnant women and in a South African population.^{35,36} The EPDS
6 consists of 10 items referring to the past 7 days with each item assessed on a scale from 0 to 3. A total
7 score was obtained by summing responses for all items and was included as a continuous score, with
8 higher scores indicating more severe depressive symptoms; total scores were included in models. To give
9 baseline cohort characteristics depression was dichotomised. A cut of score of ≥ 13 was used to classify
10 women as depressed.³⁴ The Childhood Trauma Questionnaire³⁷ Short-Form was used to assess abuse and
11 neglect experienced as a child. Each item was responded to on a 5 point scale ranging from *1=never true*
12 to *5=very often true*. Continuous scores were used with a total possible range from 28 to 140. Where
13 dichotomised, a cut off score of >36 was used to indicate exposure to childhood trauma, as described in
14 the CTQ manual.³⁸ The Modified World Mental Health Life Events Questionnaire, adapted based on
15 items used in the South African Stress and Health Study (SASH) in South Africa,³⁹ to measure stressful or
16 negative life events in the past year (e.g. serious illness, major financial crisis, serious discord with family
17 or friends) Items were scored according to whether or not the event was experienced, *0=no*, *1=yes*.
18 Individual items were then summed to create a total score, ranging from 0 to 17, with higher scores
19 indicating greater exposure to stressful life events. Dichotomous exposure to stressful life events was
20 defined as experiencing at least one such event. The SRQ-20 is a WHO-endorsed measure of
21 psychological distress.⁴⁰ The SRQ-20 consists of 20 items, which assess non-psychotic symptoms,
22 including symptoms of depressive and anxiety disorders, scored according to whether or not the symptom
23 was present, *0=no*, *1=yes*. Individual items are summed to generate a total score ranging from 0 to 20,
24 with higher scores indicating higher levels of psychological distress.⁴¹ A cut off score of ≥ 8 was used to
25 classify participants into high versus low risk, as has been used elsewhere.^{41,42}
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32 Sociodemographic variables including mother-reported household factors and maternal demographics
33 were collected using an interviewer-administered questionnaire adapted from items used in the SASH
34 Study.³⁹ Socioeconomic status (SES) was measured based on a composite score of asset ownership,
35 household income, employment and education.³⁹ Social grants (receiving government support for child
36 care or disability) were self-reported by mothers at enrolment.
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39 Perceived food insecurity was assessed using an adapted version of the U.S. Department of Agriculture
40 (USDA) Short Form Household Food Security Scale¹ which captures food hardship due to financial
41 constraints. Specific questions asked about whether meals were made smaller for children in home,
42 whether children skipped meals or went hungry and whether children in home went a full day without
43 eating - due to limited financial means within the home, as described previously.²⁸ Questions included
44 referred to children in the home as a conservative estimate of perceived food insecurity; studies have
45 shown that parental buffering often mean that children are the last household members to experience food
46 insecurity.^{43,44} Five items were used and an affirmative response to two or more items was coded as being
47 food insecure.
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51 *Ethics*

52 Ethical approval was obtained from the Faculty of Health Sciences Research Ethics Committee,
53 University of Cape Town (401/2009) and the Provincial Research committee. Mothers gave written
54 informed consent at enrolment.
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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 conceptualisation or analysis of the specific aims reported in the current study, however, study findings are routinely fed back to the study community.

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, mediational 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.

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 versus the whole cohort differed significantly only regarding whether mothers received social grants (Supplementary Table 1). Detailed baseline demographic characteristics, stratified by recruitment site, are presented in Table 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.

Table 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 \geq 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 \geq 13; Childhood trauma above threshold where score > 36; Psychological Distress dichotomized into low and high risk categories where high risk = score \geq 8; Stressful life events presented where greater than 1.

