

TRAJECTORIES OF MATERNAL DEPRESSION AND THE IMPACT ON CHILD
COGNITIVE DEVELOPMENT: LONGITUDINAL DATA ANALYSIS WITH
INTERNATIONAL PARTICIPANTS FROM THE MAL-ED STUDY

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ABSTRACT

Depression is recognized as a disabling and impairing condition, impacting mood, cognitions, and daily functioning (APA, 2013; WHO, 2017). Women are more likely to develop depression than men (Gutierrez-Lobos et al., 2002; Noble, 2005). The perinatal period is a sensitive time when mothers are vulnerable to developing depression (Noble, 2005; Schiller et al., 2015). Further, postpartum depression is a risk factor for negative outcomes for both mother and child (Goodman & Gotlib, 1999), including child cognitive development (Grace et al., 2003).

The onset and course of depression involves a variety of biopsychosocial components that are often accounted for in research on maternal depression (Billings & Moos, 1993; Cummings & Davies, 1994; Nobel, 2005). Examining the severity, chronicity, and time of onset of maternal depression reveals specific patterns or trajectories for the mother's experience; these trajectories can provide better understanding of maternal depression and its impact on child development (Brennan et al., 2000). Maternal depression is prevalent yet under-studied and under-identified in low-middle income countries (LMICs), with most research of postpartum depression centering Western and English-speaking families (Gelaye et al., 2016; Halbreich & Karkun, 2006). To better understand and treat maternal depression across cultures, research is needed in diverse locations with culturally sensitive methods.

The purpose of the present study is to identify trajectories of maternal depression in diverse, international locations including LMICs. The MAL-ED Study involves eight study sites (Dhaka, Bangladesh (BGD); Fortaleza, Brazil (BRF); Vellore, India; (INV), Bhaktapur, Nepal (NEB); Loreto, Peru (PEL); Naushahro Feroze, Pakistan (PKN);

Venda, South Africa (Dzimauli Community, SAV); and Haydom, Tanzania (TZH)) and incorporates several health-related factors pertaining to mothers and children (Murray-Kolb et al., 2014). The present study included five of the eight international sites. Maternal depression, as measured by the Self-Report Questionnaire (SRQ; Beusenberg & Orley, 1994), was assessed across the first two years postpartum, allowing for longitudinal analysis of trajectory using latent class growth analysis (LCGA). Maternal depression trajectories differed across the five sites, but demonstrated a general pattern of high, moderate, and low symptoms for the total sample.

Path models were used to determine if there was a relationship between maternal depression trajectories and child cognitive development as measured by the Bayley Scales for Infant and Toddler Development, 3rd Edition (BSID-III, Bayley, 2009) for the total sample. To address the influence of contextual factors, the Home Observation for the Measurement of the Environment (HOME; Caldwell & Bradley, 1984, 2003) was incorporated in analysis as a mediator. However, the mediation analysis was not statistically significant and maternal depression trajectory was not a strong predictor of child cognitive development with the total sample. The results indicated that better home environment predicted improved cognitive scores, regardless of maternal depression trajectories.

The present study provided evidence that maternal depression trajectories varied based on cultural group. Although maternal depression trajectories did not predict child cognitive development with the total sample, future research can explore trajectories in each location and relationships with other variables. Additionally, further investigation of

how the home environment impacts child cognitive development in the five different locations can be informative for providing services to children and their families.

DEDICATIONS

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CHAPTER 1

INTRODUCTION

Depression is a debilitating condition associated with impairments in mood, reduced energy, negative thinking patterns, and disturbances in diet and sleep (APA, 2013). The World Health Organization (2017) identifies depression as one of the most significant sources of global disability. Due to a combination of interacting factors, women are twice as likely as men to experience depression at some point in their lifetime (Gutierrez-Lobos et al., 2002; Noble, 2005).

Depression & Gender

Different developmental points characterized by hormonal shifts, such as puberty and menopause, have been associated with depression for women (Albert, 2015). One key point for these hormonal shifts is pregnancy and the postpartum period, together known as the perinatal period (Schiller et al., 2015). A woman's risk for developing depression increases during the perinatal period, (Bennett et al., 2004; Deave et al., 2008). Women may experience perinatal depression as their only episode of depression or as the first of many episodes across their lifetime (Goodman, 2008). The prevalence of perinatal depression is estimated to be about 10 to 12% in Western nations (Cooper & Murray, 1998) but has been reported to be as high as 20% (Cooper & Murray, 1998; Leigh & Milgrom, 2008).

Based in conventional gender-roles, society places a significant burden on women to fulfill their obligations as wives and mothers, providing stability within families (Kessler, 2006). Women often experience chronic stress that is directly related to their gender (Nolen-Hoeksema, 2002). Compared to men, women are more likely to experience sexual assault, lower wages and more frequent sexual harassment at work, the

burden of caring for vulnerable family members, and the responsibility of domestic work (Nolen-Hoeksema, 2002). There are biological markers that may increase the risk for women developing depression (e.g. reproductive hormones; Schiller et al., 2015). However, the over-focus on hormones as the primary indicator of mental instability has been stigmatizing and harmful to women (Gannon, 1998). Many of the environmental factors that lead to or exacerbate depression are linked to gender, class, and racial power differentials (Gannon, 1998; Nolen-Hoeksema, 2002). The combination of social vulnerabilities and biological components leads women to be at a greater risk for developing depression (Noble, 2005; Nolen-Hoeksema, 2002). This is not to say that men do not experience depression, however the present study highlights the specific burden placed on women.

Depression is impactful and can create an insidious level of burden on individuals and their families (WHO, 2017). Because women are integral members of society, particularly within the family unit (Nolen-Hoeksema, 2002), care and consideration should be taken to understand their experiences, respect their humanity, and identify the most appropriate treatment. Although women have highly important roles within society, their experiences with mental illness are often reduced to innate feminine instability rather than challenges partially based in sociopolitical inequity (Gannon, 1998). Ultimately, researchers, psychologists, and other health professionals need to prioritize women's health, including mental health.

Intersectional Feminist Perspective

Intersectional feminism addresses fixed biological and social factors that shape a person's identity and impacts their experiences (McCall, 2005; Shields, 2008). Biological

explanations of depression often do not account for the impact of sociocultural factors and intersecting identities (Banks & Kohn-Wood, 2002). Postpartum depression is often a stigmatized condition within the traditional medical framework (Mauthner, 1993). Rather than pathologizing postpartum depression within a medical paradigm, psychologists and medical professionals can examine PPD with a holistic approach that considers a mother's mental health within the social context (Evagorou et al., 2016; Mauthner, 1993). Often women are considered at fault for being depressed, even if the source of their depression is considered mostly hormonal (Dalton, 1989; Mauthner 1993). Mauthner (1993) interviewed women regarding their needs in reducing stress and postpartum depression. The women in the study reported that social norms for women to recover from pregnancy and childbirth, to return to work, and to juggle multiple roles with minimal support make the transition to motherhood especially stressful (Mauthner 1993). Often, mothers with postpartum depression are offered medications to cope with mood or anxiety symptoms when they would prefer emotional and tangible support (Mauthner 1993). Some cultures prioritize rest and providing support during the transition to motherhood, potentially mitigating some of the stress that exacerbates or causes symptoms of postpartum depression (Dankner et al., 2000). Thus, considering cultural factors creates a clearer understanding of a mother's depression experience.

Accounting for multiple dimensions of identity is a means of more respectfully engaging in conversations about depression and postpartum depression in particular (Mauthner, 1993). The interactions of race, gender, and class change a person's experience with depression (Banks & Kohn-Wood, 2002; Hudson et al., 2013). For example, in the United States, women who are low income and in marginalized ethnic

groups are more likely to have increased difficulty in gaining support and treatment for a mental health condition (Goodman et al., 2009). White women are more likely than other women to seek treatment for depression (Nadeem et al., 2007). People of most ethnic groups experience mental illness stigma, but one study found that stigma was the primary barrier to treatment for white American (Nadeem et al., 2007). For Black, Latina, and immigrant women, logistical barriers to treatment such as not being able to find childcare, lack of insurance or finances, or inability to take off work are more impactful than stigma alone (Nadeem et al., 2007). These experiences were reported by women from the United States and their experiences may not reflect women from other nations.

Depression Across Cultures

Most research on maternal depression incorporates Western methods of identifying symptoms, (Halbreich & Karkun, 2006) contributing to under-identification of depression in non-Western nations (Evagorou et al., 2015; Ghubash & Abou-Saleh, 1997). Cultural norms and attitudes regarding depression may impact the presentation of symptoms and the ability to identify symptoms (Halbreich & Karkun, 2006). Many countries in Asia and Africa are considered ethnokinship cultures where the mother's health is the main priority during the postpartum period (Posmontier & Horowitz, 2004). In Western nations, the culture is considered technocentric and the baby's needs take priority and the mother is less of a focus (Posmontier & Horowitz, 2004). Japanese culture is often considered a mixture of both ethnokinship and technocentric perspectives (Evagorou et al., 2016). In Japan, mothers are provided practical support, but not as much emotional support; demonstrating weakness and emotionality are discouraged and may lead mothers to suppress their emotions and present more somatic symptoms (Hau &

Levy, 2003; Kumar, 1994). These cultural differences can impact both the mother's experience with depression and the reported prevalence of depression in certain countries (Halbreich & Karkun, 2006). Similar to mothers in Asian countries, many mothers in African countries display depression through somatic and physical symptoms due to the cultural stigma around women being emotionally unstable (Bashiri & Spielvogel, 1999). Mothers in African countries often have the protective factor of family support during the postpartum period, but the increased risk of morbidity due to pregnancy and childbirth complications (Sawyer et al., 2010). Using a multicultural, intersectional perspective to examine maternal depression requires accounting for sociocultural factors specific to different groups and moving beyond a strictly Western perspective of depression.

Maternal Depression is considered a global concern (WHO, 2017), yet research is typically focused on higher income populations (Patel et al., 2003). People in low and middle income countries (LMICs) are often not represented by the maternal depression literature, which does not account for culturally relevant risk factors and a potential lack of medical resources (Garman et al., 2019). A study by Fisher and colleagues (2012) indicated that maternal depression is often overlooked in LMICs due to the prevalent concern of infant and mother mortality. It is important to have more research on maternal depression in these places and utilize measures that demonstrate validity across cultures (Pendergast et al., 2014). Further research on maternal depression, particularly in non-Western countries, is necessary to improve depression screening, prevent severe and chronic symptoms, and ultimately support mothers and their children (Goodman, 2008).

MAL-ED Study

The Etiology, Risk Factors, and Interactions of Enteric and Malnutrition and the Consequences for Child Health and Development (MAL-ED) Study uses a multinational, longitudinal design to address multiple factors in maternal health and child development (Miller et al, 2014). This large study involves eight international sites: Dhaka, Bangladesh (BGD); Fortaleza, Brazil (BRF); Vellore, India; (INV), Bhaktapur, Nepal (NEB); Loreto, Peru (PEL); Naushahro Feroze, Pakistan (PKN); Venda, South Africa (Dzimauli Community, SAV); and Haydom, Tanzania (TZH). Previous studies within the MAL-ED project have identified a significant negative impact of poor nutrition and infection on child growth (Acosta et al., 2017; Amour et al., 2016) and cognitive development (Murray-Kolb et al., 2018). MAL-ED studies have also demonstrated cross-cultural validity of a number of measures (Jones et al., 2017; Pendergast et al., 2014; Pendergast et al., 2018). The present study will examine the relationship between trajectories of maternal depression, child cognitive development, and the home environment with five of the international sites (BGD, INV, PEL, PKN, and SAV).

Summary

International and culturally diverse studies are needed to build a better understanding of depression symptoms across cultures, to inform treatment, and address barriers to mental health. New mothers are particularly susceptible to developing depression which can impact their well-being and their child's development (Cooper & Murray, 1998). Research on maternal depression often focuses on mothers from high income nations; it is important to include LMICs and culturally valid assessment tools in research to improve outcomes for mothers and children. Prioritizing maternal mental

health is one method of supporting women, particularly as they embark on a stressful and life-altering experience. Examining maternal depression through an intersectional feminist lens is both grounded in theory (McCall, 2005) and a means of respectfully addressing a significant challenge for mothers. Longitudinal analysis of maternal depression trajectories with women and children from diverse international locations is an appropriate method to incorporate intersectionality into maternal depression research.

CHAPTER 2

LITERATURE REVIEW

Maternal Depression

Major depression is a psychiatric disorder leading to symptoms such as consistently depressed mood, feelings of hopelessness, difficulty with thinking and concentrating, low energy, and diminished interest and ability to carry out daily activities (APA, 2013). Compared to men, women are two times as likely to develop depression (Brummelte & Galea, 2016; Gutierrez-Lobos et al., 2003). Women are also more likely to have more severe presentation of symptoms and simultaneously experience anxiety (Brummelte & Galea, 2016; Kornstein et al., 2002; Sloan & Kornstein, 2003). During the reproductive years, the sex difference in prevalence becomes even more pronounced (Brummelte & Galea, 2016). Maternal depression is a broad term that includes any time during motherhood; because pregnancy, childbirth, and early motherhood are sensitive times for both the mother and the child, a majority of maternal depression research focuses on these time periods. Hereinafter, maternal depression refers to any time in which a mother experiences depression.

Types of Maternal Depression

Postpartum depression (PPD), sometimes referred to as postnatal depression, is a global concern (WHO, 2017). The onset is typically within the first four weeks and symptoms endure at least to three months postpartum, although depression that endures through the first twelve months is often considered PPD (Slomian et al., 2019; Stewart & Vigod, 2016). Identifying PDD can be difficult, as many symptoms of depression can be experienced as a typical of becoming a new mother (i.e. changes in sleep patterns, energy levels, and appetite (Stewart & Vigod, 2016). Antenatal depression refers to

experiencing depression symptoms during the pregnancy (Brummelte & Galea, 2016). Perinatal depression is any depressive episode that occurs during pregnancy through the first year postpartum (Goodman, 2009). Some mothers experience the “postpartum blues” which typically occurs within the first week following birth, while PPD is considered to begin four to six weeks postpartum (Halbreich & Karkun, 2006; Stewart & Vigod, 2016). When a mother experiences postpartum blues, she might feel irritable, restless, and confused; these feelings typically subside on their own within two weeks (Halbreich & Karkun, 2006). PPD symptoms are similar to major depressive disorder, including persistent sadness, disturbances in sleep, forgetfulness, and anxiety (APA, 2013; Patel et al., 2002; Stuchbery et al., 1998). In addition to typical depression symptoms, a mother with PPD might be overwhelmed with their maternal role, concerned about her parental efficacy, and obsessive over the child’s development (Leahy-Warren et al., 2011; Stewart & Vigod, 2016). In some cases, mothers experience suicidal ideation and concern about causing harm to their children (Stewart & Vigod, 2016). With role transition, new mothers might feel a loss of identity as well as a loss of control over their new challenging circumstances (Beck, 1992; Nicolson, 1990; Scrandis, 2005). Antenatal depression and postpartum depression differ from other forms of depression due to the specific co-occurring biological and environmental experiences such as role transition into motherhood and perinatal hormonal shifts (Slomian et al., 2019).

Prevalence of Maternal Depression

Some estimates indicate that more than 17% of mothers with young children experience symptoms of depression (Lyons-Ruth et al., 2002; McLennan et al., 2001). The prevalence of postpartum depression is estimated to be between 6.5 and 12.9% in

developed nations (Stewart & Vigod, 2016). The global prevalence of PPD is widely considered to be 10% to 15% (Darcy et al., 2011; Halbreich & Karkun, 2006), but prevalence can range from 0% to 60% (Halbreich & Karkun, 2006). The prevalence may differ depending on access to resources (Stewart & Vigod, 2016), stigma (Goodman, 2009) or the diagnostic criteria and demographic differences (Brummelte & Galea, 2016; Darcy et al., 2011). In one study of young Black mothers from low income families in the United States, nearly half of the mothers experienced depression in the first two years of motherhood (Ramos-Marcuse et al., 2010). Although the sample was small ($n = 177$) and included only participants from the United States, the results provide insight into the experiences of marginalized communities (Ramos-Marcuse et al., 2010). Because perinatal care typically concludes after six weeks postpartum, identifying the onset of PPD is often difficult (Darcy et al., 2011). Consistency of perinatal care and identification of depression symptoms varies based on sociodemographic factors (Darcy et al., 2011; Halbreich & Karkun, 2006). Further research in marginalized communities will help to better understand the prevalence of depression for mothers with socio-demographic risk factors.

Etiology and Risk Factors for Developing Maternal Depression

Reproductive Hormones. Researchers have studied various theories regarding the onset of maternal depression. One area of focus in the etiology of maternal depression is hormonal shifts. Researchers believe antenatal depression has hormonal impacts on the mother and the fetus, changing the inherent biological development of the baby (Brummelte & Galea, 2016; Noble, 2005). Reproductive hormones including estradiol, progesterone, and corticosterone typically increase in the third trimester and drastically

drop right after childbirth (Brummelte & Galea, 2016). Fluctuations in estradiol levels have been identified as potentially responsible for lower serotonin, which is implicated in depressed mood (Brummelte & Galea, 2016). Reproductive hormones are implicated in basic brain functions such as emotional regulation, motivation, and other cognitive processes, regardless of sex or gender (Schiller et al., 2015). Further, reproductive hormones are involved in the neural pathways that contribute to depression; some women may develop PPD in part due to a particular sensitivity to the shifts in reproductive hormones during the perinatal period (McKinnon et al., 2009; Schiller et al., 2015). Specifically, the rapid changes in estradiol and progesterone levels during birth and immediately postpartum may trigger the onset of PPD for some women (O'Hara et al., 1991; Schiller et al., 2015). Although withdrawal of estradiol levels has been suspected to lead to PPD, this natural shift in hormones typically occurs during pregnancy and cannot adequately explain why some women develop PPD and others do not (Schiller et al., 2015).

