A Longitudinal Study of the Stress-buffering Effect of Social Support on Postpartum Depression

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DISSERTATION

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Acknowledgments

When I started learning English in elementary school, I noticed that an address in English always starts from the smallest unit: room number, street name, county then country. It seems like in Chinese, a subject or time is always described from the largest unit to the most focal point. I am writing the acknowledgments in English, but I will organize it following the habit of my first language.

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Abstract

Background: Postpartum depression (PPD) impacts about one out of eight new mothers, and it has a unique and pervasive impact on a woman, a child, and a family. Research has demonstrated that perceived social support has a positive effect on PPD. Nevertheless, there has been disagreement on how social support influences depression. The overall goal of this study is to test the stress-buffering effect of social support on postpartum depression by using two different definitions of stress and following a rigorous procedure of research design and statistical analyses.

Methods: Secondary longitudinal data were used to answer the research question. In total, 512 first-time mothers comprised the study sample. Parenting stress and difficult life circumstances measured at six months postpartum was used to predict the changes in depressive symptoms from 6 to 12 months postpartum and social support measured at six months postpartum was used as a moderator between stress and PPD. Structural Equation Modeling (SEM) was adopted for statistical analyses.

Results: The results showed that parental distress, one component of parenting stress, had a significant long-lasting impact on PPD. The other two components of parenting stress, difficult child and parent-child dysfunctional interaction, did not have a direct effect on PPD. Difficult life circumstance also showed a significant enduring influence on PPD.

Social support was not found to moderate the influence of parenting stress or difficult life circumstances on PPD. A significant direct effect of social support on depression was not found by this study either. Neither the stress-buffering theory of social support nor the main-effect model of social support was endorsed by the longitudinal study.

Conclusions: The findings encourage social workers to be mindful of the impact of parental distress and difficult life circumstances on new mothers' mental health. Problem-solving tools and interventions that aimed to enhance self-mastery and self-efficacy are recommended to help new mothers be more resilient in dealing with parental distress and daily hassles.

Measures for social support and parenting stress with higher capability of discrimination should be used in future stress-buffering research. More longitudinal studies with shorter lags between measurement occasions are warranted in order to figure out at what point social support is most useful for new mothers' mental health.

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Chapter 1 Introduction

Problem Statement and Significance

Depression during the peripartum phase is one of the most common complications of pregnancy (Gavin et al., 2005). The DSM-5 (American Psychiatric Association, 2013) defines peripartum depression as a major depressive disorder with peripartum onset, and the "peripartum" is specified as during pregnancy (antepartum) or in four weeks after childbirth (postpartum). The current study focuses on the examination of postpartum depression (PPD). The postpartum time period is specified as immediately after childbirth to 4 weeks after childbirth by the DSM-5 (American Psychiatric Association, 2013). There is ongoing dispute about the time frame of "postpartum" since depressive symptoms have been observed up to 12 months after childbirth (Munk-Olsen, Laursen, Pedersen, Mors, & Mortensen, 2006; Segre & Davis, 2013) and researchers call for a more flexible view of the cut-off time for the postpartum period (O'Hara & McCabe, 2013). PPD in this study is referred to as depressive symptoms from childbirth to 12 months after childbirth.

The prevalence of PPD ranges from 6.5% to 12.9% (Gavin et al., 2005; Mann, Gilbody, & Adamson, 2010). Women suffering from PPD bear a higher risk of preterm birth (Accortt & Schetter, 2014) and have a lower quality of mother-infant interaction (S. H. Goodman, Broth, Hall, & Stowe, 2008). Children of mothers who suffer from PPD are more likely to develop insecure attachment (Atkinson et al., 2000; Martins & Gaffan, 2000), to have compromised emotional and social development (Glasheen, Richardson, & Fabio, 2010), and to show behavioral disturbance (Deave, Heron, Evans, & Emond, 2008; Stein et al., 2014).

To better help women with postpartum depression, it is crucial for researchers and healthcare providers to identify and understand factors that are associated with a higher risk of PPD. Social support is one of the most important factors that has been recognized to have direct and indirect positive effects on depression. Three meta-analyses (C. T. Beck, 2001; O'Hara & Swain, 1996; Robertson, Grace, Wallington, & Stewart, 2004) reported that social support is a moderate or a strong predictor of PPD.

While social support is widely accepted as a protective factor, a lack of consensus on how social support influences depression characterizes the literature. Two theories—stress-buffering theory and main-effect theory—have been guiding most of the studies on social support and depression. Stress-buffering theory posits that social support moderates the relation between stress and depression. The primary function of social support is to attenuate the relationship between stress and depression. One fundamental assumption of the stress-buffering theory is that the effect of social support is conditioned on the levels of stress. The higher levels of stress, the more important social support is to protect people against developing depressive symptoms. Different from the stress-buffering model, the main-effect model of social support proposes that regardless of stressors, a lack of or a low level of social support, in and of itself, increases the risk of onset and development of depressive symptoms. Correspondingly, higher levels of social support lead to a more favorable outcome in one's mental health.

The primary goal of this study is to understand the mechanism through which social support influences postpartum depression by empirically testing the two competing theories of social support. Elucidating the theories of social support has practical significance. When designing a support-enhancing-focused intervention for postpartum depression, researchers or

practitioners may find the main-effect model philosophically appealing and practically straightforward (Monroe, Imhoff, Wise, & Harris, 1983). According to the main-effect theory, lack of social support is directly related to higher levels of depression, consequently, improving clients' self-perception or increasing clients' social support should be sufficient to ease the depressive symptoms. However, if the theoretical underpinning of the stress-buffering model is closer to reality—social support primarily plays a buffering role between stress and depression—then the role of stress cannot be overlooked because social support has a joint effect with stress on depression. Analyzed from another angle, the interaction between stress and support indicates that the magnitude of the association between social support and depression is conditioned on stress. Let us suppose that social support influences depression solely through stress-buffering, social support will have no effect on depression whatsoever if someone perceives no stress. On the other hand, the higher levels of stress presented, the more important social support becomes in preventing depression. Without assessing stress, the main effect of social support on depression can be spurious; without investigating the influence of stress-support interaction on depression, using the main-effect model of social support as a guideline in practice can be misleading. In addition, recognizing that social support is more critical for people under high levels of stress, social workers can help their clients more efficiently through addressing the stressor(s) and mobilizing social network resources that are functionally related to the stressor(s). Considering the theoretical and practical significance, it is time to go beyond merely proving the association between support and depression but to further examine the mechanism through which social support prevents the onset and development of depressive symptoms.