In bivariate analysis (Table 2), antenatal food insecurity was significantly more likely among participants from Mbekweni (aOR 5.82; 95% CI 4.20, 8.07), those who had not completed secondary school (aOR 0.43; 95% CI 0.32, 0.57), mothers with lower income levels (aOR 0.39; 95% CI 0.27, 0.56), mothers who had experienced emotional IPV (aOR 1.44; 95% CI 1.07, 1.94) or physical IPV (aOR 1.84; 95% CI 1.35,

Table 2. Hierarchical logistic regression of variables associated with food insecurity

Variables	Block 1		Block 2		Block 3			
	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value		
<i>Demographic variables</i>								
Community	5.82 (4.20, 8.07)	***	6.02 (4.30, 8.41)	***	8.22 (5.60, 12.06)	***		
Maternal Income	0.39 (0.27, 0.56)	***	0.42 (0.28, 0.62)	***	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)	***		
<i>Intimate Partner Violence</i>								
Emotional IPV	1.44 (1.07, 1.94)	*			1.67 (1.09, 2.56)	*		
Physical IPV	1.84 (1.35, 2.52)	***			1.41 (0.91, 2.18)	0.121		
Sexual IPV	1.62 (0.98, 2.68)	0.061			1.77 (0.92, 3.39)	0.085		
<i>Trauma/Stress+</i>								
Childhood Trauma	1.49 (1.13, 1.97)	**			1.66 (1.18, 2.33)	**		
Stressful Life Events	0.96 (0.90, 1.02)	0.157			0.98 (0.91, 1.06)	0.585		
<i>Mental Health+</i>								
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.

2.52) in the past twelve months and mothers with higher levels of antenatal depression (aOR 1.09; 95% CI 1.06, 1.12), childhood trauma (aOR 1.49; 95% CI 1.13, 1.97) and psychological distress (aOR 1.04; 95% CI 1.01, 1.08).

Hierarchical regression

A hierarchical logistic regression was done to investigate the additive impact of risk factor groups on food security (Table 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 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.

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3 Mothers who experienced emotional IPV in the past twelve months were 60% more likely (aOR 1.60;
4 95% CI 1.04, 2.46), mothers with higher depression scores on EPDS were 5% more likely (aOR 1.05;
5 95% CI 1.01, 1.08) and mothers with a history of childhood trauma were 52% more likely (aOR 1.52;
6 95% CI 1.08, 2.15) than mothers without these psychological risk factors to experience food insecurity.
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9 *Depression as a mediator of the relationship between IPV and food insecurity*

10 In mediation models including both communities (figure 2a), depression partially mediated the
11 relationship between emotional IPV and food insecurity (direct effect p-value = 0.0001; indirect effect =
12 0.16, 95% CI 0.07, 0.29) and partially mediated the relationship between physical IPV and food insecurity
13 (direct effect p-value=0.001; indirect effect = 0.17, 95% CI 0.07, 0.28). Sexual IPV was not tested in a
14 mediation model because the bivariate relationship between sexual IPV and food insecurity was not
15 significant (OR 1.62; p=0.06). Mediation models were split by community due to the high significance of
16 recruitment community as an independent predictor of food insecurity; when split by community differing
17 degrees of mediation were found. At TC Newman (figure 2b), depression fully mediated the relationship
18 between emotional IPV and food insecurity (direct effect p-value = 0.13; indirect effect = 0.24, 95% CI
19 0.05, 0.50) as well as between physical IPV and food insecurity (indirect effect = 0.23, 95% CI 0.06,
20 0.46). At Mbekweni (figure 2c), depression partially mediated the relationship between emotional IPV
21 and food insecurity (direct effect p-value = 0.0004; indirect effect = 0.11, 95% CI 0.03, 0.25) and partially
22 mediated the relationship between physical IPV and food insecurity (direct effect p-value = 0.008;
23 indirect effect = 0.13, 95% CI 0.04, 0.29).
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29 *Depression as a mediator of the relationship between childhood trauma and food insecurity*

30 In mediation models including both communities (figure 3), depression partially mediated the relationship
31 between childhood trauma and food insecurity (direct effect p-value = 0.025; indirect effect = 0.13, 95%
32 CI 0.05, 0.23). These mediation models were also split by community, due to the high significance of
33 community as a risk factor for food insecurity. When applying mediation models to childhood trauma at
34 TC Newman, depression did not mediate the relationship between childhood trauma and food insecurity
35 (direct effect p-value = 0.0009; indirect effect 0.12, 95% CI -0.12, 0.35). Additionally, at Mbekweni,
36 depression did not mediate the relationship between childhood trauma and food insecurity (direct effect p-
37 value = 0.63; indirect effect 0.04, 95% CI -0.02, 0.13).
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41 **Discussion**