Bloch and colleagues (2000) studied the impact of reproductive hormones on depression, removing the influence of pregnancy and childbirth. Women were given high doses of reproductive hormones while not pregnant and in a stable, non-depressed mood. When women with a history of PPD received a high dose of estradiol and progesterone, they developed depression symptoms. Their symptoms were aggravated by hormone withdrawal. Women without a history of PPD were relatively unaffected by the changes in hormone level (Bloch et al., 2000). These results indicate that, for some women, reproductive hormone shifts that take place during the perinatal period may lead to depression, regardless of sociocultural or environmental factors. Historically, there has

been a belief that women are biologically prone to mental illness and instability due to the role of hormones (Nolen-Hoeksema, 2002). However, the perception of mental illness as a strictly hormonal infliction has perpetuated a patriarchal view of women as inferior (Gannon, 1998).

Sociodemographic Factors. Research has also identified stressful life events as risk factors for developing maternal depression (Cooper & Murray, 1998). Stressors exacerbate depression and create a cyclical effect (Cicchetti et al., 1998; Cummings & Davies, 1994). For example, depressed mothers might become more isolated and struggle to reach out to family for support. The lack of family support may be a source of depression, as well (Cummings & Davies, 1994). Another possibility is that both parental depression and challenges in child development are caused by environmental factors, such as stressful events or family discord, or an interaction with genetic factors (Downey & Coyne, 1990). Rutter and Quinton (1984) noted that although the genetic component of depression can be implicated in a mother and child developing symptoms of depression, environmental factors are also implicated in challenges in child development overall. Considering the family system and environmental stressors may provide a more complete explanation of maternal depression. Additionally, clinical levels of depression are more correlated with heritability, while more mild symptoms have a higher, positive correlation with environmental factors (Goodman & Gotlib, 1999).

Billings and Moos (1993) compared mothers with similar socioeconomic demographics and found that depressed parents reported more life stressors than their own spouses and non-depressed parents. However, regardless of depression, risk factors had a positive correlation with child developmental challenges. Life stressors (negative

events, arguments, illness, work stress) provided an equivalent prediction of a child's functioning as the chronicity of depression, but marital support was an even stronger prediction.

There is evidence to suggest that multiple biological and environmental factors coalesce to influence the onset of PPD (Billings & Moos, 1993; Cummings & Davies, 1994; McGrath et al., 2008; Brummelte & Galea, 2016; Schiller et al., 2015). Mothers are also at a greater risk for developing PPD if they have a history of mood or anxiety disorders prior to or during pregnancy, especially if those disorders have gone untreated (O'Hara, 2009; Stewart & Vigod, 2016). Sensitivity to reproductive hormone fluctuations may be a significant contributor in developing PPD (Bloch et al., 2000, Schiller et al., 2015). Considering all relevant factors to a mother's experience is essential for a more comprehensive and respectful understanding of PPD and maternal depression.

Depression Symptoms Impact on Mothers

Maternal depression is associated with other physical health problems such as fatigue, digestion issues, head and body aches, and vaginal pain (Webb et al., 2008). Having symptoms of depression can impact parental functioning which may lead to poorer child outcomes (Cooper & Murray, 1998). For example, depressive symptoms such as social withdrawal, low-energy, sleep and appetite disturbance, and feelings of hopelessness can impact a mother's ability to care for themselves and their children. When a mother experiences depression, her symptoms can directly impact her parenting behaviors and interactions with her children (McGrath et al., 2008; Brummelte & Galea, 2016). Depression can disrupt a mother's ability to engage in typical parenting behaviors such as play and reading (McLearn et al., 2006; Paulson et al., 2006). Addressing

maternal mental health is one component of supporting a mother's overall health and her ability to effectively parent.

Maternal depression is often studied and is now considered a prominent risk factor for negative child outcomes, particularly psychopathology (Cooper & Murray, 1998; Reuben & Shaw, 2015). PPD specifically occurs during a sensitive time in motherhood and can impact the mother's functioning and her relationship with her infant (Beck, 1995). An infant's environment is predominantly comprised of interactions with their mother, thus mother-infant interactions in the early months are particularly important for child development (Murray, 1992). While PPD is considered a specific type of maternal depression, the occurrence of depression at any point of motherhood can impact the mother and her child (Downey & Coyne, 1990).

Cognitions and Behaviors. Cummings and Davies (1994) detailed the behavioral and emotional patterns of depression and how those patterns can manifest in parenting behaviors. Persistent negativity and reduced energy may lead a parent to struggle providing emotional support, increase intrusive and critical behaviors, and have reduced responsiveness to their child's cues. Depressed parents can exhibit hostility and rejection towards their children. Negative social cognitions, lower self-esteem, and unrealistic expectations can also alter interactions with children (Cummings & Davies, 1994). Depressed mothers tend to make more negative appraisals of their children compared to non-depressed mothers, likely due to reduced tolerance for negative behaviors (Schaughency & Lahey, 1985). Low self-esteem and perceived lack of control are strongly associated with parenting impairments. Depressed mothers often perceive themselves as less competent than other mothers, leading to unassertiveness and

withdrawal when faced with behavioral difficulties in their children (Schaughency & Lahey, 1985). Research suggests the symptoms of maternal depression can alter a mother's perspective of her infant's behaviors; a study by McGrath and colleagues (2008) found that depressed mothers provided lower ratings of their infant's temperament at three months and six months. An altered perspective of infant behavior is often accompanied by a negative perspective of maternal competence, thus creating parenting impairments (McGrath et al., 2008). Although research suggests that mothers have an altered perspective of their infant's behavior (e.g. McGrath et al., 2008; Schaughency & Lahey, 1985), it is possible that an infant's difficult temperament is genuinely occurring due to biological or environmental factors. For example, Davis and colleagues (2004) found that professional observation indicated a relationship between antenatal depression and infants presenting a fearful temperament. These results indicate potential difference in infant temperament based on fetal exposure to depression, as well as differences in child behavior based on the time of onset of the mother's depression. Regardless of whether the mother is able to accurately perceive her child's temperament, depression can impact a mother's confidence in caring for her child (Cummings & Davies, 1994; McGrath et al., 2008).

Self-efficacy is a bidirectional concept; beliefs about one's ability influence their behavior and performance influences beliefs about oneself (Bandura, 1982, 1989). However, several researchers have identified a negative relationship between self-efficacy and maternal depression (Cutrona & Troutman, 1986; Kohlhoff & Barnett, 2013; Leahy-Warren et al., 2012; Teti & Gelfand, 1991). A study by Leahy-Warren and colleagues (2012) of first-time mothers also identified a strong negative correlation

between self-efficacy and postpartum depression; when mothers experienced depression, they reported lower rates of self-efficacy in parenting. This study was conducted in the Republic of Ireland and all mothers were White, English-language speakers. At six weeks postpartum, the mothers reported their parental self-efficacy. Functional and informal support was also reported. The findings indicated a strong inverse relationship between social support and postpartum depression. Maternal self-efficacy was positively correlated with social support. These results reflect the importance of social support in motherhood and the potential interaction of support and self-efficacy in mitigating the negative impacts of depression, particularly for new mothers. Because this study focused on specifically White and European mothers, further research is needed to address cultural differences (Leahy-Warren et al., 2012).

Mother-Infant Interactions

As depression impacts a mother's behaviors and cognitive processing, research has focused on how maternal depression can impact mother-infant interactions, the ability to provide care, and building attachment. Researchers hypothesize that maternal depression leads to challenges in a mother's ability to provide care for and build appropriate attachment with her infant, thus creating risk factors for the child's development (McGrath et al., 2008; Teti & Gelfand, 1991).

Some symptoms of depression such as irritability, hostility, and excessive concern for the child may lead to disruptions in interactions with the child (Campbell et al., 1995). Thus, mothers with depression may struggle to appropriately respond to the infant's behavioral cues. This reduced sensitivity to the infant is believed to interrupt secure mother-infant attachments (Cummings & Cicchetti, 1990). Further, research suggests that

even when mothers recover from depression, they continue to demonstrate challenges in communicating and interacting with their children (Murray, 1992). A study by Campbell and colleagues (1995) measured mother-infant interaction through observation, hypothesizing that depressed mothers experienced impairments in their interactions with their infants. The researchers specifically included first-time mothers who were relatively low-risk in order to more clearly isolate the impact of depression. All of the participants were married and middle-class living in the United States. In this study, maternal depression was identified as a significant factor related to noted poor attachment. These results suggest that in a low-risk population, maternal depression was associated with negative mother-infant interactions (Campbell et al., 1995). Although Campbell and colleagues' findings provide support for the impact of maternal depression on parenting, it may not generalize to high-risk groups or cultures outside of the United States.

Trajectories of Maternal Depression

Depression can range in degree of severity impacting an individual's experiences; severity of depression symptoms has been associated with a decrease in functioning, thus having a greater impact on parenting behaviors than milder depression (Brennan et al, 2000). Trajectories of maternal depression are studied in part to detect differences in how a mother's depression impacts her child's outcomes (Brennan et al., 2000; Hammen & Brennan, 2003). Chronic depression in mothers has been associated with insecure attachment, lower verbal comprehension, impaired cognitive functioning, and severe behavior problems in early childhood (Goodman et al., 2011; Prenoveau et al., 2017; Teti et al., 1995). Brennan and colleagues (2000) note that chronicity and severity of

depression are often difficult to distinguish because more severe symptoms are often more persistent.

Adding a third dimension, time of onset, helps to create distinct classifications that can be associated with a pattern of outcomes for the mother and child (Hammen & Brennan, 2003). A study by Murray (1992) hypothesized that when depression is specifically related to the pregnancy, childbirth, and the infant-mother dyad (i.e. postpartum depression as opposed to depressive symptoms prior to motherhood that may persist over time), there may be more negative impact on the child's global development. As indicated previously, infant attachment may be impacted by maternal depression (Cicchetti et al., 1998; Teti et al., 1995). Researchers hypothesized that maternal depression that has an onset during the first two years of life may be more impactful for the child's development due to the crucial role of attachment (Campbell et al., 1995; Teti et al., 1995). Infancy, toddlerhood, and early childhood are formative and sensitive times of child development; maternal depression during this time presents a significant risk (Goodman & Gotlib, 1999).

Although some of the seminal research on the topic indicates that more severe maternal depression is associated with greater impairments for the mother's functioning and risk for the child (Teti et al., 1995; Brennan et al., 2000), Connors-Burrow and colleagues (2016) found that low level symptoms of maternal depression during the first two years can also predict behavioral problems in children. Compared to children with non-depressed mothers, children with mothers who had low-level depression symptoms were twice as likely to have clinically elevated behavioral symptoms at 14 months. These children also had an increased chance of developing both internalizing and externalizing

behavior problems at age 11. This study indicated that the timing of depression symptoms was a significant risk factor for later behavior problems. However, this study did not address potential differences in child outcomes based on perinatal exposure to depression, fluctuations in severity, or recurring depressive episodes. For example, consistent low levels of depression may have different effects on a mother and child than severe symptoms that occur during the postpartum period but diminish over time (Brennan et al., 2000). Trajectories of maternal depression may have a different effect on child outcomes when accounting for personal characteristics and socio-cultural factors (Cicchetti et al., 1998).

Person-Centered Approaches

The specific trajectories of depression vary depending on the study design and participant characteristics. Many studies of maternal depression focused on severity of symptoms and are considered variable-centered. Variable-centered analyses tend to focus on those with or without clinical symptoms, whereas person-centered studies examine potential patterns that may explain symptoms or common experiences, often considering socio-cultural factors (Laursen & Hoff, 2006). Person-centered approaches to maternal depression identify the level of severity (low, moderate, and high) and how chronic or consistent the symptoms are (stable, intermittent, increasing) while accounting for characteristics that could predict patterns. The following studies used person-centered approaches to analyze trajectories of maternal depression.

Campbell and colleagues (2007) used person-centered approaches to identify six trajectories of maternal depression: low-stable, intermittent, moderate-stable, moderate-increasing, high-decreasing, and chronic/high-stable. These groups were identified in

order to examine the relationship between maternal depression, other maternal or family characteristics and child cognitive and social outcomes through infancy and into early childhood. The study's longitudinal design allowed the researchers to assess maternal depression symptoms periodically up to 54 months. Nearly half of the mothers (45.6%, $n = 577$) demonstrated consistent and low-level symptoms of depression, placing them in the "low-stable" category. It was less common for mothers to demonstrate more severe depression symptoms. The analysis indicated that trajectory group did not have a significant main effect on maternal sensitivity, one behavior that may be impacted by depression and thus affect parenting and child outcomes. However, accounting for trajectory improved analysis of the relationship between maternal depression and maternal sensitivity. The researchers collected behavioral ratings of the children at 54 months when they were in the first grade. Based on parent rating, children of mothers with moderate and high levels of depression had greater difficulty with internalizing and externalizing behavioral problems than children of mothers classified as low-stable. This trend continued: the higher the level of depression symptoms, the greater likelihood that the child was rated as demonstrating internalizing and externalizing behaviors. Teacher ratings of school adjustment also indicated that children had greater difficulties when mothers were more severely depressed over time. Trajectory group was also considered a significant factor in impairing cognitive performance and observed classroom competence; children of mothers in the moderate-increasing trajectory group were rated as having more behavioral and social difficulties by their teachers. Although there is a common belief that depressed mothers may provide inaccurate ratings of their children, Richters (1992) found inter-rater reliability between depressed mother and other raters in

83% of studies. The use of teacher report provides additional reliability to support the parent report of behavior (Campbell et al., 2007).

A significant finding from this study (Campbell et al, 2007) was that sociodemographic risk factors were highly correlated with different trajectory classifications. Women in the low-stable group were more educated, financially stable, and often in a stable marriage or partnership. Women with higher and more persistent levels of depression often had less support, stability, and resources (Campbell et al., 2007). Research indicates mothers with more demographic risk factors might have more intense depressive symptoms (Billings & Moos, 1983; Cicchetti et al., 1998). Further research that focuses on the relationship between trajectories and patterns of sociodemographic risks would be beneficial to predicting outcomes for children. Culture and location impacts the type of risk factors or environmental stressors might impact a family. A majority of studies on maternal depression trajectories take place in European or North American countries and therefore do not account for the full breadth of sociodemographic risks and cultural factors families in non-Western nations are likely to experience.

Park and colleagues (2018) studied child behavior at three and six years old based on the trajectory of maternal depression symptoms. They measured depression symptoms from the second trimester to ten months, three years, and at six years, identifying three trajectories: increasing, decreasing, and low. Mothers with a decreasing trajectory ($n = 15$) had high levels of symptoms during pregnancy but decreased over time. Mothers with an increasing trajectory ($n = 27$) had more moderate symptoms during pregnancy and symptoms steadily increased over time. Mothers in the low group ($n = 105$)

experienced consistent low levels of depression. At age three, children of mothers in the increasing group demonstrated more challenging behaviors than children in the other trajectory groups. At age six, trajectories did not significantly predict differences in child behavior, but mothers with low and increasing symptoms reported higher levels of ADHD-related symptoms in their children than the decreasing group. Some of the limitations of this study by Park and colleagues (2018) can be addressed by future research. Maternal depression was not measured between ten months and three years or between three years and six years; assessing depression during this time might have revealed variations in symptom presentation and allowed for more accurate predictions. Additionally, mothers were more likely to have low levels of depression leading to smaller sample sizes for the increasing and decreasing trajectory groups (Park et al., 2018). Further research with women from diverse backgrounds would provide more information about possible trajectories and how those different trajectories impact child development.

Hammen and Brennan (2003) assessed the impact of maternal depression symptoms on adolescent mental health, as opposed to early childhood. The duration and the severity of the mother's depressive episode did not predict the presence of adolescent depression; teens that were exposed to severe or moderate maternal depression for up to two months were just as likely to experience depression themselves as teens who were exposed to maternal depression for longer periods of time. There were three key time periods when mothers experienced depression; between birth and two, between three and five years, and between six and ten years. The time period in which a mother experienced depression did not influence the severity of their symptoms or predict adolescent anxiety.

In general, the children of depressed women were more likely to have anxiety and depression as adolescents. Researchers agree that children of depressed parents are more likely to also experience depression (Cicchetti et al., 1998; Cummings & Davies, 1994; Downey & Coyne, 1990). However, Hammen and Brennan (2003) remark that their results involve a specific birth cohort in Queensland, Australia and may not reflect the experiences of families in low and middle income areas.