Besides the theoretical and practical significance of testing the two theories of social support, the investigation of the interaction between stress and social support is also essential in

studies of depression, especially postpartum depression. Research has also demonstrated that stress is a risk factor for postpartum depression (O'Hara & Swain, 1996). For a woman who just gave birth to a baby, stress is virtually everywhere: attending the baby's demands, getting used to the new identity as a mother, and fighting to keep her multi-faceted identities—herself, a good wife, a responsible employee, etc. In addition to the stress new mothers commonly encounter, living in poverty adds more strains and makes a certain group of women more vulnerable to PPD. In short, given that stress is prevalent among new mothers and a risk factor of PPD, it is substantially important and methodologically necessary to include stress in studies of the relationship between social support and PPD.

Stress-buffering theory of social support has been challenged because of inconsistent empirical evidence. Burton, Stice, and Seeley (2004) reviewed previous prospective studies and found little support for the stress-buffering model: only 3 out of 58 stress-support interactions tested were significant. Lakey and Cronin (2008) also implied that the main-effect theory may be more valid since there is consistent evidence for the main-effect model yet very few studies showed evidence for the stress-buffering effect. I argue that the critique ignored the fact that the stress-buffering model is more complex than the main-effect model. Because of the complexity, higher statistical power is required to detect a true interaction effect. Secondly, it is uncommon to see that researchers concluded that the main-effect model had been better supported by empirical evidence without providing a rigorous evaluation of inconsistent and competing evidence. The more complicated stress-buffering model is more vulnerable to low statistical power caused by measurement errors, poor research design, and inappropriate data analysis. In other words, the null findings of an interactive effect

between stress and social support may be attributable to methodological issues. This alternative reason should be closely examined and ruled out before claiming that the main-effect model is more valid than the stress-buffering model.

The Current Study

Investigating the interaction between stress and social support as well as its influence on PPD contributes to social work practice and the clarification of the two competing theories of social support. Given that the contradictory empirical evidence on the stress-buffering model may be attributed to methodological issues, this dissertation firstly critically evaluated the existing stress-buffering studies, then conducted another test of the stress-buffering model. In this study, difficult life circumstance and perceived parenting stress were both conceptualized as stress and used to test the stress-buffering model respectively. Measures of stress, social support, and depression with high reliability and validity were selected to keep measurement error as low as possible. Furthermore, structural equation modeling (SEM) was applied to explicitly model measurement error and to evaluate the latent interaction effect between stress and social support on PPD. Last but not least, this study employed a longitudinal design to capture the temporal relations among stress, social support and depressive symptoms.

Chapter 2 Overview of Literature

This literature review addressed the current theories and research on the relationships among stress, social support, and postpartum depression (PPD). I organized the literature review by (a) describing concepts of postpartum depression, stress, and social support, (b) discussing the two dominant theories regarding the relationship between social support and depression, and (c) examining the empirical evidence on the theories and research gap this dissertation is aimed to fill.

Major Concepts of the Study

Postpartum depression.

Conceptualization.

Many terms have been used to describe depressive symptoms that are related to pregnancy or childbirth: prenatal depression, antepartum depression, peripartum depression, perinatal depression, postpartum depression, and perinatal mood and anxiety disorders, etc. The DSM-5 (American Psychiatric Association, 2013) adopted the term "peripartum depression" and defined it as a major depressive disorder with peripartum onset. The diagnostic criterion of a major depressive disorder is that at least five out of nine symptoms have been present during the same two weeks and represent clinically significant distress or impairment in social or occupational functioning. The nine symptoms are as follows (American Psychiatric Association, 2013, pp. 160-161) :

1. "Depressed moods most of the day, nearly every day";

2. “Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day”;

4. “Insomnia or hypersomnia” nearly every day;

3. A significant change in weight or appetite nearly every day;

5. “Psychomotor agitation or retardation nearly every day”;

6. “Fatigue or lack of energy nearly every day”;

7. “Feeling of worthlessness or excessive or inappropriate guilt” nearly every day;

8. “Diminished ability to think or concentrate” nearly every day;

9. Suicidal ideation or attempt.

Among the symptoms, at least one is either depressed moods (the first) or diminished interest or pleasure (the second).

The “peripartum onset” is specified as the onset of a major depressive disorder occurring during pregnancy (antepartum) or in four weeks after childbirth (postpartum) (American Psychiatric Association, 2013). However, there have been disputes about the time frame of the postpartum period. Segre and Davis (2013) argued that many depressive episodes occur after one month postpartum and they advocated to extend the time frame of postpartum depression to six months. A few studies support the argument. One piece of evidence is from a 32-year nationwide cohort study in Denmark. Munk-Olsen et al. (2006) reported that risks of hospital admission for psychiatric disorder among new mothers increased significantly through three months postpartum compared with women who had given birth one year prior; specifically, risks of admission for unipolar depression were considerably higher from childbirth through

five months postpartum. Also, significantly increased risks of outpatient contact for psychiatric disorders persisted through five months postpartum. A study conducted among 120 sibling pairs with recurrent unipolar depression also suggested that the four-week-postpartum window may be a bit restrictive. The working group for the DSM-5 initially considered extending the time frame but eventually concluded that the existing empirical evidence is not enough. Since there is no consensus as to the definition of postpartum onset, O'Hara and McCabe (2013) call for a more flexible view of the cut-off time for the postpartum period. This study focused on the changes in depressive symptoms after childbirth and its dynamic with stress and social support. Considering that depressive symptoms, stress and social support can fluctuate significantly in the first year after childbirth, the postpartum period in this study is referred to as from immediately after childbirth to 12 months after childbirth. Depressive symptoms in the postpartum period were referred to as postpartum depression (PPD) in this study.

Prevalence, incidence, and consequence.

Prevalence of PPD has been reported with broad ranges. The Pregnancy Risk Assessment Monitoring System (PRAMS), a surveillance project of the Centers for Disease Control and Prevention (CDC) and state health departments, reported that the average prevalence of self-reported postpartum depressive symptoms in the United States in 2012 was 11.5%. The prevalence ranged from 8.0% (Georgia) to 20.1% (Arkansas) in 27 participating states (Ko, Rockhill, Tong, Morrow, & Farr, 2017).