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43 Our goal was to investigate the association between IPV or maternal childhood trauma and food
44 insecurity during pregnancy, as well as to investigate maternal depression as a mediator for these
45 relationships in a LMIC country, South Africa. We found significant effects of emotional IPV and
46 maternal childhood trauma on antenatal food insecurity, after adjusting for community, maternal income
47 and education. Mothers experiencing emotional IPV or with a history of childhood trauma were 60% and
48 52% more likely, respectively, to live in food insecure households while pregnant. Though previous
49 studies have investigated links between IPV or childhood trauma and food insecurity, the current study
50 extends this research to a low resource setting with a large sample size.
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54 Hernandez and colleagues found that IPV was a significant predictor of food insecurity and that this was
55 mediated by depression.²⁴ However, this US-based study did not find significant associations between
56 subtypes of IPV and food insecurity - only a composite measure of IPV was found to be significant. Our
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3 research found that sub-types of IPV were differentially associated with food insecurity, with emotional
4 IPV the only significant predictor in the final model. While mediation models split by site found a
5 mediational effect of depression on this relationship at both clinics; emotional IPV did maintain a direct
6 effect on food insecurity at Mbekweni. This may be an important distinction when planning effective
7 interventions that consider community contexts; qualitative research has found that women feel
8 emotionally abusive acts are more devastating than physical violence.⁴⁶ Emotional IPV, therefore, may be
9 a critical and often overlooked risk factor for food insecurity. Further, emotional IPV may manifest
10 differently in a LMIC setting, compared to a high-income setting, where traditional gender norms may
11 affect women's sense of power and identity and therefore, compounded by potential mental health
12 sequelae, may further decrease her ability to manage household resources.⁴⁷
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17 Maternal childhood trauma also emerged as a critical risk factor for food insecurity during pregnancy.
18 Sun and colleagues investigated this link in a large US-based study.²² These authors reported that
19 childhood trauma was linked to food insecurity during pregnancy, and found that maternal depression
20 modified this relationship. They found a dose-response relationship between number of childhood
21 adverse events and severity of food insecurity; when considered together with depression there was a
22 greater impact on food insecurity. While other high-income country studies have also investigated this
23 association, these have been limited by small sample sizes (n=44, n=31).^{48,49} To our knowledge, our
24 study is the first to investigate the link between childhood adversity and food security in a LMIC or
25 mental health as a mediator in this relationship. Childhood trauma measured by family instability,
26 violence exposure at a young age, food insecurity in childhood and neglect is associated with many of the
27 known risk factors of current food insecurity such as lower levels of education, employment and poor
28 mental health outcomes in adulthood.⁵⁰ This highlights a critical link between childhood experiences and
29 adult outcomes and the intergenerational effects of trauma. In the context of maternal mental health, this
30 may be particularly relevant as maternal hardship and stress may increase the likelihood of a traumatic
31 childhood for their offspring. As noted by Sun and colleagues, there is an intergenerational transmission
32 of disadvantage, which highlights the need for a multi-faceted approach to address food insecurity.²² Our
33 findings reveal important intergenerational associations between food insecurity and maternal childhood
34 exposure to violence and suggest that future research is needed to understand how intergenerational
35 transmission of trauma occurs between mothers and children and what can be done to break this cycle. In
36 high-prevalence settings in particular, intervention programs should offer more than nutrition support and
37 should include trauma-informed mental health services to reduce the transmission of trauma from one
38 generation to the next. Though further study is needed to determine if trauma counselling or interventions
39 may help to alleviate the prevalence of food insecurity.
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46 The co-occurrence of psychosocial risk factors was high (12-16%) in our study sample. In order to better
47 understand how these risk factors influence one another, we investigated depression as a mediator in these
48 relationships. In overall models depression partially mediated the relationship between emotional and
49 physical IPV and food insecurity. Notably, the degree to which depression mediated this relationship
50 differed between clinic communities. Depression fully mediated the relationship between emotional and
51 physical IPV and food insecurity at TC Newman, but only partial mediation was found at Mbekweni.
52 This highlights depression as important in the pathway through which IPV affects food insecurity at TC
53 Newman. However, at Mbekweni, though depression also exacerbates this relationship, there may be
54 other factors that explain the significant relationship between IPV and food insecurity. While maternal
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3 income was controlled for in mediation models, SES quartiles indicate that Mbekweni mothers are
4 economically worse off than TC Newman mothers. This may be impeding the process of food
5 management at Mbekweni, especially in the context of IPV. In overall models investigating depression as
6 a mediator for the relationship between childhood trauma and food security, partial mediation was again
7 seen; however, no mediation was found when models were split by community. At TC Newman,
8 childhood trauma maintained a significant direct effect on food insecurity. It may be that social support
9 networks are more robust at Mbekweni, thus mitigating the downstream effects of childhood trauma in
10 that community. A study in a similar community in South Africa found that social support buffers the
11 effect of trauma on depression symptoms;⁵¹ further, social support has been found to be particularly
12 important for females, compared to males in mitigating mental health outcomes such as depression.⁵²
13 Additional research is needed to understand how or why depression mediated the effects of childhood
14 trauma on food insecurity in overall models whereas this effect did not persist when models were split by
15 community.
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20 Additionally, this study indicates that community level factors should be considered when developing
21 nutritional and mental health interventions. Many communities in South Africa are still dealing with the
22 long-term effects of apartheid, this may have a continued effect on stress and mental health in these
23 communities.⁵³ However, racial disparities exist globally affecting physical and mental health in specific
24 communities differentially to others.^{54,55} Specifically, in targeting mental health, contextual factors such
25 as differences in stigma to accessing care, gender norms affecting agency or education levels for women,
26 may have significant differential effects within communities. This community context may be important
27 to understand how to best address key risk factors for food insecurity and to inform design of effective
28 interventions.
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32 *Strengths & Limitations*