Guyon-Harris and colleagues (2015) conducted a study of first-time mothers using a person-centered approach to incorporate individual differences in patterns of depression. The study was longitudinal, measuring depression four time points from pregnancy to two years postpartum. They predicted low level maternal depression would be associated with less severe social emotional difficulties in toddlers compared to higher level, persistent symptoms of maternal depression. For this group of women, depression levels were highest during pregnancy and decreased over time. They identified four trajectories: stable-moderate ($n = 26$), low-decreasing ($n = 57$), stable-low ($n = 27$), and increasing ($n = 10$).

Guyon-Harris and colleagues (2015) did not identify a group that started with high levels of depression that decreased over time; mothers that started with high levels of depression maintained this level of symptoms for the duration of the study. Women in the increasing group had lower levels of education than the women with stable and low depression levels. Toddler emotions and behaviors were assessed at the fourth time point; both parent report and observations of unstructured play were utilized to increase reliability. Women in the increasing group reported more internalizing and externalizing behaviors in their toddlers compared to the other trajectory groups. Because the multiple

imputation method was utilized for this analysis, standard deviations were not reported. The researchers found that trajectories were related to perceptions of toddler emotions, but not direct observation of toddlers. In this study, mothers were recruited from low-income areas, reflecting families with less education and less access to resources than most studies of maternal depression. However, the researchers had a small sample and reported that delays in assessment might have interfered with accurately identifying fluctuations in depression symptoms. Additionally, observation of toddler behavior was a singular assessment for a brief ten minute period, which may have decreased accuracy of that measure (Guyon-Harris et al., 2015).

Kingston and colleagues (2018) conducted a study of Canadian mothers and their children. Maternal depression was measured across time, from pregnancy to three years postpartum. Through latent class modeling, symptoms were categorized into four classes: minimal ($n = 1238$), early postpartum ($n = 216$), subclinical ($n = 372$), and high ($n = 112$). Multivariable models were used to demonstrate relationships between trajectories and child behavior at age three. Early postpartum, subclinical, and high maternal depression trajectories were associated with hyperactivity and inattention for their child at age three. Only the subclinical trajectory for mothers was associated with a risk of physical aggression at age three. Early postpartum, subclinical, and high levels of maternal depression were associated with internalizing behaviors (emotional disorder and anxiety) in children at age three. Overall, more severe maternal depression was associated with a greater likelihood that a child will experience behavioral challenges. Being a first-time mother was associated with risk for hyperactivity, inattention, and emotional symptoms in children, while lower relationship satisfaction was associated specifically

with separation anxiety in children. This study included English-speaking, Canadian mothers who were married, had post-secondary education, and financial stability (Kingston et al., 2018).

A Finnish study by Vanska and colleagues (2011) identified five distinct groups from pregnancy to the first year postpartum: stable low, prenatal, early postpartum, late postpartum, and heterogeneous high. The purpose of this study was to address the potential difference in outcomes if a mother experienced antenatal depression. This study was unique for grouping mothers based on their infertility history; 417 mothers had successful infertility treatment and 388 mothers became pregnant without infertility treatment. While Campbell and colleagues (2007) determined that chronicity was a more significant predictor of child mental health than timing, Vanska and colleagues (2011) focused specifically on the timing of onset. There were no significant differences in level of depression symptoms between women who have a history of infertility and women who did not. A majority of the mothers in this study were classified as having low-level depression symptoms ($n = 609$). The researchers found that accounting for trajectory was a significant predictor of a child's internalizing behaviors but not externalizing behaviors. Specifically, the early postpartum and heterogeneous high groups were associated with higher levels of internalizing difficulties in children. The heterogeneous high group was also associated with executive dysfunction and memory problems in children. These results indicate that experiencing depression during the early stages of motherhood is particularly impactful for the infant's development. A small proportion of the mothers (5.8%) had antenatal depression, but not postpartum depression. Children in this category experienced more favorable outcomes compared to children whose mothers had

postpartum depression. These results are supported by previous research; the postpartum period is an important time for mother-infant interactions and setting a foundation for future development (Beck 1995; Campbell et al., 1995). However, this trajectory group was small ($n = 47$) and the results should be interpreted with caution. This study utilized a brief version of the Beck Depression Inventory to monitor symptoms in Finnish mothers, thus further research in different places with cultural considerations would strengthen the findings.

History of Depressive Episodes

Although a significant amount of research focuses on pregnancy and postpartum periods, maternal depression trajectories can also include episodes of depression prior to pregnancy and motherhood. Acknowledging a history of depression other psychiatric concerns is typical aspect of prenatal care in Western nations; if women are seeking treatment for depression, trying to conceive or becoming pregnant may impact the course of treatment or their ability to take certain medications (Dietz et al., 2007). Cooper and Murray (1995) compared mothers who had a previous experience with depression to mothers for whom PPD was their first episode of depression. When PPD was the first onset of depression, the mother experienced a shorter episode than the mothers who have had depression previously. Women with a history of depression were more likely to have another episode of depression unrelated to pregnancy, while women with postpartum onset were more likely to have another episode of specifically postpartum depression. A history of depression may predict more persistent symptoms, but not necessarily more severe symptoms (Cooper & Murray, 1995).

Murray (1992) compared women with and without depression, including a history of depression symptoms. The mothers were grouped into four categories: no history/no depression since delivery ($n = 42$), no history with depression since delivery ($n = 40$), a previous history of major depression with no depression since delivery ($n = 14$), and history of depression and depression since delivery ($n = 21$). When comparing the two postpartum groups, the women who did not have a previous history demonstrated a greater difficulty with concentration but less challenges with fatigue than women with a history. Women who had a history of depression but did not suffer from postpartum depression demonstrated greater levels of anxiety and fear than women with no history or postpartum development of depression. The different categorizations for these women were associated with corresponding trajectories for their child's outcomes. At nine months, infants were given an object concept task. Infants with mothers who had postpartum depression with no history of previous depression performed more poorly than the other groups. At 18 months, cognitive performance was predicted by performance at nine months. There was not a significant difference in performance across trajectories; infants performed statistically the same regardless of whether their mother had depression prior to giving birth. A history of depression may be a significant factor in maternal depression trajectory and predicting child outcomes (Noble, 2005). Cultural norms impact awareness of depression; for example, in some Asian countries, stigma around depression and emotionality may prevent a mother from disclosing her experiences with depression (Hau & Levy, 2003; Kumar, 1994).

Summary of Trajectory Research

In summation, research on the trajectory of maternal depression indicates that determining multiple dimensions of a mother's experience can provide greater insight into a child's outcomes (Brennan et al., 2000). Studies have identified between three and six different trajectories incorporating the symptom severity, duration of symptoms, and time of onset (Campbell et al., 2007; Guyon-Harris et al., 2015; Kingston et al., 2018; Park et al., 2018; Vanska et al., 2011). Research demonstrated that mothers most often experience low levels of depression (Kingston et al., 2018; Guyon-Harris et al., 2015). Trajectory studies are often longitudinal and utilize analytical methods that incorporate multiple variables. Mothers who have lower levels of education, less social support, and more stressful events typically have more severe and persistent depression (Cicchetti et al., 1998; Darcy et al., 2011; Noble, 2005). Timing of onset, including a history of depression prior to the perinatal period, impacts a mother's experience with depression (Cooper, 1992; Cooper & Murray, 1995; Noble, 2005). One study suggests that episodes of PPD might last longer for mothers who have a history of depression, but symptoms may not be more severe (Murray, 1992). However, there is still conflicting results regarding the impact of maternal depression patterns on child development (Park et al., 2018). Some studies have found that chronic and severe depression symptoms, regardless of the time of onset, are most harmful for children (Campbell et al. 2007; Kingston et al., 2011). Other studies have found that onset during infancy and toddlerhood, regardless of its longevity, is the trajectory of maternal depression that most severely impacts child development (Vanska et al., 2011). Research has also shown that maternal depression

symptoms that increase in severity over time can present challenges for child development (Guyon-Harris et al., 2015; Park et al., 2018).

Many of the studies described above (i.e. Campbell et al., 2007; Guyon-Harris et al., 2015; Vanska et al., 2011) are considered to have person-centered approach, identifying individual or demographic factors that may influence depression patterns rather than identifying broad, global trends. Accounting for demographic characteristics and contextual risk in addition to trajectory provides a more accurate and comprehensive understanding of the mother's experience and the impact on the child. However, a majority of depression trajectory studies are centered on mothers from Western, high income nations. A history of depression and antenatal depression are indicators of postpartum depression and future episodes (Cooper & Murray, 1995; Murray, 1992, Noble, 2005). However, in low and middle income countries (LMICs), medical professionals often do not have specialized training in identifying symptoms of mental illness (Gelaye et al., 2016). In general, identification of depression symptoms varies by culture (Halbreich & Karkun, 2006; Hau & Levy, 2003; Kumar, 1994). Examining possible trajectories of maternal depression in LMICs can provide more insight into how to support mothers within a multicultural framework. Trajectory studies also primarily focus on social-emotional and behavioral development and less frequently include cognitive development. Maternal depression is often a controversial topic, highlighting numerous pathways that a mother's mental health impacts her child's well-being. It remains important to understand the impact of maternal depression on children, while maintaining the humanity and dignity of mothers, prioritizing support, and considering the various sociocultural systems involved in mental illness.

Impact of Maternal Depression on Child Development

As discussed previously, maternal depression can lead to challenges with parent-child interactions and attachment (Campbell et al., 1995; Cummings & Cicchetti, 1990). Depressive symptoms such as low self-esteem, self-efficacy, and isolation can impact a mother's ability to provide care for her child (Cutrona & Troutman, 1986; Leahy-Warren et al., 2012; Teti & Gelfand, 1991). Research demonstrates that maternal depression can negatively impact children across their development, beyond the impact of genetics or other risk factors (Goodman & Gotlib, 1999). There are vulnerable points of child development when risk factors can have a significant long-lasting impact. Thus, it is important to consider the possible trajectories of depressive symptoms in the mother, accounting for the age of their children and the onset of the symptoms (Goodman & Gotlib, 1999). Maternal depression does not necessarily cause children to develop psychopathology, but is a risk factor for various outcomes (Cicchetti et al., 1998; Goodman & Gotlib, 1999). This risk is increased when other family risk factors are present, such as financial burden, marital discord, and abuse (Cooper & Murray, 1998; Cummings & Davies, 1994; Downey & Coyne, 1990). When determining the extent to which maternal depression accounts for differences in child development, it is more clarifying and accurate to account for external factors and the different trajectories of depression.

A study by Patel and colleagues (2003) found that, because the first six months are critical for development, it is likely that maternal depression would be particularly impactful for a child at this time (Patel et al., 2003). When considering trajectories, researchers have identified a number of outcomes that are predicted by different

sequences in the onset and duration of the mother's depression. Not only can postpartum depression impact early development, research suggests that it can impact a child's development into adolescence (Hammen & Brennan, 2003; Korhonen et al., 2012). Studying maternal depression has implications for long-term outcomes for children (Downey & Coyne, 1990). Longitudinal studies provide particularly beneficial information regarding patterns of maternal depression and child outcomes, demonstrating an impact on early infant attachment, school performance, and behavioral development across ages (Brennan et al., 2000).

Social-Emotional Development

Research on maternal depression's impact on child development often focuses on the child's behavior, social development, and emotional disorders (Goodman & Gotlib, 1999). Maternal depression can create a strain in mother-child interactions, leading children to develop a pattern of maladaptive coping strategies established in infancy. In depressed families, a child may develop an insecure attachment as a means of coping with parents' behaviors and emotions. These insecure attachments can lead to avoidant or dysregulated behavior across contexts, sometimes manifesting as behavioral disorders. According to Stern (1985), infants of depressed mothers may not get the attention they need when experiencing bodily distress which can lead to over-arousal. This early experience of dysregulation can lead to a pattern of dysregulation and possible internalizing and externalizing disorders such as anxiety, depression, and ADHD. Conners-Burrow and colleagues (2015) found that lower severity symptoms of maternal depression can increase the presence of later behavioral problems in children.

Analyzing trajectories of maternal depression provides insight into the impact on child behavior. A study by Campbell and colleagues (2007) found that, by first grade, children had higher presentation of internalizing and externalizing behaviors when their mothers had high-decreasing, chronic, or moderate-increasing levels of depression. Teachers reported poorer social skills and higher behavioral challenges for first grade children whose mothers had moderate-increasing depression. However, differences in teacher ratings were better explained by demographic differences, which covaried with trajectory group (Campbell et al., 2007).

A longitudinal study of children from birth to nine used latent class growth analysis to compare trajectories of maternal depression to trajectories of child irritability (Wiggins et al., 2014). This study accounted for additional factors such as paternal depression and alcohol use, trauma/exposure to violence, and mother's education level. Irritability is related to other components of a child's behavior and personality, thus providing insight into their social-emotional development. Wiggins and colleagues (2014) found that children who were more severely irritable had exposure to maternal depression. Maternal depression during infancy predicted irritability at age three and maternal depression at age three predicted irritability at age five. However, exposure to maternal depression at age five did not predict irritability at age nine. Paternal depression, maternal drug use, and alcohol use from either parent were also risk factors for severe irritability. Further, irritability had a positive correlation with both internalizing and externalizing behaviors (Wiggins et al., 2014).

Evidence suggests that the time of exposure to maternal depression can change the impact on the child's social-emotional development. A study by Vanska and

colleagues (2011) addressed the variability in child outcomes based on the trajectory of the mother's depression. Children who experienced maternal depression at two months demonstrated greater levels of internalizing symptoms when they approached school-age compared to children who did not experience maternal depression.

As previously indicated, researchers have found that maternal depression might impact adolescent behavior. Korhonen and colleagues (2012) conducted a longitudinal study on mothers and their offspring in Finland from 1989 to 2006. Based on maternal report with the Child Behavioral Checklist, prenatal and postpartum depression did not predict a significant relationship with adolescent psychological functioning. However, adolescents reported more externalizing behaviors on the Youth Self Report when their mothers experienced prenatal depression. Adolescent males also reported lower social competence when their mothers experienced prenatal depression. Additionally, postpartum depression predicted difficulties with externalizing behavior and social competence for both male and female adolescents, as reported by both the mother and the adolescents. When mothers presently experienced depression, they were more likely to rate their teens as having poorer social competence and increased difficulties with internalizing and externalizing behaviors. Youth Self Report scores demonstrated a similar pattern. These results indicate that the timing of maternal depression can predict behavioral challenges for children across their development (Korhonen et al., 2012).

A study from Hay and colleagues (2008) conducted a study of mothers in the United Kingdom and accounted for the likelihood that postpartum depression occurs within the context of a lifetime of depression, including antepartum depression and subsequent episodes of depression. These researchers hypothesized that exposure to

maternal depression in infancy could partially explain adolescent outcomes. Authors considered comorbidity with anxiety, antepartum depression, alcohol/nicotine use, and the child's sex to account for both teratogenic effects and hormonal changes. Many of the women who experienced depression during pregnancy also experienced symptoms of anxiety. When examining the relationship between maternal depression and child behavior, adolescents were more likely to experience emotional disorders (depression or anxiety) when their mothers experienced depression during pregnancy. Depression during pregnancy or during the postpartum period was not a significant predictor of disruptive behaviors in adolescence. However, maternal depression that occurred past three months postpartum was a significant predictor of disruptive behaviors in adolescence. The results indicated that antenatal depression and postpartum depression may predict adolescent psychopathology, but other factors such as drug and alcohol use and subsequent depressive episodes provide further explanation for that relationship (Hay et al., 2008).

Difficulties in social-emotional development may be related to the sensitive time in which a child is exposed to maternal depression (Goodman & Gotlib, 1999). Because the first three years of life are important for myelination and growth of the pre-frontal cortex, toddlerhood is a critical time for developing executive functions (Roman et al., 2016). Early delays in these abilities can lead to increased difficulties over time. Research supports the notion that executive functions can mitigate some of the negative effects of maternal depression on a child's development of behavioral difficulties (Roman et al., 2016). Maternal depression can impact social emotional development in children, but research suggests environmental factors and trajectories are necessary to consider when disentangling the mother-child relationship (Campbell et al., 2007; Cicchetti et al., 1998).

Cognitive Development

Maternal depression is most often considered in relation child emotions and behaviors (Cummings et al., 2000; Goodman & Gotlib, 1999). However, there is literature supporting a relationship between maternal depression and a child's cognitive development (Grace et al., 2003). Cogill and colleagues (1986) conducted a study of mothers in London and their firstborn children. They found that maternal depression in the first year of a child's life is associated with poorer performance on cognitive measures at age four. Marital conflict and the husband's experience with psychiatric challenges were positively correlated with maternal depression, potentially affecting the relationship between the mother's depression and the child's cognitive performance. Although depression in the first year seemed to impact cognitive development, maternal depression at age four did not demonstrate a relationship with cognitive performance. These findings indicate that specifically postpartum depression can be a risk factor for poor performance on cognitive measures (Cogill et al., 1986).

The impact of maternal depression on cognitive development may appear differently depending on the onset of depression and the child's age when exposed to their mother's symptoms (Deave et al., 2008). Deave and colleagues (2008) conducted a study of mothers in England and the impact of depression on their children, assessment at 18 weeks gestation, 32 weeks gestation, eight weeks postpartum, and eight months postpartum. The persistence of maternal depression presented a more significant risk factor for developmental delay compared to short-lived episodes of depression. This risk may be increased if symptoms are more severe and persistent during pregnancy.