Mann et al. (2010) published a systematic overview of existing systematic reviews of PPD prevalence. Only two systematic reviews (Gavin et al., 2005; O'Hara & Swain, 1996) provided quantitative summary estimates of the prevalence. O’Hara & Swain (1996) reported an overall PPD prevalence of 13% (n=12,810, 95% Confidence Interval (95% CI): 0.123-0.134).

Furthermore, self-report based measures of PPD yielded a significantly higher mean prevalence (14%, 95% CI: 0.131-0.149, n=28 studies) than interview-based measures of PPD (12%, 95% CI: 0.113-0.127, n=31 studies; t (57) =0.28, $p<.05$). Based on 28 studies with interview-based measures, Gavin et al. (2005) reported that the point prevalence from pregnancy to one year postpartum ranged from 6.5% (8- to 12-months postpartum) to 12.9% (3-months postpartum). The 95% CIs of estimates were wide, indicating a considerable amount of variation in the prevalence of PPD. Mann, Gilbody, and Adamson (2010) concluded that Gavin et al. (2015) study has a higher quality of methodology than the O'Hara & Swain study (1996). First, the review by O'Hara & Swain did not provide sufficient details about the inclusion criteria. Second, the mean prevalence calculated in that study is an unweighted arithmetic summary, which failed to consider the impacts of research quality and sample size for each study. In conclusion, it is estimated that postpartum depression influences about one out of eight new mothers and the prevalence of PPD is highest around three months postpartum.

Regarding the onset of depression after childbirth, it was estimated 7.8% from delivery to one month postpartum and 14.5% from childbirth to three months postpartum (Gavin et al., 2005). Cox, Murray, and Chapman (1993) observed a threefold risk of the onset of depression within five weeks postpartum compared with non-childbearing women. In other words, the risk of depression onset is much higher within five weeks after childbirth compared with women of similar ages and socioeconomic status (SES) who did not give birth.

O'Hara & Swain (1996) and Gavin et al. (2005) both reported a significant association between lower SES and PPD. Yonkers et al. (2001) found that 17% of women who visited an inner-city maternal clinic met the criteria of postpartum depression based on the Edinburgh Postnatal Depression Scale (a self-report measure). The average age of participants in the study

was 24 years old, and most had not completed high school. Another inner-city study reported that 23.4% of new mothers were depressed based on an interview-based measure (Hobfoll, Ritter, Lavin, Hulsizer, & Cameron, 1995). Almost all participants in the Hobfoll et al. (1995) study were on public assistance.

PPD has a pervasive impact on a woman, a newborn and the family. Women suffering from perinatal depression bear a higher risk of preterm birth (Accortt & Schetter, 2014), and have a lower quality of mother-infant interaction (S. H. Goodman et al., 2008). A mother plays the most critical role in the early development of a child (Sherryl H. Goodman et al., 2011; Stein et al., 2014). Attachment insecurity of a child is significantly related with the mother's depression (Atkinson et al., 2000); infants of depressed mothers were more likely to show avoidant (Type A) and disorganized (Type D) types of insecurity (Martins & Gaffan, 2000). A prospective cohort study (Kahn, Zuckerman, Bauchner, Homer, & Wise, 2002) indicated that 3-year-old children of mothers with PPD had delayed development in language, showed more frequent tantrums, and were more difficult to manage and to get along with other kids. At the age of five, these children showed diminished responsiveness in mother-child interactions and presented more behavioral disturbance at home (Murray, Sinclair, Cooper, Ducournau, & Turner, 1999).

Stress.

Conceptualization.

The concept of stress has been around for centuries. Definitions of stress have evolved along with a deeper understanding of the biopsychosocial model and its influence on one's well-

being. Butler (1993) summarized three ways of conceptualizing stress: stimulus-based definition, response-based definition, and stress as a dynamic process.

The stimulus-based definition focuses on environmental input. When the external pressure becomes too big, the internal collapse becomes inevitable. The stimulus-based definition assumes that an adverse event has the same impact on different individuals. The response-based description focuses on the individual's physiological and psychological response to an adverse event. The same event can have widely varying effects on people. As Butler (1993) concluded, both definitions were helpful in understanding the phenomenon of stress but with limited utility. The stimulus-based definition reflects 100% of the outside influence from the environment but ignores the variation in personality traits. On the contrary, the response-based definition acknowledges the difference in personal characteristics but overlooks the complexity of environmental input.

A more comprehensive and up-to-date definition of stress combines the strengths of the stimulus perspective and response perspective. It fits into the "Person in Environment" (PIE) model, which takes personal characteristics as well as the external input into account. According to Lazarus and Folkman (1984, p. 21), psychological stress is "A relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being."

Being a new mother can be stressful. While trying to recover from delivery, a woman has to adapt to her new identity as a mother and take responsibility for the newborn— a creature who demands constant attention and care. It is not hard to imagine that the new identity and extra responsibilities may outweigh a woman's available resources and tilt the balance. When a new

mother perceives the imbalance between her resources and the excessive demands, parenting stress takes place.

Parenting stress was also defined by Deater-Deckard (2004, p. 6) as "a set of processes that lead to aversive psychological and physiological reactions arising from attempts to adapt to the demands of parenthood." Parent-child-relationship (PCR) theory—the most widely applied parenting stress theory (Deater-Deckard, 2004)—posits three resources of parenting stress: a parent's functioning problems, a difficult child, and a dysfunctional relationship between the parent and the child.

Stress and depression.

Stress and illness are closely associated. When stress is sustained for a long time, it can affect one's physiological functioning as well as psychological status. Physically, stress increases the risk of coronary heart disease and dermatological disease. It also exerts an adverse impact on the immune system and reproductive function. Psychologically, long-lasting stress leads to a higher risk of depression, anxiety, and panic disorder (Wheatley, 1993).

It should be noted that the relationships between stress and many physical and mental issues are two-way streets. Depression can develop insidiously "under the cloak of continuing anxiety symptoms" (Wheatley, 1993, p. 6), and in turn, depressive symptoms may aggravate the stressful situation and cause a further imbalance between demands and available resources. The fact that the stress-depression relationship can be a vicious circle requires a longitudinal design if a specific causal direction is of interest. For this study, one of the premises is a causal direction from stress to the increase in depressive symptoms. Therefore, a longitudinal design will be necessary to answer the research question of interest.