33 The inclusion criteria for the parent study were broad to ensure generalizability. However, recruitment
34 was done during antenatal care visits, so mothers who did not present for antenatal care or who presented
35 in their third trimester were excluded, which may affect overall generalizability. Further, generalizability
36 may be limited to similar population groups, specifically pregnant mothers and similar communities. In
37 addition, approximately 200 mothers who were enrolled in the study were not included in the analysis due
38 to incomplete data. While it is possible that this subset of mothers is at higher risk for many of the factors
39 investigated; there were not significant differences in key factors investigated for mothers included versus
40 those excluded in the current study. As the current study included cross-sectional data, we cannot assert
41 the direction of causality. While a strength of this study was its investigation of the individual impact of
42 different subtypes of IPV, too few mothers experienced or reported sexual IPV to allow this to be
43 investigated fully. Finally, as all variables used were based on self-report, mothers may have
44 underreported both risk factors and food security due to social desirability bias. Despite these limitations,
45 the current study provides a novel quantitative analysis with a large sample size conducted in a LMIC.
46 Our findings corroborate previous research on risk factors for food insecurity; and build on unpublished
47 data in this cohort by investigating subtypes of IPV as well as maternal depression as a mediator for both
48 childhood trauma and IPV.
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54 *Conclusions*

55 Addressing depression during pregnancy through screening and referral services may help to alleviate the
56 negative impact of IPV, childhood trauma and depression on food security; though direction of causality
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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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Declaration of interest

The authors have no conflicts of interest to declare.

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Author contributions:

WB & JP conceptualized the analysis and 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 co-investigators 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.

Data sharing statement: No additional data are available. All study instruments used in this analysis are available to requesting researchers.

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Figure legends

Figure 1. Conceptual framework for study.

Fig 2a-2c. Covariates included in the model are: community, maternal income, maternal education, social grants, number of children in the household, HIV status and childhood trauma.

Fig 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.

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Figure 1. Conceptual framework for study

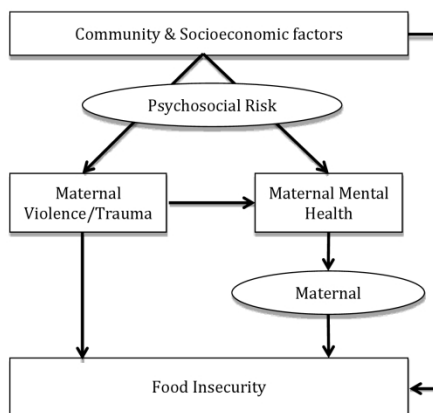


Figure 1. Conceptual framework for study.