Hay and colleagues (2001) reported that, when compared to their same-age peers, children of mothers with PPD demonstrated difficulties with cognitive performance and attention at age 11. The individuals in this study represented an urban population in Britain, including predominantly white and working class mothers. Specifically, male children whose mothers were depressed ($n = 13$) at three months postpartum scored lower on IQ assessments than boys of non-depressed mothers ($n = 49$). Paternal IQ was also an important factor in predicting child IQ at 11, but did not negate the impact of maternal depression. Other sociodemographic factors were also implicated in a child's cognitive performance at age 11; less education of parents, single-parent house, and having a working class background predicted lower IQ while being bilingual predicted higher IQ. When social class was controlled for, maternal depression demonstrated a significant impact on cognitive performance (Hay et al., 2001).

Trajectories of depression have been studied to determine differences in a child's cognitive outcomes. Cornish and colleagues (2005) found that maternal depression that lasts beyond 12 months was associated with poorer cognitive and psychomotor performance in infants at 15 months. Maternal depression was not a significant predictor of language impairments. Results from Vanska and colleagues (2011) suggest that chronic levels of maternal depression are associated with executive functioning difficulties and memory problems in children. These difficulties can impact cognitive functioning and academic success.

Summary of Maternal Depression and Child Development

Previous maternal depression literature has primarily focused on how maternal depression impacts child social-emotional development in European and North American

countries. Researchers have found that maternal depression is associated with insecure attachments (Cicchetti et al., 1998), irritability (Wiggins et al., 2014), poor social skills in school (Campbell et al., 2007), and emotional and behavioral challenges in adolescence (Korhonen et al., 2012; Hay et al., 2008).

Research has also illuminated a relationship between maternal depression and child cognitive development. Postpartum depression has been associated with risk for developmental delay (Deave et al., 2008) and poor performance on cognitive measures in children (Cogill et al., 1986; Hay et al., 2001). Researchers have found that chronic maternal depression may be a significant predictor of challenges with memory, executive functions, and psychomotor development (Cornish et al., 2005; Vanska et al., 2011).

Maternal depression, particularly during the postpartum period, has been associated with a number of child development outcomes (e.g. Downey & Coyne, 1990; Goodman & Gotlib, 1999), including poor cognitive development (e.g. Cogill et al., 1986; Grace et al., 2003). Maternal depression can be influenced by cultural factors as well as interact with different demographic variables (Halbreich & Karkun, 2006). Addressing cultural factors and demographic differences is important for a comprehensive understanding of maternal depression and its relationship with child cognitive development.

Maternal Depression in Low and Middle Income Countries

A majority of the studies that have addressed the relationship between maternal depression and child outcomes have involved White, English speaking participants in higher income countries (Halbreich & Karkun, 2006). Postpartum depression is one risk factor that can negatively impact mothers and children in low and middle income

countries (Gelaye et al., 2016). International and cross-cultural research can provide greater understanding of the prevalence of PPD, possible trajectories, and the impact of PPD on child cognitive development.

Prevalence and Risk Factors for Mothers

A meta-analysis by Gelaye and colleagues (2016) reported that the pooled prevalence of postpartum depression across 23 LMICs was 19.7%. Demographic risk factors for developing PPD included financial distress, hormonal changes, and a history abuse (Gelaye et al., 2016). In Nepal, the lack of access to maternal health care has been cited as a contributing factor to the prevalence of psychiatric conditions and a high maternal mortality rate; suicide is largest cause of death among women of reproductive age (Ho-Yen et al., 2006). One study found that the prevalence of depression symptoms in sample of 426 new mothers across clinical, rural, and urban settings in Nepal was 4.9% (Ho-Yen et al., 2006). All participants in this study were married and 203 women were recruited from a hospital. In Nepal, typically 10% of women who give birth do so in a hospital (Ho-Yen et al., 2010). Use of hospitals and awareness of obstetric health were potential factors in the lower prevalence of postpartum depression in this group of women (Ho-Yen et al., 2006).

Chaaya and colleagues (2002) compared the prevalence of postpartum depression in women in rural Beka's Valley, Lebanon ($n = 235$) to women in the city of Beirut, Lebanon ($n = 303$). There was a significant difference in prevalence: 26% of mothers in Beka's Village had PPD compared to 16% of women in Beirut. Women from Beka's Valley were more likely to experience both prenatal and postpartum depression. Regardless of rural or urban location, lack of social support and depression during

pregnancy predicted postpartum depression. In this particular culture, social support from more than one person predicted a reduced likelihood of having PPD. In general, it is typical in Lebanese culture to have social support regardless of education or other socioeconomic demographics. Type of delivery was another factor that predicted PPD. In Beka's Valley, natural childbirth was expected and preferred and mothers were less likely to request epidurals for pain. Women in Beirut had greater access to health services and reported a preference for caesarean section to avoid the pain of vaginal birth. Ultimately, women in Beirut were more likely to experience depression if they had a vaginal birth while women in Beka's Village were more likely to experience depression if they gave birth via caesarean section. These findings suggest that cultural norms impact the development of depression symptoms (Chaaya et al., 2002). These studies (Chayya et al., 2002; Ho-Yen et al., 2006) demonstrate one difficulty in determining prevalence of postpartum depression in LMICs. Access and quality of perinatal care can impact identification of symptoms and prevalence rates in LMICs (Dankner et al., 2000; Halbreich & Karkun, 2006).

Agoub and colleagues (2005) found that in a sample of Moroccan mothers, between 18.7% and 20.1% of the mothers in the study demonstrated symptoms of depression two weeks postpartum. These findings were consistent with a study of mothers in Dubai (Abou-Saleh & Ghubash, 1997) and in Lebanon (Chaaya et al., 2002). This prevalence is noted as being at the higher end of the prevalence indicated in European and North American studies of postpartum depression (Da Costa, et al. 2000). Additionally, Agoub and colleagues (2005) did not find a difference in prevalence of depression based on socio-economic factors. In a study in India, the rate of postpartum

depression was higher; 23% of mothers reported symptoms of depression at six to eight weeks postpartum (Patel et al., 2002). A Cooper and colleagues (1999) study found that 34.7% SAV mothers had depression, which is much higher than in European and North American countries.

A recent study by Garman, Schneider, and Lund (2019) identified just two trajectories in a South African sample. This study found that amongst women with perinatal depression, some women experienced antenatal depression alone and other women had symptoms that persisted postpartum. The women in the antenatal group had symptoms that decreased steadily and the women who postpartum depression experienced a decline at three months but increasing symptoms at 12 months. Although this study did not identify more specific trajectories, these results indicate that screening for depression during pregnancy may help prevent persistent depression symptoms (Garman et al., 2019).

Impact on Child Development

Studies of maternal depression in low income countries primarily focus on infant growth and breastfeeding (Patel et al., 2003, Nasreen et al., 2012). Although these outcomes are important for development, fewer studies address other domains of child development. Abdollahi, Abhari, and Zarghami (2016) studied the impact of postpartum depression on child development in Iran. This was a longitudinal cohort study where mother's levels of depression were measured at two weeks, 12 weeks postpartum. When the children reached four, mother's depression levels were measured again. The results indicated that postpartum depression was correlated with the presence of developmental disabilities at age four primarily related to gross-motor and personal-social domains.

When mothers currently presented with depressive symptoms, with or without a history of PPD, the four year olds were also more likely to demonstrate delays across fine motor and communication domains. When the researchers accounted for other factors, such as gender and other diseases, PPD alone did not predict the presence of developmental disabilities. One significant limitation of this study was that depression was not monitored throughout the four years. There may be a difference in the child's outcomes if depression was persistent throughout early childhood or only at specific points. The severity of the mother's symptoms and socio-economic factors may also account for differences between children. These results might reflect the importance of addressing the chronicity of depression and providing support to reduce the likelihood of long-term symptoms, which impact both the mother and child (Abdollahi, et al., 2016).

Cultural Factors

Because a majority of research on postpartum depression takes place in Western countries, understanding of depression symptoms and prevalence in non-Western countries is limited (Global Forum for Health Research, 2000). Culture influences expression of depression symptoms as well as societal perception of depression (Evagorou et al., 2015). For example, depression symptoms in Asian women are typically physical, including fatigue, aches, and chills (Evagorou et al., 2015). The health of the baby and continuing the family legacy is also particularly important in Japanese families; one study found that Japanese mothers were relatively more likely to tolerate intense mental and physical distress, prioritizing their baby's health but neglecting their own mental health (Morsbach et al., 1983). Stigma is a notable cross-cultural barrier to reporting symptoms and seeking treatment for PPD (Chandran et al., 2002; Goodman,

2009; Kumar, 1994); for example, some women may be more likely to report their symptoms in a self-report measure as opposed to an interview (Ghubash & Abou-Saleh, 1997; Gotlib et al., 1989). In general, using primarily Western diagnostic criteria for identifying symptoms of depression may lead an inaccurate report of PPD prevalence (Ghubash & Abou-Saleh, 1997). Cultural considerations are necessary when assessing symptoms of depression.

Social support is another important factor that is impacted by culture (Halbreich & Karkun, 2006). In Japan and other Asian countries, social support is typically provided by the mother's family as opposed to her husband (Yoshida et al., 1997). One study from Chen and colleagues (2013) demonstrates the importance of accounting for culturally specific factors in addressing maternal depression. Mothers who were Chinese or Vietnamese immigrants and married to Taiwanese husbands were included in the study. The researchers found that maternal depression impacted the home environment which impacted child development. Immigrant mothers reported greater depressive symptoms and less social support than Taiwanese mothers due to the separation from their families (Chen et al., 2013).

Summary of Literature Review and Present Study

Maternal depression is often studied in Western, high-income nations, focusing on the perinatal period. Similar to major depressive disorder, perinatal depression leads to depressed mood, difficulty completing daily tasks, sleep and diet disturbances, and irritability (APA, 2013). Antenatal and postpartum depression occurs at vulnerable times for child development, impacting parenting behaviors and mother-infant interactions (e.g. Campbell & Cohn, 1991; Goodman & Gotlib, 1999). It is important to take a more

intersectional approach to understanding postpartum depression (Mauthner, 1993), accounting for various bio-psycho-social factors and examining postpartum depression across all cultures (Halbreich & Karkun, 2006).

In addition to hormonal shifts, evidence suggests that a history of depression (Cooper & Murray, 1995), environmental stressors, and sociodemographic risk factors are often associated with maternal depression (Cicchetti et al., 1998). Maternal depression is not one-dimensional: the time of onset, the severity of symptoms, and the duration of the episode impacts the mother's experience and the child's outcomes (Brennan et al., 2000).

Research has identified between three and six different trajectories incorporating the symptom severity, duration of symptoms, and time of onset (Campbell et al., 2007; Guyon-Harris et al., 2015; Kingston et al., 2018; Park et al., 2018; Vanska et al., 2011), with mothers most often experience low levels of depression (Kingston et al., 2018; Guyon-Harris et al., 2015). Trajectory studies are often longitudinal and utilize analytical methods that incorporate multiple variables, which lends to an intersectional approach to studying maternal depression. Timing of onset, including a history of depression prior to the perinatal period can affect mother's experience with postpartum depression (Cooper, 1992; Cooper & Murray, 1995; Noble, 2005). Some studies have found that chronic and severe depression symptoms, regardless of the time of onset, are most harmful for children (Campbell et al., 2007; Kingston et al., 2011). Other studies have found that onset of maternal depression during infancy and toddlerhood, regardless of how long the symptoms persist, is the trajectory of maternal depression that most severely impacts child development (Vanska et al., 2011).

Person-centered approaches used by some studies of maternal depression trajectory (Campbell et al, 2007; Guyon-Harris et al., 2015; Vanska et al., 2011), identify individual or demographic factors that may influence depression patterns. Accounting for sociocultural factors in addition to trajectory improves understanding of the mother's experience and the impact on the child. Trajectory studies primarily focus on social-emotional and behavioral development and less frequently include cognitive development. Child cognitive development is an important indicator of future ability (Fergusson et al., 2005). Maternal depression, particularly in the perinatal period, has been found to negatively impact various areas of child development (Cummings & Davies, 1994; Murray, 1992; Murray et al., 1996). More specifically, postpartum depression has a significant negative impact on child cognitive development (Grace et al., 2003). Addressing trajectories of maternal depression as they relate to child cognitive development can improve understanding of the impact on children and provide insight for treatment.

A majority of depression trajectory studies are centered on mothers from Western, high income nations. However, in low and middle income countries (LMICs), medical professionals often do not have specialized training in identifying symptoms of mental illness (Gelaye et al., 2016). In general, identification of depression symptoms varies by culture (Halbreich & Karkun, 2006; Hau & Levy, 2003; Kumar, 1994). Although there is a growing awareness of mental health in LMICs (WHO, 2017), maternal depression is often neglected, in part due to the necessary focus on preventing mother and child mortality (Gelaye et al., 2016). Because prevalence rates can be skewed by cultural factors such as stigma (Chandran et al., 2002; Kumar, 1994) and lack of access to

healthcare (Evagorou et al., 2016), more research is needed to provide more valid estimates of maternal depression rates in LMICs, incorporating relevant environmental and cultural factors and using culturally sensitive measurements.

International and cross-cultural research is needed to build a more comprehensive understanding of the relationship between maternal depression and cognitive development. Analyzing trajectories of maternal depression have provided valuable information to understanding that relationship (Campbell et al., 2007). Because trajectories of depression seem to vary across samples (e.g. Guyon-Harris et al., 2015; Park et al., 2018; Vanska et al., 2011), there may be cultural differences in patterns of depression symptoms based on prevalence, reporting of symptoms, and environmental factors. Therefore, identifying trajectories across cultures and countries can provide better insight into mothers' experiences, prevalence of depression, and the impact on children. An international, longitudinal study of mothers and children from diverse, international locations will help to address these gaps. The present study is designed to answer the following questions:

1. What are the trajectories of maternal depression in the international sites?
2. Is there a difference in the trajectories of maternal depression based on location?
3. Is there a relationship between maternal depression trajectories and child cognitive development at 24 months?
 - In what way does the home environment mediate the relationship between maternal depression trajectories and child cognitive development?
4. How does this relationship vary across sites?

CHAPTER 3

METHODS

Context: MAL-ED Cohort Study

The present study is a part of the Etiology, Risk Factors, and Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health (MAL-ED) Study, which uses an international, multi-site, longitudinal design to address multiple factors in maternal health and child development (Miller et al, 2014). Although the primary focus of MAL-ED is malnutrition and the impact of enteric infection, the study incorporates a broad range of factors that occur in LMICs. The present study incorporates maternal depression symptoms, child cognitive development, and the home environment.

The eight international locations involved in the study are Dhaka, Bangladesh (BGD); Fortaleza, Brazil (BRF); Vellore, India (INV); Bhaktapur, Nepal (NEB); Loreto, Peru (PEL); Naushahro Feroze, Pakistan (PKN); Venda, South Africa (Dzimauli Community, SAV); and Haydom, Tanzania (TZH). Starting in November 2009, families enrolled in the study within 17 days of the infant's birth (MAL-ED Network Investigators, 2017). In the present study, five of the eight locations were included in the analysis; Dhaka, Bangladesh; Vellore, India; Loreto, Peru; Naushahro Feroze, Pakistan; and Venda, South Africa. Due to measurement inconsistencies, Fortaleza, Brazil; Bhaktapur, Nepal; and Haydom, Tanzania could not be included in these analyses.

Participants

The MAL-ED study includes mothers and children from diverse cultures from low and middle income areas. The present study included five distinct groups of the eight that were initially involved in MAL-ED. Many of the families in this study live in

extended family systems including grandparents and adult siblings (Jones et al., 2017). Literacy rates and access to resources varies from site to site (MAL-ED., 2017).

The MAL-ED site at Dhaka, Bangladesh is widely considered a “slum” of the city (L. Pendergast, personal communication, June 20, 2022; UNICEF, 2015). Bangladesh is a densely populated country and it is projected that nearly half of the population will live in urban areas by 2050 (Adams et al., 2015). Natural disasters have increasingly pushed more people from rural to urban areas (Jones et al., 2017; UNICEF, 2015). Families in Dhaka slums typically live in one-room homes with high risk for danger and trauma, particularly for women and children (UNICEF, 2015). These neighborhoods also experience lack of resources, including access to quality healthcare (Adams et al., 2015). Vellore is a city in the southern region of India and the MAL-ED site was also a slum (John et al., 2014). These participants had access to electricity, but lacked of formal plumbing facilities and high rates of unemployment (John et al., 2014; Jones et al., 2017).

The Naushahro Feroze site in Pakistan is a rural, agriculture-based area (Jones et al., 2017). This area has limited resources and some schools do not have access to electricity (Jones et al., 2017). Homes have access to electricity and drinking water, but few homes have indoor toileting facilities (Turab et al., 2014). The MAL-ED site in Peru is based in semi-urban communities along the Nanay River in the province of Loreto (Jones et al., 2014). Compared to other areas of Loreto, the site proximity to the capital has allowed improved access to electricity, water, and public health facilities (Yori et al., 2014). The Loreto site’s tropical rainforest climate, proximity to the river, and related climate patterns has attracted environmental research as well as viral infection research

(Yori et al., 2014). Most mothers included in the study attended some amount of school and a majority of children over age 6 attend school (Jones et al., 2014).