Social support.

Conceptualization.

Durkheim's study of suicide (1951) inspired generations of social scientists to delve into the impact of social relationships on mental health. Nevertheless, there is no consensus regarding the definition of social support. Lin (1986, p. 18) provided an inductive definition of social support by synthesizing definitions used in empirical research: *The perceived or actual instrumental and/or expressive provisions supplied by the community, social networks, and confiding partners.*

This synthesized definition acknowledges different layers of the social environment around a person. The outer and most general layer is a community, which reflects people's social integration in larger social groups or the broader social structure. Support from neighborhood, school, church, and voluntary groups are examples of community support. Social networks are one layer closer to the core of one's social support system. Compared with the community, social networks are more specific: kinship, friendship, working relationship, etc. An individual develops a sense of bonding through social networks. Finally, the core layer of the social support system is support from confiding partners. A confidant relationship is expected to be reciprocal, intimate and more responsible for each other's well-being than the other two types of social support.

Perceived support and received support.

The definition also distinguishes perceived social support from received social support. Perceived social support is one's perception of social resources to be available

if needed. Received social support is the actual resources one gets from his or her social relationships. A weak association between perceived support and received support has been reported by Lakey and Cassady (1990): received social support accounted for only 8.4% of the variance in perceived support. The low shared variance indicates that perceived support is not simply a reflection of received support. Lakey and Drew (1997) proposed that perceived support is a reflection of received support and the support recipient's unique relationship with the provider. Two persons can have different perceptions with the same amount of support depending on their unique relationship with the support providers. The social constructivist theory posits that perceived social support is a blending of specific personality constructs and social relations (Sarason, Sarason, & Pierce, 1990). On the other hand, perceived support is neither a simple reflection of personality traits nor a simple reflection of cognitive constructs. A factor analysis demonstrated that perceived social support is a psychosocial construct distinct from cognitive constructs (e.g., self-esteem, dysfunctional attitudes) and affective constructs (e.g., dysphoria and anxiety) (Lakey & Cassady, 1990).

Empirical evidence has also shown that the association between received social support and depressive symptoms is weak. The received support performs more like an indicator of actual needs than a reflection of the strength or the supportiveness of social relations (Lakey & Cohen, 2000). In this study, perceived social support will be employed to represent the magnitude and quality of social relations.

The support system around new mothers.

Having a child is a life-changing event, and it puts extra responsibilities—sometimes in the form of strains—on a woman. While recovering from delivery and taking care of a needy infant, the new mother can get overloaded by other demands,

such as household chores and errands (Cutrona, 1996). The fluctuation of hormones during the postpartum period, body changes, constant demands from the newborn, together with daily hassles may induce emotional disturbance. For a new mother in her transition to parenthood, a strong support system is particularly valuable. According to Hobfoll and Walfisch (1984), a support system with a variety of resources that meet different challenges can increase one's well-being. The core of a new mother's support system is her partner and parents (most of the time).

Numerous studies have described that partner support is particularly important, if not most important, for women during illness or transitional periods (Cutrona, 1996; Norbeck & Anderson, 1989; O'Hara, Rehm, & Campbell, 1983). Logsdon, Birkimer, and Barbee (1997) interviewed 50 new mothers during the six-week postpartum examination about their needs and resources. The researchers found that partners were the most frequently listed support resource for almost all types of problems: day-to-day concerns, the infant's urgent needs, work problems, emotional disturbance, family issues, etc. The emotional, empathetic understanding from partners was especially appreciated by new mothers.

Logsdon et al. (1997) also found that help was most needed by new mothers in day-to-day concerns and urgent needs from the infants. Due to the compromised physical status after delivery, doing household chores and running errands are particularly challenging. Moreover, a new mother, especially a first-time mother, responds strongly to the urgent cry of the newborn. A helping hand with these daily hassles and immediate demands is very much needed. Thoits (1986) demonstrated that support from those who have had a similar experience and successfully dealt with the

challenge is more likely to be perceived as useful. A new mother's parents are excellent resources of informational support: they give specific advice(e.g., how to change diapers, what kind of material is better for an infant's skin, what to check when the newborn cannot stop crying) and share their experience of raising a kid. Grandparents can also provide practical support. In some cultures, it is widely accepted that grandparents live together with new parents for a few months and help with the transition. In many cases, grandparents ease the new mother's burden by taking care of chores around the house, e.g., cooking, house cleaning, doing laundry, and grocery shopping (Leung, 2001).

While partner support and parental support comprise the core of a new mother's support system, the different types of support help with different challenges a new mother encounters. Razurel, Kaiser, Antonietti, Epiney, and Sellenet (2017) found that support from partners alleviated new mothers' depressive symptoms and anxiety, yet parental support boosted new mothers' sense of competency. Some studies also reported that the associations between depressive symptoms and support from different resources vary in their magnitude. Haslam, Pakenham, and Smith (2006) reported a significant correlation between higher levels of parental support and depressive symptoms, but an insignificant one between partner support and depression. Because of the importance of core support system around new mothers and the different roles that partner support and parental support may play, the present study will differentiate support from the baby's father and parental support so that their influence on postpartum depression can be assessed separately.

Theories on the Relationship between Social Support and Depression

In this section, I will describe and discuss two dominant theories on the relationship between social support and depression. One is the stress-buffering theory, and the other is the main-effect theory.

The Stress-buffering model of social support.

Lazarus and Folkman's (1984) stress, appraisal, and coping theory is the theoretical framework of stress-buffering perspective. According to Lazarus and Folkman (1984), one's psychological stress level depends on how a person appraises the relation between the self and the environment. Two forms of cognitive appraisal take place when someone encounters an adverse event. The first one, traditionally called primary appraisal, is a process of categorizing the encounter: is it irrelevant, benign-positive or stressful? Stressful appraisals can be further classified as harm/loss, threat, or challenge. Harm/loss concerns damage that has been sustained. Threat concerns harm or loss that has not yet occurred but is anticipated. The anticipatable feature of threat permits anticipatory coping, which is the critical difference between harm/loss and threat. The third type of stressful appraisals is challenge. The challenge appraisal centers on potential gain and growth from a stressful situation, whereas threat appraisal focuses on the potential harm or loss.