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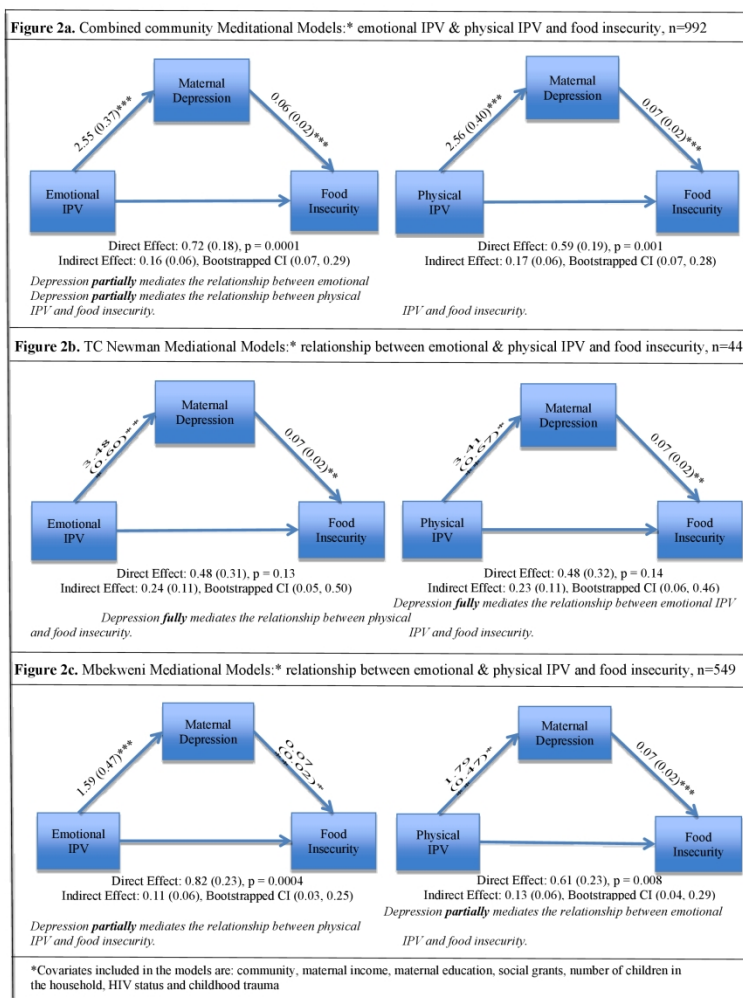


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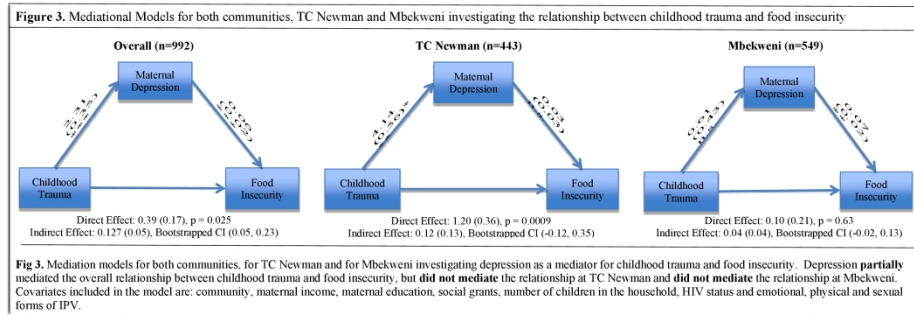


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Supplemental Table 1. Sensitivity analysis: comparison of key sociodemographic variables between participants included in and excluded from the current study.

	Included sample	Excluded sample	p-value
Number of mothers	992	233	
Clinic			
Mbekweni	549 (55)	131 (56)	0.808
TC Newman	443 (45)	102 (44)	
Race			
Black	548 (55)	132 (57)	0.708
Coloured	443 (45)	101 (43)	
Maternal Income			
<R1,000/month	767 (77)	168 (78)	0.954
R1000-R5000/month	212 (21)	44 (20)	
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)	0.066
Completed Secondary	379 (38)	103 (45)	
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

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	<i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	4,5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4,5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4,5
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4,5
		(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5,7
		(c) Explain how missing data were addressed	5
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	
Statistical methods	12	<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	n/a
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	10

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	5
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	n/a
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	n/a
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	6
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7
		(b) Report category boundaries when continuous variables were categorized	6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8,10
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8,9,10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.