The final site included in the present study was the South African site which was based in the Dzimauli community of the Vhembe district (Bessong et al., 2014). The population of the Dzimauli community was 9000 at the time of the study (Bessong et al., 2014). More than 80% of the homes at this site had access to electricity and most of the homes used a pit toileting system (Bessong et al., 2014). Mothers at the site had an average of 9 years of education (Bessong et al., 2014). This community had no previous experience with researchers; MAL-ED team met with traditional Dzimauli community leaders prior to implementing the study (Bessong et al., 2014).

Measures

The measures were translated for each of these locations by members of the MAL-ED team who were familiar with the language and culture (Murray-Kolb et al., 2014). After the initial translation from English, the scales were back-translated by another individual (Murray-Kolb et al., 2014). For each measure, items were matched based on cultural relevance and the intended difficulty level (Murray-Kolb et al., 2018).

Maternal Depression

Maternal depressive symptoms were measured using the Self-Report Questionnaire (SRQ; Beusenbergh & Orley, 1994). The SRQ consists of 20 binary (yes or no) items that assess for the presence of depressive symptoms within the past four weeks. It was specifically designed to be used with individuals from low and middle income countries (Harding et al., 1980). Mothers were assessed at one, six, 15, and 24 months postpartum by a trained interviewer (Pendergast et al., 2014). Based on responses, the

interviewer would refer the mother for follow-up mental health support (Murray-Kolb et al., 2014). A MAL-ED study by Pendergast and colleagues (2014) utilized exploratory factor analysis to identify one factor with 16 of the items. Confirmatory factor analysis demonstrated that the one-factor model was a good fit across seven of the eight sites (Pendergast et al., 2014). Analysis of the factor structure was inconclusive for the BRF site, due to validity concerns when utilizing the SRQ for postpartum depression at this location (Pendergast et al., 2014). Thus, the 16 item, one factor model is most appropriate to use in this analysis, with the exception of the BRF site. These 16 items can be found in the Appendix. Temporal invariance was also identified in the one-factor model, indicating that changes from one time point to the next are due to true change rather than time (Pendergast et al., 2014).

Child Cognitive Development

The Bayley Scales of Infant and Toddler Development (BSID-III; Bayley, 2009) was used to assess child development at six, 15, and 24 months. The BSID-III contains five scales; Cognitive, Fine Motor, Gross Motor, Receptive Language, and Expressive Language. For the purposes of this study, cognitive development at 24 months will be utilized to determine the relationship between maternal depressive symptoms and cognitive outcomes. Quality assurance of procedures indicated that protocol for administering the BSID-III in TZH differed from other locations (Murray-Kolb et al., 2018). A study by Pendergast and colleagues (2018) indicated that the BSID-III is a valid assessment of cognitive abilities for most of the 8 sites. Factor analysis revealed that BSID-III items performed differently in the NEB group (Pendergast et al., 2018). Thus, BSID-III results for TZH and NEB will not be included in this analysis.

Home Environment

The Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984) was used to assess aspects of the home environment that pertain to child development. This assessment involves a rating scale as well as an observation of the home; the administrator completes the rating scale based on the 1 hour observation and follows up with the caregiver to complete unanswered items (Jones et al., 2017). The home environment is a factor related to the impact of maternal depression and implicated in child cognitive development (Bradley et al., 2001; Evans et al., 2010; Rasheed & Yousafzai, 2015). This scale has been used internationally and demonstrates validity across populations (Murray-Kolb et al., 2014). In the MAL-ED study, a modified version of the HOME with 48 binary items (Black et al., 2004) was administered at six months and 24 months. In the MAL-ED cohort, Jones and colleagues (2017) identified a three-factor model with 43 items representing the following constructs: emotional and verbal responsivity, child cleanliness, environmental safety and healthfulness. For the purposes of the present study, the scores of the three different factors at six months were incorporated in the data analysis. The HOME inventory items can be found in the Appendix.

Data Analysis

Overview

The primary objective of the present study was to determine trajectories of maternal depression for each site. To identify trajectories, latent class growth analysis (LCGA) was used. After identifying the trajectory patterns of depression for mothers, the trajectories were assessed in relation to the child's cognitive development at 24 months. The HOME inventory was incorporated as a mediator in the relationship between

maternal depression and child cognitive development. Structural equation modeling was used to account for multiple dimensions and variables. If the mediation model was statistically significant, further analyses were proposed to compare the mediation model across study sites.

Preliminary Analyses

The multiple imputation method was used to address missing data; this systematic method produces unbiased estimates (Little et al., 2016). Specifically, Bayesian Markov Chain Monte Carlo (MCMC) was utilized to accommodate the multiple levels, variables, and scale scores within this study (Little et al., 2016). Nesting was incorporated into the multiple imputation models to appropriately estimate values for the multiple sites, child-level factors, and the mother-level factors (Little et al., 2016; Reiter, et al., 2006). SPSS Version 26 was used to create multiple imputations. Descriptive statistics, frequencies, means, and standard deviations were presented for each location and time point. Correlations between the predicting variables (Maternal Depression, Trajectory Group, and HOME factors) were analyzed using SPSS Version 26. Tables displayed descriptive statistics, frequencies, and correlations.

Trajectory Analyses

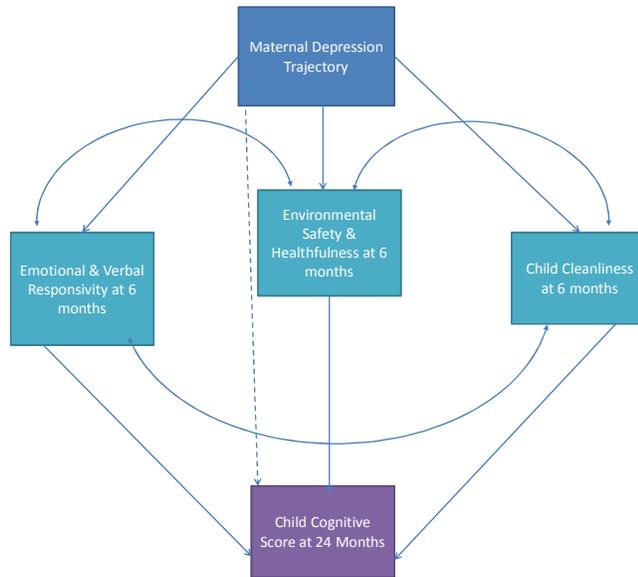
Latent class growth analysis (LCGA) was used to identify trajectories of maternal depression for each of the international sites. This method addressed unobserved variability within a group (Wang & Bodner, 2007), in this case, mothers with symptoms of depression. Multiple models were examined to determine the appropriate number of trajectories. Based on previous trajectory research (e.g. Guyon-Harris et al., 2015; Park et al., 2018), models for three, four, five, and six trajectories of maternal depression were

examined for each location. The recommended fit statistic for LCGA is the Bayesian information criterion (BIC) statistic; the model with the lowest BIC was considered the best fit (Jung & Wickrama, 2008; Wang & Bodner, 2007). A statistically significant Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) is also recommended to indicate model fit (Wang & Bodner, 2007). In addition to fit statistics, Jung and Wickrama (2008) also suggest considering parsimony and theory when identifying trajectories. Each of these criteria was considered in determining the best trajectories for each group.

Mediation Analysis

Once trajectories were established for each site, a model was created to map the relationship between maternal depression trajectories and child cognitive development at 24 months with HOME factors at six months as mediators. Please see the proposed model in Figure 1. Maternal depression trajectories were hypothesized to predict child cognitive development and that this relationship was best explained when accounting for the three domains of the HOME inventory (EVR, ES, CC). The following fit indices were considered: Chi-Square test, root mean standard error or approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis index (TLI) values (Jacobucci, 2010; Ullman & Bentler, 2013). Coefficients were examined to determine which relationships within the model are significant. This analysis was conducted with five of the eight sites (BGD, INV, PEL, PKN, and SAV) as a total sample (N = 1250).

Figure 1.
Proposed Mediation Model



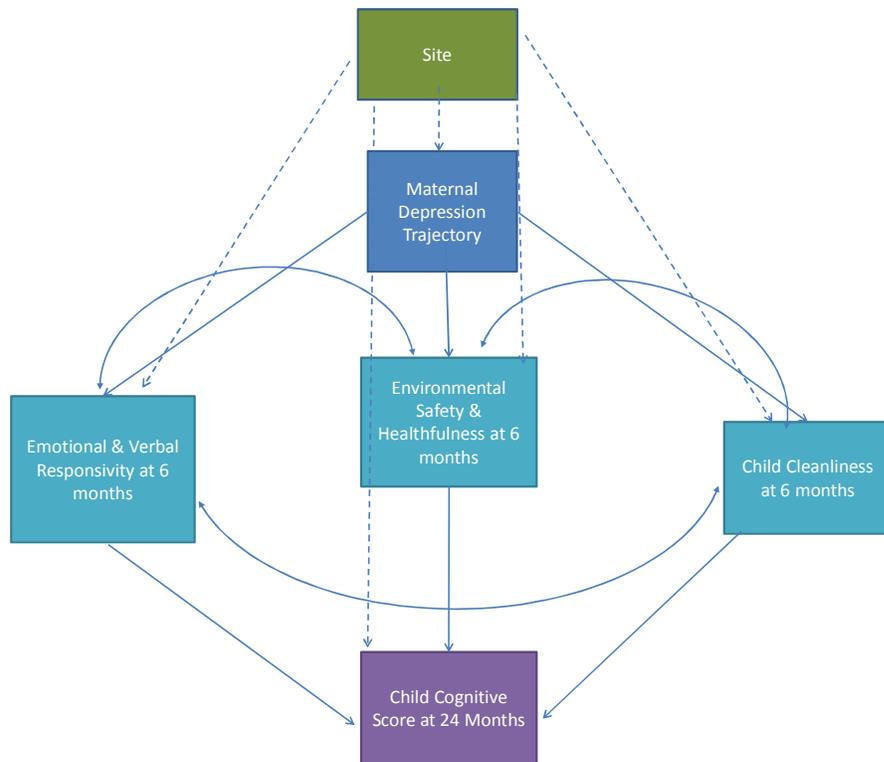
Note. Dashed lines indicate indirect relationships in the model. Solid curved lines indicate correlated residuals and solid straight lines indicate effects.

Cross-Cultural Invariance

To examine mediation model variance based on site location, differential item functioning (DIF) was considered through multiple indicators multiple causes (MIMIC) modeling (Jöreskog & Goldberger, 1975). See Figures 2 for a proposed model of differential item function. DIF was not able to be assessed in the present study.

Figure 2.

Proposed Model for Differential Item Functioning (DIF)



Note. Dashed lines indicate indirect relationships in the model. Solid curved lines indicate correlated residuals and solid straight lines indicate effects.

CHAPTER 4

RESULTS

Preliminary Analysis

Missing Data

The total sample initially consisted of 1933 participants across all sites. In the present study, the data from Fortaleza, Brazil; Bhaktapur, Nepal, and Haydom, Tanzania were not included due to validity concerns identified in prior research (Pendergast et al., 2018; Pendergast et al., 2014). Prior to analyzing the missing data, these three groups were removed from the dataset. After removal of the aforementioned three sites, the total sample was 1250 participants. Little's Missing Completely At Random test was used in SPSS Version 26 with this sample. The results were statistically significant, indicating the possibility that some data were not missing at random ($\chi^2= 385.33, p < .05$).

Due to the longitudinal nature of the study, some participants completed aspects of the study earlier in the study but not at later points, indicating that the missing data were likely missing at random (MAR: Little et al., 2016). Some missing data were likely a result of participants moving or losing interest in the study, both common occurrences in longitudinal studies. Some missing data were due to observed variables such as severe depression symptoms or location, but the missing data may be due to unobserved variables that were not considered in the scope of this study (Ibrahim & Molenbergs, 2009). For most locations, missing data were more prevalent in the later time points of the study. PEL was missing between 25 and 27% of participants from measures assessed at 24 months while PKN was missing only 5% of participants at the 24 month mark. SAV differed from the other countries; it had the most missing data (18.2%) from the first

assessment of the depression symptoms with the SRQ. This may indicate that there were specific characteristics of this group that prevented participation in the study. The HOME Inventory factors had very little missing data; it is possible that these missing values were related to a systematic relationship between the participants and other observed variables (i.e. Country of origin, health indicators, level of depression). For the total sample (N = 1250), there were only four participants missing data for the HOME Inventory factors (Emotional and Verbal Responsivity Scale, the Environmental and Healthfulness Scale, and the Child Cleanliness). All four of these participants were from SAV and participated in other aspects of the study.

When examining each variable (see Table 1), none of the variables had more than 40% of the data missing. Thus, the multiple imputation method was considered an appropriate method for handling the missing data (Jakobsen et al., 2017). This method allows for missing values to be replaced with aggregated values rather than eliminating a large number of participants from the analysis (Jakobsen et al., 2017; Little et al., 2016; Spratt et al., 2010). Missing data were non-monotonous, meaning participants were not missing all variables but only some variables. In order to address non-monotonous missing data, the fully conditional specification Markov chain Monte Carlo (MCMC) method was used with 10 iterations (Jakobsen et al., 2017).

Descriptive Statistics and Correlations

Means and standard deviations were reported in Table 2 and Table 3. Bivariate correlations were reported in Table 4 for the total sample (N = 1250). Of note, improved child cleanliness and environmental safety/healthfulness based on the HOME Inventory was associated with lower maternal depression ($p < .01$) and higher with child cognitive

scores at 24 months ($p < .01$). Poorer scores in these domains were correlated with increased endorsement of maternal depression symptoms ($p < .01$).

Table 1

Summary of Missing Data for Variables Included in the Present Study's Analysis

Country		Cog at 24 Months	SRQ at 1 Month	SRQ at 6 Months	SRQ at 15 Months	SRQ at 24 Months
BGD (n = 241)	N	53	0	5	22	57
	Missing					
	% Missing	22%	0	2.1%	9.1%	23.7%
	SD	3.08	3.59	4.16	5.99	3.89
INV (n = 235)	N	8	2	0	6	8
	Missing					
	% Missing	3.4%	0.9%	0	2.6	3.4%
	SD	2.55	3.74	3.81	3.57	2.55
PEL (n = 268)	N	71	0	1	39	74
	Missing					
	% Missing	26.6%	0	0.4%	14.6%	27.6%
	SD	2.85	2.37	2.47	2.71	2.58
PKN (n = 259)	N	14	1	2	8	14
	Missing					
	% Missing	5.4%	0.4%	0.8%	3.1%	5.4%
	SD	2.57	3.52	4.04	4.02	4.00

Table 1*Summary of Missing Data for Variables Included in the Present Study's Analysis*

Country		Cog at 24 Months	SRQ at 1 Month	SRQ at 6 Months	SRQ at 15 Months	SRQ at 24 Months
SAV (n = 247)	N	33	45	22	32	32
	Missing					
	%	13.4%	18.2%	8.9%	13%	13%
	Missing					
	SD	4.26	2.74	2.85	2.31	1.82
Total (N = 1250)	N	179	48	30	107	185
	Missing					
	%	14.3%	3.8%	2.4%	8.6%	14.8%
	Missing					
	SD	4.26	3.45	3.75	3.73	3.55

Note. Countries: BGD = Dhaka, Bangladesh, INV = Vellore, India, PEL = Loreto, Peru, PKN = Naushahro Feroze, Pakistan, SAV = Venda, South Africa.

Cog at 24 Months = Bayley Scales of Infant Development, 3rd Edition (BSID-III) Cognitive Score at 24 months Maternal Depression: SRQ = Self-Report Questionnaire for 1, 6, 15, and 24 months

HOME Inventory: EVR at 24 months = Emotional and Verbal Responsivity; ES at 24 Months = Environmental Safety and Healthfulness; CC at 24 Months = Child Cleanliness

Table 2*Descriptive Statistics for the SRQ*

Country		One Month	Six Months	Fifteen Months	Twenty-Four Months
BGD (n = 241)	Mean	4.57	5.59	5.20	5.05
	SD	3.59	4.13	3.94	3.68
INV (n = 235)	Mean	4.03	4.67	4.43	4.04
	SD	3.73	3.81	3.55	3.28
PEL (n = 268)	Mean	2.40	2.70	2.30	2.32
	SD	2.37	2.46	2.60	2.40
PK (n = 259)	Mean	5.76	5.71	5.41	4.65
	SD	3.52	4.02	3.98	3.97
SA (n = 247)	Mean	2.94	2.93	2.02	1.50
	SD	2.59	2.76	2.30	1.88
Total (N= 1250)	Mean	3.93	4.30	3.85	3.49
	SD	3.41	3.71	3.63	3.42

Note. Means and standard deviations were identified with the imputed and aggregated dataset. Countries: BGD = Dhaka, Bangladesh, INV = Vellore, India, PEL = Loreto, Peru, PKN = Naushahro Feroze Pakistan, SAV = Venda, South Africa.