Let's use parenting as an example to comprehend the three types of appraisals. When a new mother observed that her child does not seem to learn as quickly as most children, a harm/loss appraisal can be that she harmed her child. She may think: "Oh my God, my child is so much slower than other kids. I must've done something wrong during my pregnancy! I destroyed my baby's life!" or "I am so dumb that my kid takes after me." A threat appraisal can be that she is threatened by the situation. She may think: "My daughter is slower than other children and the future life for my baby will be miserable. What can she do in the future for a living? No one

wants to hire her…..” In comparison, challenge appraisal centers on potential gain and growth. She may think: “Different kids have different paces on development and learning. My kid and I are probably able to figure things out together.”

Another important construct that influences psychological stress is coping. Coping is a process defined by Lazarus and Folkman (1984, p. 141) as “constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person.” This definition of coping emphasizes two features. First, coping strategies are examined under specific circumstances. Second, coping is a process instead of a static measure of personality traits or disposition. Coping strategies change along with the change in person-environment relation. In other words, coping—as a process—is a function of continuous appraisal and reappraisal of the dynamic between resources and demands. Coping can be generally categorized into two forms: emotion-focused coping and problem-focused coping. In brief, emotion-focused coping regulates emotional responses to a stressful encounter by getting minds off the problem, seeking emotional support and changing the meaning of the objective situation, etc. Problem-focused coping manages or alters the problem that causes distress by mobilizing external resources, generating alternative solutions, lowering goals and ambition, reducing ego involvement, etc. Specifically, problem-focused coping can be directed both outward and inward.

By influencing cognitive appraisal and coping process, social support is expected to alleviate the adverse effect of psychological stress on one’s mental well-being. Let’s go back to the example of a child who is slower than his or her peers. Appropriate support could help the mother reappraise the stressful task and view the situation from a more optimistic light: it is a challenging event but not harm or a threat. By seeking informational support from a child

psychologist or parents who shared a similar experience, she may realize that the difficulty is not permanent and can be overcome. By reappraising the stressful situation, it is likely that the mother will feel less depressed even though the actual situation has not changed. Social support also can be a coping resource. For example, emotional support and expressed empathy may comfort the mother and protect her from being depressed; instrumental support may provide extra resources that she can use to handle the excessive demands.

In summary, social support changes how one appraises a stressful encounter and provides coping resources. Through reappraisal and coping, social support exerts a buffering effect on the relationship between stress and one's mental well-being. The stress-buffering perspective of social support can be expressed in Figure 1.

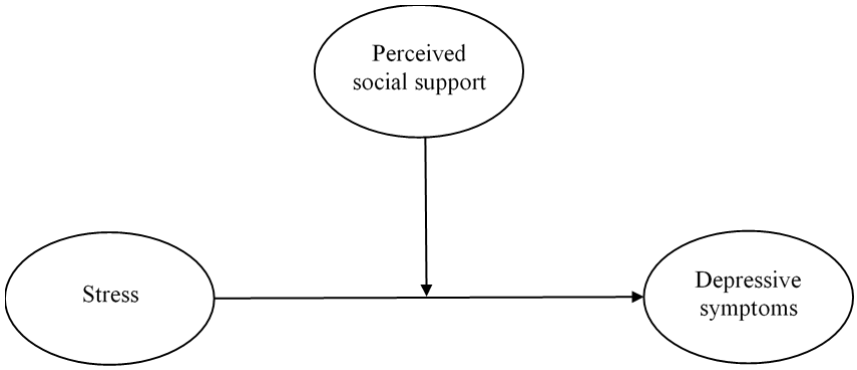

Figure 1 Stress-buffering perspective of social support

The main-effect model of social support.

In the main-effect model, social-cognition approaches are applied to conceptualize the relationship between social support and depression. From a social-cognition perspective, how people view themselves is socially constructed and the experience of "self" is largely a reflection of how one is viewed by others (Lakey & Cohen, 2000). In consequence, the perception of

lacking social support, in and of itself, can directly lead to depressive symptoms, regardless of the presence or the level of stress.

Beck proposed a negative cognitive triad, which later is called depressogenic beliefs, in his cognitive theory on emotional disorders (A. T Beck, 1970). A cognitive triad is comprised of one's view of the world, the view of self and expectations of the future. Negative interaction with the external world may reflect and influence one's self-image. For example, people who on a regular basis perceive that their acceptance by others is conditioned upon their performance are prone to develop a precarious sense of self-esteem (Baldwin & Sinclair, 1996). Furthermore, the reinforcement between a negative view of the external world and low self-image leads to one's high expectation for negative outcomes in the future (A. T. Beck & Bredemeier, 2016). The formation of this negative cognitive triad is a critical component in the development of depression.

According to the main-effect theory of social support, when one perceives a lack of social support, this negative view on social relations can lead to a negative view of the self, such as low self-esteem or self-efficacy (Lakey & Cohen, 2000); the combination of a negative view of one's social environment and low self-image, in turn, may give rise to negative emotional responses (Figure 2).