Table 3*Descriptive Statistics for the BSID-III Cognitive Scores and the HOME Inventory*

Country		HOME Inventory			BSID-III
		Emotional and Verbal Responsivity	Environmental Safety and Healthfulness	Child Cleanliness	Cognitive Score
BGD (n = 241)	Mean	9.24	3.20	3.68	7.08
	SD	2.09	.75	.52	3.01
INV (n = 235)	Mean	12.41	3.84	3.69	9.79
	SD	1.54	.49	.61	2.56
PEL (n = 268)	Mean	9.59	3.69	3.96	4.93
	SD	2.43	.54	.28	2.83
PKN (n = 259)	Mean	8.36	2.71	3.25	2.59
	SD	2.89	1.24	1.00	2.69
SAV (n = 247)	Mean	11.87	3.85	3.79	8.78
	SD	1.67	.48	.72	4.11
Total (N = 1250)	Mean	10.25	3.45	3.67	6.53
	SD	2.71	.88	.71	4.04

Note. Means and standard deviations were identified with the imputed dataset.

Countries: BGD = Dhaka, Bangladesh, INV = Vellore, India, PEL = Loreto, Peru, PKN = Naushahro Feroze, Pakistan, SAV = Venda, South Africa.

Table 4*Bivariate Correlations (N = 1250)*

	1.	2.	3.	4.	5.	6.	7.	8.
1. EVR 6 months	1	-	-	-	-	-	-	-
2. ES 6months	.29**	1	-	-	-	-	-	-
3. CC 6months	.15**	-.38**	1	-	-	-	-	-
4. SRQ 1 month	-.11**	-.19**	-.19**	1	-	-	-	-
5. SRQ 6 months	-.12**	-.22**	-.19**	.57**	1	-	-	-
6. SRQ 15 months	-.06**	-.18**	-.12**	.52**	.60**	1	-	-
7. SRQ 24 months	-.05	-.18**	-.16**	.53**	.57**	.67**	1	-
8. Cog 24 months	.38**	.31**	.14**	-.12**	-.08**	-.10**	-.08**	1

Note. EVR is HOME Emotional and verbal responsivity, ES is Environmental safety and healthfulness, CC is Child Cleanliness, SRQ is Self Report Questionnaire total standard score, Cog is Bayley Infant Scales of Development, 3rd Edition, Cognitive score.

** p < .01, * p < .05

Maternal Depression Trajectories

Bakk, Tekle, and Vermunt (2013) propose a three step process when associating latent class membership with external variables. First, identify the latent classes, in this case, the maternal depression trajectories. Next, predict the class membership based on scores. Finally, use the predicted group membership in analyses with the external variables. Once trajectories are established, relationships between depression patterns, the home environment, and child cognitive development can be examined through structural equation models.

Latent class growth analysis (LCGA) was used to identify trajectories of maternal depression for each of the five groups and the total sample. The Guidelines for Reporting on Latent Trajectory Studies (GRoLTS; Schoot et al., 2017) were consulted to ensure that necessary information was reported for transparency, clarity, and future research. The SRQ was administered at four time points postpartum; one month, six months, 15 months, and 24 months. The SRQ has 20 dichotomous items, but a 16 item-model focusing on depression symptoms was identified for the MAL-ED study (Pendergast et al., 2014).

The latent class model with the lowest Bayesian information criterion (BIC) statistic was considered the best fit (Jung & Wickrama, 2008; Wang & Bodner, 2007). A statistically significant Lo-Mendell-Rubin likelihood ratio test (LMR-LRT), parsimony, and existing literature were also consulted in identifying trajectories (Jung & Wickrama, 2008; Wang & Bodner, 2007). Trajectories of SRQ scores across the four time points were identified for each of the international sites. Trajectories were plotted and visually inspected as an additional means of determining the appropriate number of classes.

Total Sample

The mean SRQ score for the total sample of mothers ranged from 3.49 to 4.30 across the four time points. Based on the BIC and LMR-LRT, the models with three, four, and five groups were viable options. Because the BIC increased with the addition of a sixth group, the six-class model was not considered a viable fit for the data. See Table 5 for fit statistics each model.

Examining the fit statistics (lowest BIC and statistically significant LMR-LRT) and considering the rule of parsimony, the four-class model was determined to have the

best fit. Visual examination of the line graphs provided additional support for the four-class model. See Figure 3 for the selected model. The four-class model reflected four distinct groups, including a moderate-increasing group and moderate-decreasing group. Considering two different moderate groups rather than a general moderate group can provide clinical utility when screening for depression symptoms and following up with mothers. See Table 6 for group labels and percentage of mothers in each group. The most common trajectory group was Low with 60.72% of mothers.

Table 5

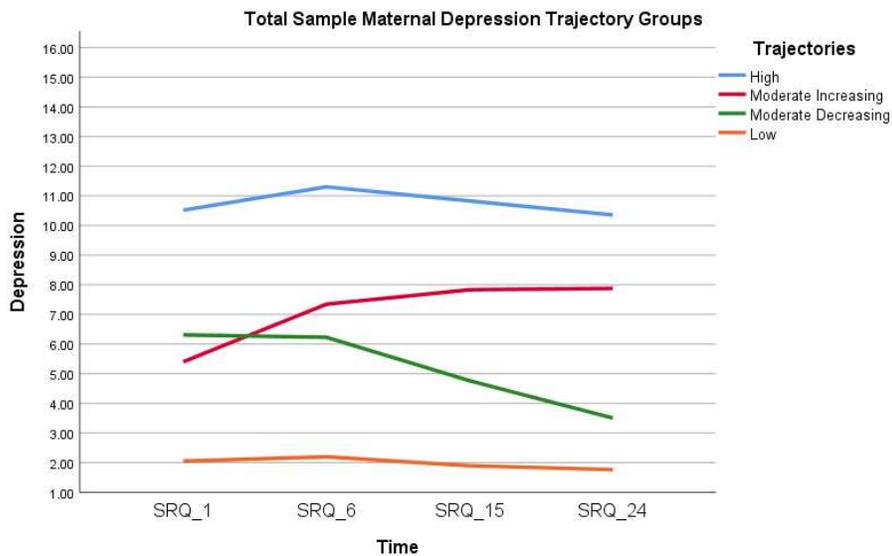
Fit Statistics for Trajectory Models for Total Sample of Mothers (N = 1250)

Model	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df = 3)
Null	26877.31	-
2- Class	25044.53	1771.38*
3-Class	24674.73	373.71*
4-Class	24597.66	94.06*
5-Class	24546.91	63.94*
6-Class	24568.30	-0.00

*Lo Mendell-Rubin Adjusted Likelihood Ratio with p value < 0.001

Table 6*Total Sample Trajectory Groups in 4-Class Model (N = 1250)*

	Low	Moderate- Decreasing	Moderate- Increasing	High				
n	759	246	152	93				
Percentage of Mothers	60.72	19.68	12.16	7.44				
Means and standard deviations for SRQ Scores at each time point								
SRQ	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1 Month	2.05	1.82	6.31	2.57	5.40	2.77	10.52	2.98
6 Month	2.20	1.94	6.23	2.89	7.34	3.18	11.30	2.53
15 Month	1.94	1.94	4.76	2.52	7.83	2.81	10.83	3.00
24 Month	1.76	1.80	3.51	2.00	7.88	2.21	10.35	3.01

Figure 3.*Line Graph for 4-Class Model for Total Sample (N = 1250)*

Dhaka, Bangladesh (BGD)

The mean SRQ score for mothers from Dhaka, Bangladesh ranged from 4.57 to 5.59. Based on the BIC and LMR-LRT, the three and five class models were viable options. See Table 7 for fit statistics for each model.

Examining the fit statistics (lowest BIC and statistically significant LMR-LRT) and considering the rule of parsimony, the three-class model was determined to have the best fit. The three-class model yielded the smallest BIC value. Adding a fourth group increased the BIC, thus the four-class model was not considered a possible fit. Visual examination of the line graphs for each model provided additional support for model selection. See Figure 4 for the line graph of the selected model's trajectories. For this group, a model with high, moderate, and low trajectories was the best fit. For the high and moderate groups, depression symptoms increased slightly at six months. See Table 8 for group labels, percentage of mothers in each group, and SRQ mean scores for each time point. The most common trajectory group was Low with 47.72% of mothers, nearly half the group.

Table 7*Fit Statistics for BGD Trajectory Models (n = 241)*

Model	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df = 3)
Null	5341.16	-
2- Class	5047.79	292.09*
3-Class	4975.72	83.46*
4-Class	4982.22	9.39
5-Class	4979.60	17.98*
6-Class	4996.05	-0.00

*Lo Mendell-Rubin Adjusted Likelihood Ratio with p value < 0.001

Table 8*Trajectory Groups for BGD Mothers in 3-Class Model (n = 241)*

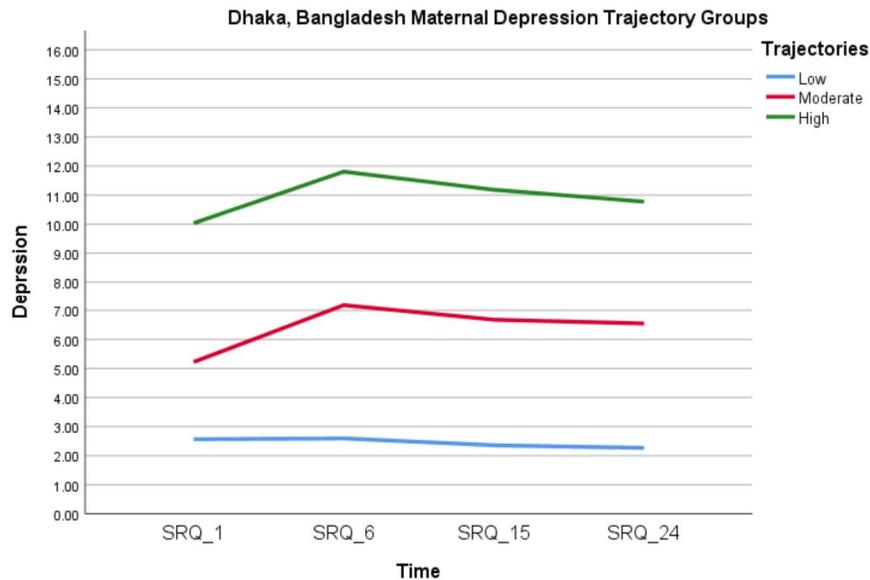
	Low	Moderate	High
n	115	95	31
Percentage of Mothers	47.72	39.42	12.86

Means and standard deviations for SRQ Scores at each time point

SRQ	Mean	SD	Mean	SD	Mean	SD
1 Month	2.57	2.45	5.22	2.77	10.03	2.95
6 Month	2.59	2.24	7.18	3.13	11.81	2.07
15 Month	2.36	2.28	6.68	2.45	11.18	3.25
24 Month	2.27	1.67	6.55	2.56	10.77	2.60

Figure 4.

Line Graph for 3-Class Model for BGD Mothers' Depression Symptoms (n = 241)



Vellore, India (INV)

The mean SRQ score for mothers from Vellore, India ranged from 4.03 to 4.67. Based on the BIC and LMR-LRT, the four and five-class models were considered most optimal. See Table 9 for fit statistics. The five-class model had the lowest BIC value and a statistically significant LMR-LRT value.

Examining the fit statistics and parsimony (lowest BIC and statistically significant LMR-LRT), the five-class model was determined to have the best fit. Adding a sixth group did not improve model fit for INV mothers. The four-class model yielded two moderate groups which did not demonstrate different, meaningful patterns. The five-class model presents three distinct moderate groups which could be more clinically useful than the redundant moderate groups yielded in the four-class model. See Table 10 for labels,

percentages, and mean scores at each time point. The most common trajectory group was the Low group with 40.85% of mothers. In the High-Decreasing group, SRQ scores increased slightly at six months and then decreased at 15 and 24 months.

Table 9
Fit Statistics for INV Trajectory Models (n = 235)

Models	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df =3)
Null	5088.13	-
2-Class	4730.98	352.04*
3-Class	4670.28	72.65*
4-Class	4650.03	34.52*
5-Class	4642.26	22.76*
6-Class	4658.64	-0.00

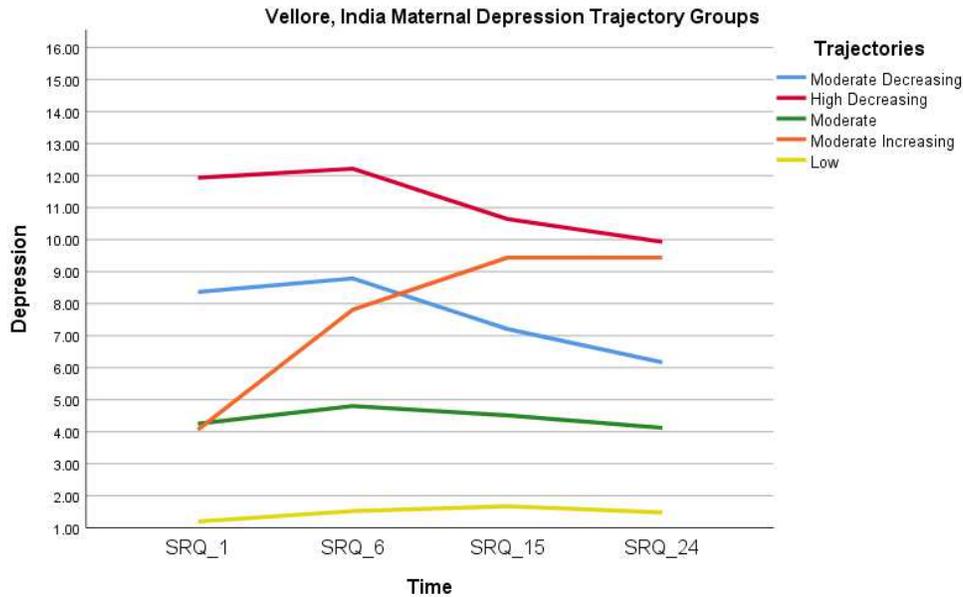
*Lo-Mendell-Rubin Adjusted Ratio with p-value of <0.001

Table 10
Trajectory Groups for INV Mothers in 5-Class Model (n = 235)

	Low	Moderate	Moderate-Decreasing	Moderate-Increasing	High-Decreasing					
n	96	76	33	16	14					
Percentage of Mothers	40.85	32.34	14.04	6.81	5.96					
Means and standard deviations for SRQ Scores at each time point										
SRQ	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1 Month	1.20	1.27	4.25	2.52	8.36	2.38	4.06	1.98	11.93	2.90
6 Month	1.52	1.50	4.80	2.26	8.78	2.25	7.81	2.74	12.21	1.97
15 Month	1.67	1.68	4.51	1.97	7.21	2.56	9.44	3.08	10.64	2.81
24 Month	1.48	1.73	4.12	1.86	6.17	1.88	9.44	1.71	9.93	2.50

Figure 5.

Line Graph for 5-Class Model for INV Mothers' Depression Symptoms (n = 235)



Naushahro Feroze, Pakistan (PKN)

The mean SRQ score for mothers from Naushahro Feroze, Pakistan ranged from 4.65 to 5.77. Based on the BIC and LMR-LRT, the two and three class models were considered the most viable models. See Table 11 for fit statistics.

Examining the fit statistics (lowest BIC and statistically significant LMR-LRT) and parsimony, the three-class model was determined to have the best fit. The BIC values increased and the LMR-LRT values were statistically insignificant when adding a third, fourth, and fifth group. The two-class model represents a low-decreasing group and a high group whereas the three-class model represents low-decreasing, moderate-decreasing, and high-increasing groups. Distinguishing women in the “high” group from the two-class model as either moderate-decreasing or high-increasing could be clinically useful. See Table 12 for group labels and percentage of mothers in each group of the three-class model. The most common trajectory group was Low with 49.03% of mothers.

Table 11*Fit Statistics for PKN Trajectory Models (n = 259)*

Model	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df = 3)
Null	5765.14	-
2-Class	5478.22	286.40*
3-Class	5435.37	56.16*
4-Class	5443.08	8.46
5-Class	5457.49	2.13
6-Class	5474.16	-0.00

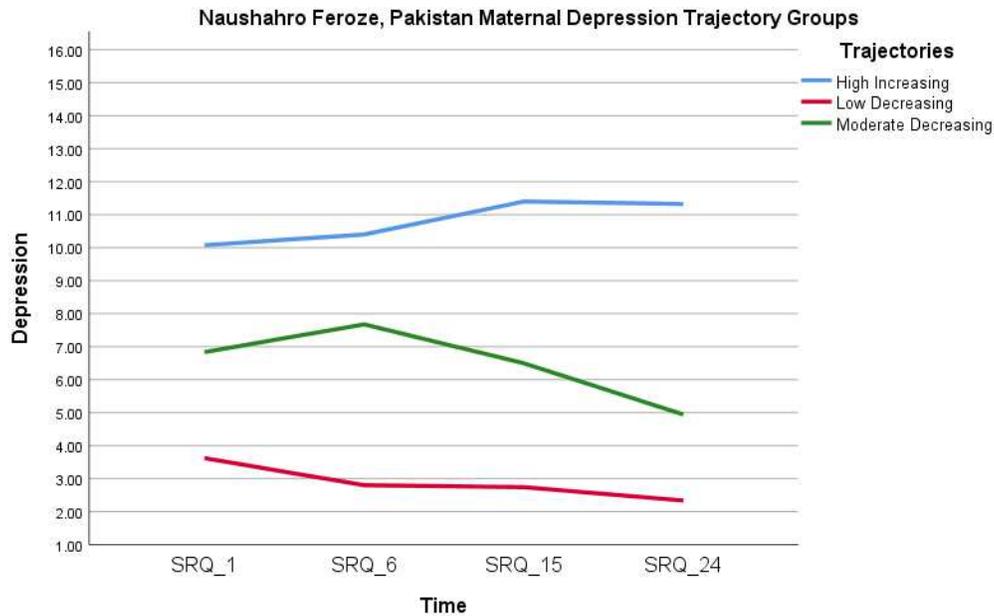
*Lo-Mendell-Rubin Adjusted Ratio with p-value of <0.001

Table 12*Trajectory Groups for PKN Mothers in 3-Class Model (n = 259)*

	Low-Decreasing	Moderate-Decreasing	High-Increasing			
n	127	92	40			
Percentage of Mothers	49.03	35.52	15.44			
Means and standard deviations for SRQ Scores at each time point						
SRQ	Mean	SD	Mean	SD	Mean	SD
1 Month	3.62	2.27	6.84	2.81	10.08	3.24
6 Month	2.80	2.12	7.68	3.13	10.40	3.21
15 Month	2.74	2.17	6.50	2.97	11.40	2.46
24 Month	2.34	2.01	4.94	2.98	11.32	2.69

Figure 6.