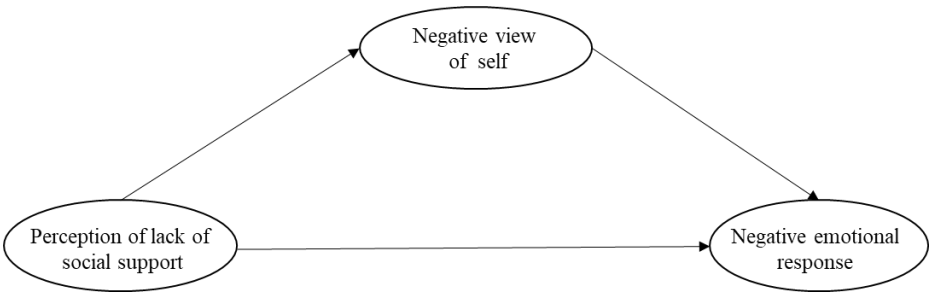

Figure 2 Social-cognition perspective of social support

Empirical Evidence

In the previous section, I reviewed concepts of postpartum depression, stress and social support, and the two dominant theories of the support-depression relationship: the stress-buffering model and the main-effect model. Since the 1980s, there has been disagreement on which model reflects the real relationship between support and depression more accurately. A study named "*A prospective test of the stress-buffering model of depression adolescent girls: No support once again*" expressed doubt about the stress-buffering model (Burton et al., 2004) . Many researchers concluded that there is scant evidence for the stress-buffering effect (Lakey & Cronin, 2008). Payne (2010, p. 47) stated in his dissertation that "the majority of studies provide either full support or partial support for a main effect model where social support impacts depression directly rather than through interactions with negative events as proposed by the buffer theory." Through my literature review, however, I found most studies used empirical evidence without any evaluation on the quality of research where the empirical evidence was derived. Nevertheless, the validity of empirical evidence can vary significantly depending on the quality of the study. This problem is particularly salient while comparing the stress-buffering model with the main-effect model. The stress-buffering model is more complex than the main-effect model: the former one has one more predictor and one interaction term. Hence, testing the stress-buffering model requires higher statistical power. The complexity of the stress-buffering model was rarely acknowledged; meanwhile, the main-effect model was frequently endorsed to have more empirical support. I argue that without a rigorous evaluation of the inconsistent evidence, it is not tenable to claim that the main-effect theory is better supported than the stress-buffering model.

Cohen and Wills (1985) provided an excellent review of studies published through 1983 on the interaction between stress and social support. Their evaluation covered in great detail the operational definitions of stress and support, and a variety of methodological issues. Cohen and Wills (1985) concluded that there is evidence consistent with both models, depending on how social support is conceptualized and measured. In my literature review, the effort was made to provide a further evaluation of studies published through 2017 that specifically focused on the stress-buffering effect of social support on depressive symptoms. Following Cohen and Wills (1985), the operational definitions and measurements for stress and social support, and issues in research design and statistical analysis will be critically examined.

What kind of empirical evidence counts?

Before delving into details, I'd like to mention that only studies that included all the three key variables—stress, social support, and depressive symptoms—were included. The reasons that I did not review studies that only assessed support and depression are as follows. First, I argue that evidence that shows social support precedes and predicts depression is not sufficient to support the main-effect model because this significant association can also hold in the stress-buffering model. To rule out the stress-buffering model, the interaction between stress and social support must be nonsignificant along with a significant association between support and depression. In other words, to support the main-effect model of social support, evidence that the strength of the association between support and PPD is not influenced by stress level is needed. Another scenario is that even if the interaction between stress and social support is significant, social support showed a significant effect on depression through the whole range of stress. In this situation, we can conclude that social support has a unique direct influence on depression and also buffer the influence of stress on depression. Second, a left-out variable error occurs when a

critical variable, i.e., stress, in this case, is left out of the analysis. The left-out variable error indicates that the association between social support and depression without controlling for stress can be inaccurate or spurious (Kline, 2016). Taken together, studies that did not measure stress are not able to test either the stress-buffering model or the main-effect model of social support. Therefore, these studies were not included in my literature review.

In contrast to studies that did not measure stress when they should have, another scenario is that stress was not directly measured in stress-buffering studies. Ortiz (2013) studied the relationship between social support and depressive symptoms among students whose English is a Second Language (ESL students). The levels of English proficiency were used as a proxy of stress. Similarly, Cutrona and Troutman (1986) did not measure stress directly, but they construed difficult infant temperament as a stressor for new mothers and reported a significant interaction effect between support and difficult infant temperament on maternal depression. From my perspective, significant findings from studies where stress was indirectly measured could be counted as evidence for the stress-buffering model because learning in a second language or dealing with a difficult infant, in and of itself, is a stressor.

Have discussed the eligibility of empirical evidence, in the following sections, I first overviewed studies in groups by whether they found evidence to support or oppose the stress-buffering model. Then I discussed the gaps in the literature regarding operational definitions of key variables, measurements, research designs, and statistical analyses.

Literature searching strategy.

I used Cochrane Review, ProQuest Dissertation and Theses, PubMed, PsycINFO, Social Work Abstracts, and Web of Science as my databases for the literature search. Combinations of

search terms and truncations are *stress AND depress* AND support, stress AND depress* AND support AND (protec* OR buffering OR moderat*), stress AND depress* AND support AND (protect* OR buffer* OR moderat*).*

By reading abstracts, I excluded studies that did not investigate the stress-buffering effect of social support on depression. In total, 64 full-text articles were downloaded for further review. Among the 64 articles, seven are conference abstracts, and their full texts cannot be accessed through my databases, UH Onesearch, UH interlibrary loan, and Google search. Another 20 studies were further excluded from analysis due to one of the following reasons: a) the stress-buffering effect of social support on depression was not investigated, b) the role of social support was conceptualized as a mediator rather than a moderator (Aneshensel & Frerichs, 1982; Iles, Slade, & Spiby, 2011; Reid & Taylor, 2015), c) the outcome variable was not depressive symptoms (Gremore et al., 2011), d) there are considerable flaws in operational definitions of key variables, or e) the articles are literature review or methodology oriented. Finally, 32 research articles that reported empirical findings of the stress-buffering effect of social support on depression were included in my literature analysis.

The 32 articles covered studies from 1980 to 2017, among which 17 found a significant interaction effect between support and stress, whereas 15 did not support the stress-buffering model. In the next few sections, I first overviewed the empirical evidence by each group, then carefully examined the operational definitions of stress different studies have employed. After that, I discussed the methodological issues revealed from the literature that may limit the statistical power to detect an interactive effect.

Overview of empirical evidence that supported the stress-buffering model.

Seventeen studies reported social support as a buffer between stress and depressive symptoms. These studies had diverse targeted populations: six of them focused on adolescents (Anderson, Salk, & Hyde, 2015; Auerbach, Bigda-Peyton, Eberhart, Webb, & Ho, 2011; Dubois, Felner, Brand, Adan, & Evans, 1992; Raffaelli et al., 2013; Yang et al., 2010; Zhang, Yan, Zhao, & Yuan, 2015), four on a community population (Chen, Siu, Lu, Cooper, & Phillips, 2009; McFarlane, Norman, Streiner, & Roy, 1983; Takizawa et al., 2006; Uebelacker et al., 2013), three on college students (Habif & Lahey, 1980; Monroe et al., 1983; Pretorius, 1994), three on postpartum women (Coburn, Gonzales, Luecken, & Crnic, 2016; Paykel, Emms, Fletcher, & Rassaby, 1980; Razurel et al., 2017), and one on the elderly population (Chan, Anstey, Windsor, & Luszcz, 2011).

More than half of these studies adopted a cross-sectional design (Chan et al., 2011; Chen et al., 2009; Habif & Lahey, 1980; Paykel et al., 1980; Pretorius, 1994; Raffaelli et al., 2013; Razurel et al., 2017; Takizawa et al., 2006; Zhang et al., 2015) and the other half are longitudinal, with a measurement gap from six weeks (Coburn et al., 2016) to three years (Uebelacker et al., 2013).

Overview of empirical evidence that did not support the stress-buffering model.

Fifteen studies reported that they did not find a significant interaction effect between social support and stress. These studies also had diverse targeted populations: seven studies focused on adolescents (Burton et al., 2004; Dumont & Provost, 1999; McCarty, Stoep, Kuo, & McCauley, 2006; Ortiz, 2013; Payne, 2010; Zimmerman, Ramirez-Valles, Zapert, & Maton, 2000); four on community population (Aneshensel & Stone, 1982; Cranford, 2004; Marks, 2007;

Monroe, 1983); two on the elderly population (Paukert et al., 2010; Russell & Cutrona, 1991); one on women with young children (Manuel, Martinson, Bledsoe-Mansori, & Bellamy, 2012), and one on patients suffering from rheumatoid arthritis (Brandstetter et al., 2017).

Seven studies (Aneshensel & Stone, 1982; Brandstetter et al., 2017; Dumont & Provost, 1999; Marks, 2007; McCarty et al., 2006; Ortiz, 2013; Paukert et al., 2010) adopted a cross-sectional design and five were longitudinal, with measurement gaps from six weeks to two years.

Gaps in literature: inconsistent operational definitions of stress.

The investigation of the buffering role of social support on the stress-depression dynamic is premised upon a significant and unique relationship between stress and depression. How stress is defined and measured influences the magnitude of association with depression. There was wide variation in how stress was measured in studies of the stress-buffering model. Some studies defined stress as external input and measured stress with a checklist of negative life events one experienced in a fixed period (usually six months or one year). Other researchers believe that stress is a result of external input and internal judgment. Correspondingly, they adopted measures for stress that assessed external input with a certain degree of subjective evaluation.

Eight studies measured stress as the number of adverse events a person experienced in a certain period of time (Burton et al., 2004; Dubois et al., 1992; McCarty et al., 2006; McFarlane et al., 1983; Monroe et al., 1983; Russell & Cutrona, 1991; Uebelacker et al., 2013; Zimmerman et al., 2000). The negative life events can be major life events, minor life events, daily hassles or strains. These measures are commonly referred to as checklists of negative life events, which reflect the stimulus-based perspective of stress, solely focusing on the external input.

Majority of stress-buffering studies adopted more sophisticated ways to assess stress. With 4-, 5- or 7-point Likert scales, some studies asked participants to evaluate the frequency of a negative event while some studies asked participants to rate the degree of undesirability or impact of a negative event. In short, most studies took one's subjective evaluation of an event into consideration. These measures integrated external input and internal evaluation of the input, which mostly reflects the stimulus-response definition of stress.

In general, studies that used Likert scales yielded stronger bivariate correlations between stress and depressive symptoms than studies that counted negative life events. Among the seven studies that used a binary checklist, the concurrent bivariate correlations between stress and depression ranged from 0.137 (Russell & Cutrona, 1991) to 0.412 (McFarlane et al., 1983), indicating a weak or moderate correlation. Among studies that used 4-, 5- or 7-point Likert scales, the concurrent bivariate correlations had a wide range: two studies reported correlations between .2 and .3 (Chen et al., 2009; Pretorius, 1994); ten studies reported a moderate to strong bivariate correlation between stress and depression, ranging from .3 to .5, (Anderson et al., 2015; Chan et al., 2011; Coburn et al., 2016; Habif & Lahey, 1980; Monroe et al., 1983; Paykel et al., 1980; Payne, 2010; Razurel et al., 2017; Yang et al., 2010; Zhang et al., 2015); four studies reported a strong correlation from .53 to .7 (Auerbach et al., 2011; Cranford, 2004; Dumont & Provost, 1999; Payne, 2010; Raffaelli et al., 2013).

Researchers who used a count of adverse life events argued that introducing subjective evaluation (e.g., the frequency of negative events, the degree of undesirability or impact of events) confounds the objective environmental impact with the individual's perception. Monroe et al. (1983, p. 346) argued: "Although such an approach (measure with subjective weights) may be useful for attempting to maximize event-disorder associations, clearly such methods

ultimately constrain inferences of event-related etiology and must eventually be complemented with further work bearing upon the relative importance of individual differences, perception, and event incidence." Dohrenwend, Askenasy, Krasnoff, and Dohrenwend (1978, p. 207) also argued that although integrating an individual's perception of an event "may be useful for understanding and treating individual cases," it is not "a clean measure of environmental input in a stress process" but "some resultant of environmental input, the affected individual's predisposition, and his assessment of the outcome."

On the other hand, it is true that a checklist of negative life events is easier to use and interpret, yet its underlying assumptions should be further examined. The checklist of negative life events measures stimuli. It assumes that each stimulus introduces the same amount of stress and that the total amount of stress follows an additive model. I argue that this measurement oversimplifies the mechanism of stress. First, people may react to the same event in widely different manners. For instance, parents' divorce is an event that is almost always included in a checklist of negative life events. To some children, parents' divorce may be extremely stressful and can exert a long-term psychological impact. On the contrary, some kids may take the situation well and do not perceive much stress. Second, events on the same checklist may have different levels of severity, undesirability, and impact. Counting the occurrence for each item assumes that each event carries the same weight of stress. McQuaid, Monroe, Roberts, Kupfer, and Frank (2000) argued that this additive model does not reflect how stress works. Furthermore, they argued that the frequency of stressful situations, the degree of undesirability and the degree of negative impact of an event should be taken into consideration while measuring stress. Third, in studies for stress-depression relation, the use of a stimulus-focused measure of stress implies that the external input, in and of itself, causes depression (Cohen, Kamarck, & Mermelstein,

1983). Lazarus and Launier (1978) argued that the depressive response is not based solely on some inherent qualities of the event but rather is developed from a collective effect of environmental, personal and cognitive factors.