Line Graph for 3-Class Model for PKN Mother's Depression Symptoms (n = 259)



Loreto, Peru (PEL)

The mean SRQ score for mothers from Loreto, Peru ranged from 2.28 to 2.70. Based on the BIC and LMR-LRT, the three and four class models were considered the most viable models. See Table 13 for fit statistics.

The three-class model was determined to have best fit for the PEL mothers considering the lowest BIC, statistically significant LMR-LRT, and the rule of parsimony. PEL mothers reported a generally low level of depression symptoms compared to the other mothers. In the three-class model, the two higher groups were “Moderate-Increasing” and “Moderate-Decreasing.” Some mothers reported higher level of depression symptoms than other mothers, but scores remained lower than the “High” trajectories of other groups and the total sample. Adding additional groups did not improve model fit. Because the mean SRQ scores were generally lower, identifying

different trajectories may have diagnostic utility to identify and provide treatment for the mothers reporting higher symptoms. See Table 14 for group labels, percentage of mothers in each group, and mean SRQ scores at each time point. The most common trajectory group was the Low trajectory with 75.37% of mothers. See Figure 7 for a line graph of trajectories for PEL mothers.

Table 13
Fit statistics for PEL Trajectory Models (n = 268)

Model	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df = 3)
Null	4998.54	-
2-Class	4747.35	243.45*
3-Class	4710.25	60.28*
4-Class	4708.54	17.44*
5-Class	4715.66	9.11
6-Class	4732.43	-0.00

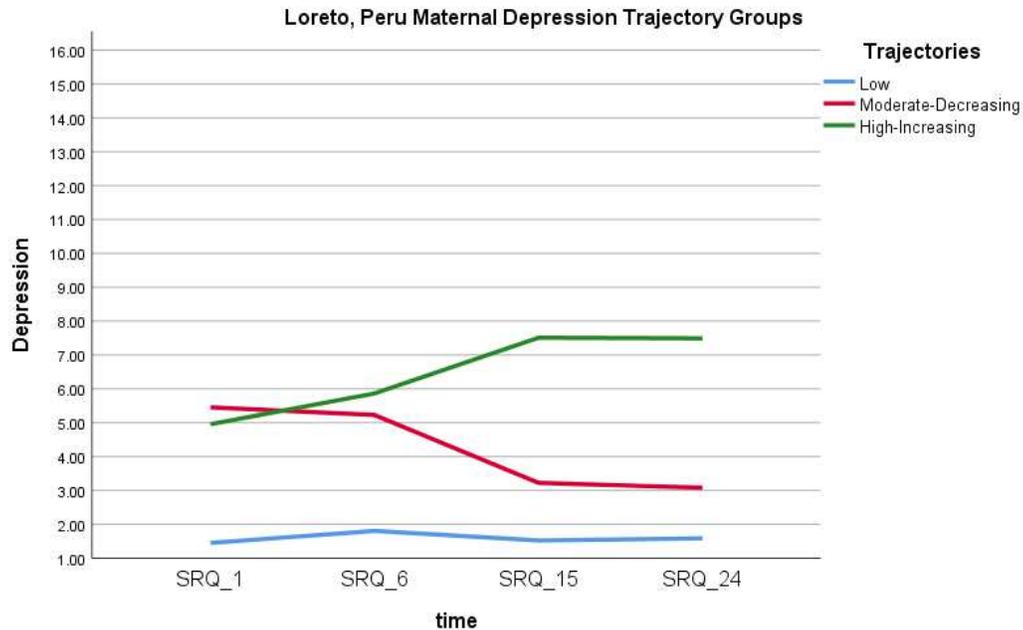
*Lo Mendell-Rubin Likelihood Ratio with p value < 0.001

Table 14
Trajectory Groups for PEL Mothers in 3-Class Model (n = 268)

	Low	Moderate-Decreasing	Moderate-Increasing			
n	202	44	22			
Percentage of Mothers	75.37	16.42	8.20			
Means and standard deviations for SRQ Scores at each time point						
SRQ	Mean	SD	Mean	SD	Mean	SD
1 Month	1.45	1.33	5.45	2.21	4.96	3.07
6 Month	1.81	1.48	5.23	2.61	5.86	3.24
15 Month	1.53	1.61	3.22	2.64	7.51	3.29
24 Month	1.59	1.64	3.08	1.98	7.49	2.14

Figure 7.

Line Graphs for 3-Class Model for PEL Mothers' Depression Symptoms (n = 268)



Venda, South Africa (Dzimauli Community, SAV)

The mean SRQ score for mothers from the Dzimauli community ranged from 1.43 to 3.08. Based on the lowest BIC and statistically significant LMR-LRT, the four and five class models were considered the most optimal for this group. See Table 15 for fit statistics.

The three-class model was determined to have best fit for the SAV mothers, considering the BIC, LMR-LRT, and rule of parsimony. Adding a fourth, fifth, and sixth group did not improve model fit. See Table 16 for group labels and percentage of mothers in each group for the three-class model. Similar to the PEL mothers, SAV mothers reported an overall low level of depression symptoms. Over three-fourths of the mothers were in the Low group (78.95%). The High-Decreasing group reflected about 2% of the

mothers and the mean SRQ scores deviated considerably from the mean SRQ scores of the low group. Using a model that reflected the “high” group may be clinically useful in identifying mothers reporting an uncommon level of symptoms for this population. See

Table 16

Fit Statistics for SAV Trajectory Models (n = 247)

Model	Bayesian Information Criterion	Lo-Mendell-Rubin Adjusted Likelihood Ratio (df = 3)
Null	4571.57	-
2-Class	4444.97	134.97*
3-Class	4430.22	39.49*
4-Class	4446.75	-0.00
5-Class	4463.28	-0.00
6-Class	4468.69	10.49

*Lo Mendell-Rubin Likelihood Ratio with p value < 0.001

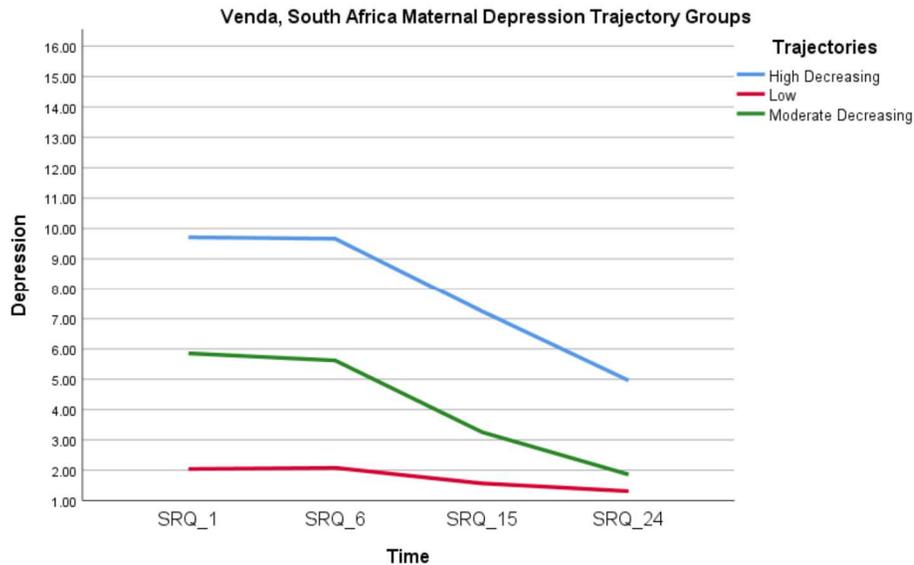
Table 15

Trajectory Groups for SAV Mothers in 3-Class Model (n = 247)

	Low	Moderate-Decreasing	High-Decreasing			
n	195	46	6			
Percentage of Mothers	75.37	16.42	8.20			
Means and standard deviations for SRQ Scores at each time point						
SRQ	Mean	SD	Mean	SD	Mean	SD
1 Month	2.04	1.64	5.86	2.41	9.71	2.76
6 Month	2.08	1.94	5.62	2.90	9.67	1.63
15 Month	1.57	1.88	3.26	2.64	7.25	2.41
24 Month	1.31	1.65	1.86	1.96	4.96	4.01

Figure 8.

Line Graph 3-Class Model for Depression Symptoms for Mothers from the Dzimauli Community, South Africa (n = 247)



Summary of Trajectory Analysis

For the total sample, Latent Class Growth Analysis was used to identify four trajectory groups: Low, Moderate-Decreasing, Moderate-Increasing, and High. In the total sample, 60.72% of mothers reported a low level of depression symptoms and 7.44% of mothers reported a high level of depression symptoms. When looking at the depression symptoms across locations, the number of trajectories varied from group to group, ranging from three to five trajectories. Because the SRQ was designed to be used with local, community-based norms rather than standardized cutoffs, examining trajectories by location provides increased diagnostic utility.

Three maternal depression trajectories were reflected for BGD, PKN, PEL, and SAV, while five trajectories were found to be most appropriate for the IVN sample. For each group, it was most common for mothers to report low levels of depression symptoms. PKN had the largest percentage of mothers reporting a high level of

depression symptoms with 15.44% of mothers in the High-Increasing group. Ultimately, the null hypothesis was rejected for each group: the data reflected different trajectories of depression rather than one homogenous group.

Mediation Path Model

A mediation model was created to determine if there was a relationship between maternal depression trajectories and child cognitive development. Based on previous research, high, chronic levels of maternal depression, particularly in early motherhood, have been correlated with difficulties in parent-child interactions and negative outcomes for child development (Campbell et al., 1995; Teti & Gelfand, 1991; McGrath et al., 2008). In the present study, it was hypothesized that mothers in trajectory groups characterized by more severe, chronic depression symptoms would have children with lower cognitive scores. To account for maternal depression's negative impact on the home environment, it was hypothesized that the three HOME domains (Emotional and Verbal Responsivity, Environmental Health and Safety, Child Cleanliness; Jones et al., 2017) mediated the relationship between trajectory group and child cognitive development at 24 months. This relationship was examined using mediation path models in R Studio. In the model, the three HOME domains were structured to be correlated with each other, each mediating the relationship between trajectories of maternal depression and child cognitive development. Because structural equation modeling theory is based on large sample sizes (Kline, 2015), the total sample of 1250 mothers was used to analyze this model.

Several indices were examined to determine if the model fit the data appropriately. A statistically insignificant Chi-Square test reflects good model fit while a

statistically significant Chi-Square test suggests that the model does not fit the data (Memon et al., 2018; Ullman & Bentler, 2013). RMSEA values close to zero ($<.05$), CFI values closer to one ($>.8$), and TLI values closer to one ($>.8$) indicate good model fit (Shi et al., 2019; Ullman & Bentler, 2013). The TLI is the relative chi square; it is less sensitive to a large sample size but often more sensitive to high correlations (Shi et al., 2019). P values ($<.05$) were also considered to determine a statistically significant total mediation model. When all of these criteria are met, the model is considered statistically significant and an appropriate fit for the data (Gunzler et al., 2013). Bootstrapping was used to improve the quality of the estimation. Please refer to Figure 1 for proposed path model. Prior to testing the model, bivariate correlations between the variables and trajectory group were examined. Please see table 17 for correlations.

Table 17
Bivariate Correlations Including Trajectory Group (N = 1250)

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. EVR 6 months	1	-	-	-	-	-	-	-	-
2. ES 6months	.29**	1	-	-	-	-	-	-	-
3. CC 6months	.15**	-.38**	1	-	-	-	-	-	-
4. SRQ 1 month	-.11**	-.19**	-.19**	1	-	-	-	-	-
5. SRQ 6 months	-.12**	-.22**	-.19**	.57**	1	-	-	-	-
6. SRQ 15 months	-.06**	-.18**	-.12**	.52**	.60**	1	-	-	-
7. SRQ 24 months	-.05	-.18**	-.16**	.53**	.57**	.67**	1	-	-

Table 17*Bivariate Correlations Including Trajectory Group (N = 1250)*

	1.	2.	3.	4.	5.	6.	7.	8.	9.
8. Cog 24 months	.38**	.31**	.14**	-.12**	-.08**	-.10**	-.08**	1	-
9. TG	-.11**	-.21**	-.19	.71**	.76**	.78**	.80**	-.11**	1

Note. EVR is HOME Emotional and verbal responsiveness, ES is Environmental safety and healthfulness, CC is Child Cleanliness, SRQ is Self Report Questionnaire total standard score, Cog is Bayley Infant Scales of Development, 3rd Edition, Cognitive score.

TG is Trajectory Group membership

** $p < .01$, * $p < .05$

Mediation Path Model Results

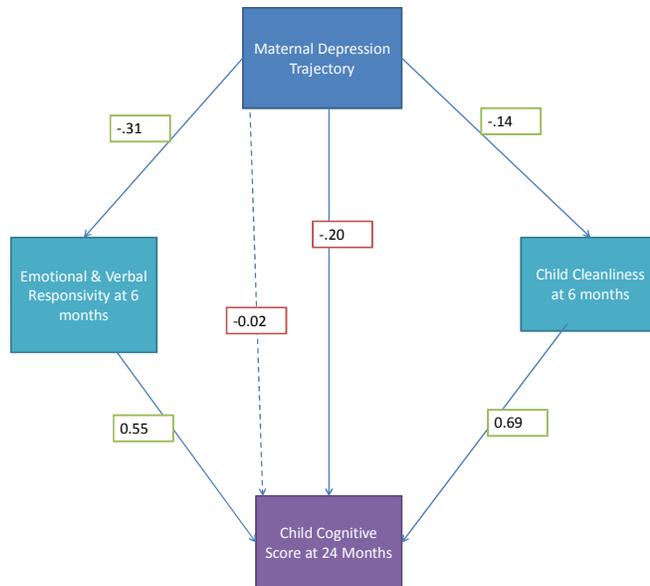
In the initial model, the three HOME variables were specified as correlated. This model could not be run properly. To adjust the model, the correlations between the HOME variables were removed. A modified model without correlated residuals revealed multicollinearity, or highly correlated variables. One mediator, Environmental Health and Safety, was removed from the model to eliminate multicollinearity.

For the two-mediator model, the Chi-Square test was statistically significant ($p < .01$, $df = 3$). The fit indices indicated less than adequate model fit; the RMSEA was 0.12, the CFI was 0.92, and the TLI was 0.74. These results indicated that this was a better fit for the data due to the higher CFI but the other fit indices reflect poor fit. Please see figure 9 for path model results. Although the model was not a statistically significant, the results revealed statistically significant relationships between Trajectory Group and each of the HOME variables ($p < .05$). Each of the HOME dimensions at six months also predicted child cognitive development at 24 months ($p < .05$). As indicated in figure 9, the

indirect relationship between Trajectory Group and child cognitive development at 24 months was not statistically significant ($p = .61$).

Figure 9.

Mediation Path Model Results



Note. Dotted straight lines indicate indirect effects. Solid straight lines indicate direct effects. Red squares indicate significant estimates. Green squares indicate significant estimates.

Summary

The Latent Class Growth Analysis results indicated that the five different sites were characterized by various maternal depression trajectories. These trajectories ranged from three to five distinct patterns. Four trajectories were identified for the total sample; Low ($n = 759$), Moderate-Decreasing ($n = 246$), Moderate-Increasing ($n = 152$), and High ($n = 93$). Once the trajectories were identified for the total sample, these groups were used to explore a hypothesized relationship with other relevant variables. Based on the literature and preliminary analysis, maternal depression trajectories were predicted to

impact child cognitive performance as mediated by the three HOME domains, Emotional and Verbal Responsivity, Environmental Health and Safety, and Child Cleanliness. The mediation analysis indicated that the model was not statistically significant. These results indicated that the HOME variables did not mediate the relationship between maternal depression trajectory and child cognitive development. Thus, differential item functioning was not examined with this model.

CHAPTER 5

DISCUSSION

Depression negatively impacts quality of life on a global scale (APA, 2013; WHO, 2017). Because women are more likely to develop depression compared to men, it is important for researchers to investigate women's experiences to better serve the population. Although there are biological markers that may predict depression in women (i.e, reproductive hormones, pregnancy, postpartum; Deave et al., 2008), socio-cultural factors (i.e. stress, gender expectations, income, cultural practices; Mauthner,1993) have a significant impact on a mother's development of depression. Depression is a global concern, yet typically examined from a Western lens (Patel et al., 2003). The present study aimed to examine maternal depression through an intersectional feminist lens with longitudinal analysis of maternal depression in several international locations.

Review of Findings

The present study included participants from the MAL-ED Study which assessed multiple factors in maternal health and child development across under-represented, international locations (Miller et al., 2014). Maternal depression symptoms were measured at one, six, 15, and 24 months using the Self-Report Questionnaire (SRQ; Beusenberg & Orley, 1994). A 16-item, one factor model was validated to measure depression symptoms with the MAL-ED participants (Pendergast et al., 2014). The Bayley Scales of Infant and Toddler Development (BSID-III; Bayley, 2009) cognitive scale was used to measure cognitive development in children at six, 15, and 24 months. The BSID-III was found to be a valid measure of cognitive abilities for the five sites in the present study (Pendergast et al., 2018). The Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984) was used to assess elements of the

home environment at six and 24 months. A three-factor model (Emotional and Verbal Responsivity, Environmental Safety and Healthfulness, Child Cleanliness) with 43 items was found to be appropriate for the MAL-ED participants (Jones et al., 2017).

Latent class growth analysis (LCGA) was used to identify trajectories of maternal depression in the total sample and for each of the five sites. With the total sample, a mediation model was created to examine the relationship between trajectory groups and child cognitive development as mediated by the three correlated factors of the HOME inventory.

The results indicated that four trajectory groups were reflected in the total sample: Low (60.72%), Moderate-Decreasing (19.68%), Moderate-Increasing (12.16%), and High (7.44%). As predicted, the most common trajectory group reported low symptoms. Because the SRQ was translated into different languages and there are cultural differences between each site, trajectories were analyzed for each of the five groups separately. Based on previous studies (Campbell et al., 2007; Guyon-Harris et al., 2015; Hammen & Brennen, 2003; Park et al., 2018;), between three and six different trajectories of maternal depression were predicted. Some studies included “stable” or “intermittent” in the labels of trajectories (Campbell et al., 2007; Guyon-Harris et al., 2015). For the present study, trajectories were labeled based on severity (low, moderate, high) and included whether the symptoms increased or decreased over time. If later time points between 24 and 60 months are included in analyzing trajectories, description of the patterns may change.

For the BGD, PKN, PEL, and SAV mothers, three trajectories were most appropriate. The BGD (n = 241) trajectories included a low group (47.72%), moderate

group (39.42%), and high symptom group (12.86%). The PKN mothers (n = 259) demonstrated similar trajectories: low-decreasing (49.03%), moderate-decreasing (35.52%), and high-increasing (15.44%). The primary difference between these two groups is the predicted level of depression at the next measure. For example, the PKN mothers with high levels of depression symptoms may have higher symptoms at 30 months whereas the BGD mothers with high levels of symptoms likely maintained or decreased in depression symptoms.

The PEL site featured lower levels of depression. The average SRQ score for the low group ranged from 1.45 to 1.81; these scores would likely not indicate clinical levels of depression. Unlike the other groups, the PEL site did not reflect a trajectory for “high” levels of depression symptoms. Although the level of symptoms seems below the total sample average (See Table 2), the PEL group’s trajectories reflected that some mothers started with above-average symptoms. Looking at two different “moderate” groups revealed that some mothers reported reduced symptoms over time and some mothers demonstrated more severe symptoms. Examining only the average depression symptoms at each time point for the PEL mothers would not highlight these differences.

The SAV group demonstrated patterns of either low depression or depression that decreased over time. Across time points, the average level of depression was lower than the total sample. The high-decreasing group consisted of only six mothers (8.2%), but this group demonstrated postpartum depression symptoms considerably higher than the other mothers in the SAV group. Examining these trajectories revealed that mothers in the SAV group reporting high levels of postpartum depression symptoms (average of 9.71) might report moderate levels of depression by 24 months (average of 4.96).

The INV mothers featured five distinct trajectory groups, varying from the other sites. IVN's high-decreasing group had similar means when compared to the high groups for BGD, PKN, and the total sample, starting with an average of 11.93 and decreasing to 9.93. The INV group featured three trajectories of "moderate" depression symptoms; each of these trajectories had different means across time. Distinguishing the three moderate groups helps to draw conclusions about the various experiences of these mothers and families. A mother who consistently reports four to five symptoms likely had a different experience than a mother who initially reported four symptoms at postpartum and then ten symptoms when their child was 24 months.

Although the site locations differed from each other, the trajectory groups that were created were generally similar (low, moderate, high). When combined in the total group, mothers in the low and high groups generally remained in those categories. The total sample trajectories accounts for moderate symptoms that were either increasing or decreasing over time. However, the trajectory groups created for the total sample may not provide as much guidance for future directions for each site location.

A path model was used to test the proposed mediation model. SEM is a large-sample technique, thus the total sample was more appropriate for conducting this analysis. The hypothesized model included correlated residuals between mediators, the three HOME factors (Emotional and Verbal Responsivity, Environmental Safety and Healthfulness, and Child Cleanliness; Jones et al., 2017). However, this model was not statistically viable. A modified model without correlated residuals revealed multicollinearity, or highly correlated variables. The results of the modification indices suggested several adjustments to the model that were not statistically possible (e.g.,

leading to a non-identified model). One mediator, Environmental Health and Safety, was removed from the model to eliminate multicollinearity.

Ultimately, the data demonstrated that trajectory group was not a strong predictor of child cognitive development despite statistically significant correlations. The HOME inventory was included in the model as a mediator; however, these results may support examining a more direct relationship between the three HOME factors and child cognitive development.

Implications

Examining maternal depression trajectories in multiple low- and middle-income countries provides insight for understanding maternal depression in non-Western cultures. The results demonstrated different trajectories across locations, which helps support the idea that maternal depression is a complex, socio-cultural experience beyond hormonal shifts (Halbreich & Karkun, 2006). One cultural factor that may impact depression symptoms is postpartum social support (Evagorou et al., 2016; Goodman et al., 2009). Some mothers reported low symptoms at one and six months postpartum but reported more higher symptoms later. It is possible that mothers endorsed more depression symptoms as the amount of social support from family decreased. In some groups, the increase of depression symptoms over time may support the need for mental health services beyond six months postpartum. For example, 15% of mothers in the PKN group reported high symptoms at one month postpartum with increasing symptoms over time.

The three HOME inventory domains (emotional and verbal responsiveness, environmental safety and healthfulness, and child cleanliness; Jones et al., 2017) were hypothesized to mediate the relationship between maternal depression trajectories and

child cognitive development. Previous research has indicated that maternal depression negatively impacts parenting behaviors, the home environment, and mother-infant interactions (Campbell et al., 1995; Murray, 1992). Additionally, preliminary correlations indicated that maternal depression trajectories and the home environment were related to child cognitive development. However, the insignificant mediation results may indicate that maternal depression trajectories may not be directly impacting a child's development, with or without accounting for the home environment. Mothers who are not depressed may struggle with maintaining their child's cleanliness and a safe, interactive environment for a number of reasons. In low- and middle-income areas around the world, including Western nations, mothers may struggle to provide for their children due to lack of resources, support, and systemic inequity. These mothers may not identify depression symptoms, but other daily stressors may impact their child's environment and development.

School Psychology Connections

Several aspects of school psychology provided a foundation for the present study. Firstly, school psychologists often research and assess cognitive development as it pertains to academic achievement and future success (NASP, 2021a). When assessing a child's development, school psychologists consider multiple socio-cultural factors (NASP, 2021a). In the United States, NASP provides guidance for culturally responsive practices and ethical considerations for working within the school system, across settings, and with diverse families (NASP, 2021b). The family and home environment play a key role in a child's development (Bronfenbrenner, 1979). Family-school collaboration is an essential component to support a child's overall development (Christenson & Reschly,

2010). This collaboration acts as a protective factor for individuals from under-resourced communities or for those who have been disenfranchised through systemic oppression (Yamauchi et al., 2017). Investigating the experiences of families from different cultures can provide insight to inform treatment and prepare clinicians to better support children, in and outside of the school setting.

Previous studies found that chronic depression symptoms starting during the postpartum period predicted social, emotional, and behavioral challenges for children (Conners-Burrow et al., 2015; Patel et al., 2003). The present study aimed to expand on the relationship between maternal depression and child development. However, the findings did not support a relationship between maternal depression trajectory and child cognitive development with these specific groups.

Strengths & Limitations

The longitudinal design of the MAL-ED study and the inclusion of participants from low- and middle-income, non-Western countries were strengths for the present study. The study also benefitted from a large sample size including data from both mothers and children. Mothers from the diverse, international locations enrolled in the study within 17 days of giving birth and continued participation for 60 months (MAL-ED Network Investigators, 2017). The measures used in the present study were translated and validated with the specific cultural groups in the MAL-ED study (Murray-Kolb et al., 2018). Identifying maternal depression trajectories in these specific groups contributes to existing research on depression symptom presentation in non-Western populations.

Interpretation of the study was limited by systematic missing data and the use of multiple imputation method. It is possible that the missing participants were related to

observed variables. For example, the PEL site was missing up to 27% of participants from measures at 24 months. The country of origin or other health indicators may have been a factor in these missing data. If mothers who endorsed higher symptoms of depression were unable to participate in the study due to their symptoms, their data would have impacted the trajectories for that group.

One limitation of the study was the inability to include maternal depression symptoms during pregnancy, prior to pregnancy, or during past pregnancies. The SRQ was not administered while mothers were pregnant or prior to pregnancy. Depression during pregnancy (Gaillard et al., 2014) and a general history of depression (Cooper & Murray, 1995) are predictors of postpartum depression. Having SRQ data prior to motherhood and during pregnancy may be helpful in understanding the chronicity of depression symptoms. Access to a mental health history would be useful for drawing more robust conclusions. Additionally, because only one depression rating scale was administered, diagnostic conclusions could not be made from these results. Use of other measures of depression to demonstrate criterion validity would be beneficial in the future.

Another limitation of the study was the use of mediation analysis with the total sample rather than the separate groups. This is a limitation because there were differences in depression symptoms and trajectories based on location. Using the total sample limits the ability to draw specific connections between cultural groups, depression trajectory, and other variables. This choice was made because participants remained generally in the same trajectory when they were in the total group. For example, a mother from BGD who fell in the “low” trajectory in the BGD analysis was also in the “low” trajectory for the total sample. However, ideally, mediation analysis would account for different cultural

groups. Because these groups are unique, results cannot be generalized to the entire country or to other countries.

Future Directions: Clinical Application & Research

Although the mediation analysis was not significant in this study, future research may examine this relationship using multilevel modeling which may account for the different cultural groups. In the future, more advanced data analysis, such as differential item functioning (DIF), may highlight the specific differences between the five groups presented in this study. For example, the three HOME domains may have varying impact on and relationships with maternal depression trajectories depending on site location. Examining the relationship between the HOME variables and child cognitive development for each location may provide guidance for family-based interventions. The breadth of data that were collected for the MAL-ED study could also be utilized to identify other relationships with maternal depression trajectories and the home environment which were beyond the scope of the present study. Maternal depression trajectories may influence other outcomes such as a child's language development, behavior, mood, and executive functions (Goodman & Gotlib, 1999; Hay et al., 2008; Vanska et al., 2011); future research can look at these relationships outside of Western countries.

It may also be valuable to continue expanding research on maternal depression trajectories to other locations that were not included in the MAL-ED study. Direct comparison between Western countries and Non-western countries may provide support for a more culturally salient understanding of depression, considering symptom reporting, severity, and predictive factors. The present study included low- and middle-income

countries. Additional research which considers variables that are unique to each location will be helpful in continuing to understand maternal depression. For example, future research can address access to mental health care, attitudes towards mental health, knowledge about symptoms, and economic and environmental factors that would be specific to certain cultural groups. For many of the MAL-ED sites, extended family units are common. In future studies of maternal depression with these groups, researchers can account for number of family members, support in childrearing, as well as roles and responsibilities in household.

To further the intersectional perspective of this issue, it would be beneficial for researchers to explore other types of parents and individuals outside of the heteronormative binary. As cultural norms shift and change, the mental health of LBGTQ+ parents, fathers, and alternative guardians will become increasingly more important to understand. Researchers with different cultural backgrounds and perspectives will also be beneficial for diversifying the understanding of depression and home environment as it pertains to the whole family and individuals within the family unit.

In applying the results of the study, it is essential that individuals from the cultural groups are consulted. For example, doctors and mental health professionals in Loreto, Peru, as well as mothers and families, should be a part of the conversation in understanding their specific depression trajectories. In this study, PEL mothers demonstrated lower levels of depression symptoms than the other groups, but some mothers in the group reported very high symptoms on the SRQ. Depression screeners and regular interactions with mental health professionals can help to identify symptoms and

treat them appropriately. Across the groups, there were mothers that demonstrated symptoms that started very low but increased over time. If these mothers had not been enrolled in the study, it is likely that they would not have had access to mental health professionals in order to report these symptoms and receive treatment. Access to mental health professionals varies by location: some sites, such as Tanzania, have less than five psychologists in the entire country (L. Pendergast, personal communication, June 20, 2022). An important clinical application of these results is the benefit of mental health screeners for mothers and visits which continue regularly during the postpartum period and into early childhood.

Conclusion

The overall purpose of the present study was to utilize an intersectional and multicultural perspective when examining maternal depression and its impact on child development. The study prioritized using a person-centered approach to maternal depression trajectories in non-Western, low- and middle-income countries. Identifying maternal depression trajectories across five different cultural groups helps to shape our understanding of maternal depression. The results revealed different trajectories for the five locations with varying severity from one month postpartum to 24 months. Although “low” levels of depression symptoms were most common in each group, high and persistent depression symptoms were also endorsed by some mothers. These results support the need for providing culturally appropriate mental health support and regular screenings for mothers up to 24 months postpartum. Further investigation of the relationship between the home environment and child cognitive development would be beneficial for low- and middle-income countries. Any future publications related to the

present study will include researchers from MAL-ED's international sites in order to provide the most culturally salient perspective.

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APPENDICES

A. HOME OBSERVATION ITEMS IN MAL-ED

Note. Item stems have been altered slightly to protect copyrighted material.

1. Caregiver spontaneously vocalizes to the child during the visit.
2. Caregiver verbally responds to child's vocalizations.
3. Caregiver tells the child the name of some person or object during the visit.
4. Caregiver's speech is clear.
5. Caregiver initiates verbal exchanges with the observer.
6. Caregiver expresses ideas and is conversational (i.e., gives more than brief answers).
7. Caregiver spontaneously praises child twice during visit.
8. When speaking to the child, caregiver's voice conveys positive feeling.
9. Caregiver does something affectionate with the child (hugs, pats, etc.) during the visit.
10. Caregiver shows some positive emotional response to the child.
11. Caregiver smiles at or laughs with the child.
12. Caregiver does not shout at the child.
13. Caregiver does not overtly display annoyance or hostility toward the child.
14. Caregiver does not slap or spank the child.
15. Caregiver reports no physical punishment within the past week.
16. Caregiver does not scold/criticize the child during the visit.
17. Caregiver keeps the child within visual range and looks at the child frequently.
18. Caregiver talks to the child while doing chores.
19. Caregiver intentionally encourages developmental advances.
20. Caregiver provides structure in the child's day.
21. Caregiver believes the child's behavior can be changed or modified by the parent.
22. When the primary caregiver is away, care is provided by one of three regular others.
23. Child is not cared for by another child (under age 12).
24. There is no evidence that anyone handles the child inappropriately.
25. Someone brings the child to a shop or market at least once a week.
27. The child is taken to the health clinic regularly.
28. The child has a special place to keep his toys and things
29. The child's play area is relatively safe and free from hazards.
30. The stove is located in a relatively safe area.
31. The house is relatively light.
32. The house is relatively ventilated.
33. The house is relatively clean.
34. The house is relatively neat and orderly.
35. There are appropriate play materials (e.g., toys, tins, balls, dolls, slates) in the house
36. The child has a riding toy for gross motor stimulation.
37. The caregiver provides toys or activities during the visit.
38. There are some magazines, newspapers, or books visible in the home.
39. The family has a pet.
40. The father plays with the child or is involved with caregiving every day.
41. The caregiver tells the child stories or nursery rhymes at least weekly.
42. The caregiver sings to the child daily.
43. The child eats at least one meal per day with the caregiver and the father.
44. The family has not moved more than once in the past year.

45. The family visits with relatives at least once per month.
46. The family visits with close friends at least once per month.
47. The child is relatively clean, with no offensive odor.
48. The child's hair is relatively clean.
49. The child's clothes are relatively clean.

B. SRQ ITEMS IN MAL-ED

1. Trouble thinking clearly
2. Feeling nervous/tense/worried
3. Feeling worthless
4. Thinking of ending life
5. Crying more often
6. Loss of interest
7. Feeling unhappy
8. Difficulty enjoying activities
9. Tiring easily
10. Hands shake
11. Daily work suffering
12. Unable to play a useful part in life
13. Difficulty making decisions
14. Always tired
15. Easily frightened
16. Loss of appetite

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