As mentioned earlier, it was found that the concurrent bivariate correlation between a number of negative events and depression is generally smaller than the correlation between stress measured in Likert scales and depression. Empirically speaking, to test the stress-buffering model, it is a prerequisite that stress uniquely contributes to the development of depression. Without a significant association between the two, there is no point to investigate how social support buffers the effect of stress on depression. Ortiz (2013) used English proficiency as the indicator of stress among Latino English learners and tested the protective role of social support on depression. The study did not find a significant interaction between support and stress, but their null finding is not surprising because the agent of stress—English proficiency—was not significantly correlated with depressive symptoms. Similarly, Paukert et al. (2010) studied the buffering role of social support between physical issues and depression among older adults and did not find evidence for the buffering model. Again, it is not surprising because the correlation between physical problems and depressive symptoms is less than .1, which is a very weak association.

In summary, different definitions of stress and different theories in the relationship between stress and depression cause disagreement on how to measure stress. Although empirically the measures that combine external input and internal judgment show a higher association with depression, it is hard to say in theory that one method is clearly better than the other. Therefore, in this study, two forms of stress will be assessed: difficult life circumstances and perceived parenting stress.

Gaps in literature: Methodological issues.

As aforementioned, the stress-buffering model is more complicated than the main-effect model. Therefore it requires higher statistical power to detect a true interaction effect if there is one in the population. Low statistical power is not uncommonly seen in the literature of stress-buffering research. In this section, I investigated some methodological issues I encountered during the literature review. It should be noted that the issues discussed here are not exclusively applicable to studies with null findings in the stress-buffering effect of social support. Some problems are prevalent across both groups.

Measurement error.

A measurement is a tool that bridges unobservable constructs—in this study they are stress, social support and depression— and observable phenomenon. As Carmines and Zeller (1979, p.11) put "measurement focuses on the crucial relationship between the empirically grounded indicators—that is, the observable response—and the underlying unobservable concepts." The stronger the relation, the more accurate inferences we can make about the underlying concepts through analyzing observed responses. On the contrary, if the relationship is weak or faulty, analysis of observed responses may lead to inaccurate inferences about the latent constructs. When the empirically grounded data do not portray the concepts we are trying to measure, a measurement error occurs (Rubin & Babbie, 2011, p. 188). It is true that the measurement process is extremely vulnerable to errors, yet the degree of measurement error does vary across studies and is worth taking into account when we evaluate empirical evidence.

One type of measurement error is random error, which can lead to low reliability of a measurement. Reliability refers to "the likelihood that a given measurement procedure will yield

the same description of a given phenomenon if that measurement is repeated." (Rubin & Babbie, 2011, p. 212). A reliable measurement is important because it is expected that the responses collected from participants do not fluctuate greatly due to randomness. The reliability of a measurement is especially important for studies of moderation since the measurement error in individual predictors reduces the reliability of the interaction term dramatically. In this study, the measurement error in stress and social support can significantly lower the reliability of the interaction term—stress × social support and reduce the power of statistical tests, which in turn lead to inaccurate inferences or faulty conclusions (Aiken & West, 1991).

Brandstetter et al. (2017) used a single item to measure perceived pain among arthritis patients and did not find a significant stress-buffering effect of social support. Similarly, Marks (2007) used one item to measure functional status and two items to measure perceived social support. He did not find significant evidence for the stress-buffering effect of social support either. The problem with single-item measurement or measurement with too few items is that some constructs are too complex or multifaceted to be measured by one or two item(s) (Rubin & Babbie, 2011). The single-item measurement might not have captured all relevant aspects of the experience of pain or functional status. Likewise, perceived social support may be too complicated to be measured by two items. The possibility that the null findings were attributable to the poor reliabilities of these measures cannot be ruled out.

Internal consistency reliability is to assess whether the multiple items in a measure are internally consistent. Cronbach's alpha is the most popular indicator of internal consistency reliability. As a rule of thumb, Cronbach's alpha should be higher than 0.7 to demonstrate acceptable internal consistency (Nunnally, 1978). In the Russell and Cutrona (1991) study, subscales of social support showed low internal consistency reliabilities: The Cronbach's alpha

ranged from 0.34 to 0.62. The insignificant finding of this study may be due to the low consistency reliability in the measurement for social support.

As mentioned earlier, the measurement error is virtually inevitable. However, conventional statistical techniques such as multiple regression unrealistically assume that all predictors were measured without error. Different than conventional methods, Structural Equation Modelling (SEM) acknowledges the inevitability of measurement error and separates measurement error from latent constructs by explicitly modeling the unexplained variance. The unexplained variance includes two parts: measurement error and specific variance that is not explained by any factor in the model (Kline, 2016). This is not to say that SEM can eliminate measurement error, but it does lend a more realistic quality to the analysis of measurement error (Kline, 2016). During my literature review, I did not find one study that employed SEM in its analysis. In my dissertation, SEM will be applied to partition the measurement error from the constructs of interest and investigate how the error-free construct of social support influences the relationship between the error-free constructs of stress and depression.

Another type of measurement error is systematic error. The systematic error causes validity problems in measurement. Validity concerns the degree that observable indicators measure the unobservable construct that is supposed to reflect (Rubin & Babbie, 2011). Indicators of an invalid measurement may reflect some other construct that research is not interested in or not intended to measure. For example, Aneshensel and Stone (1982) proposed to test the buffering effect of perceived social support, which was measured through questions like "How often during the past two months has someone provided you with the listed types of support?" Based on the description of indicators, I argue that the measurement assessed received support instead of perceived support. Payne (2010) also pointed out that measures for social

support used in some studies were so ambiguous that there was no guarantee that the magnitude of perceived support was measured.

Problems of categorizing variables.

Another issue that is commonly seen in moderation literature is categorizing continuous composite scores and designating participants into different groups. Aneshensel and Stone (1982) dichotomized depressive symptoms and trichotomized scales of social support and stress. From log-linear analyses, they concluded that social support did not show a buffering effect between stress and depression. Similarly, Manuel et al. (2012) dichotomized depressive symptoms and reported null findings of the stress-buffering effect.

Maccallum, Zhang, Preacher, and Rucker (2002) examined the practice of categorizing quantitative measures in psychology studies and concluded that the dichotomization of continuous scales is rarely defensible and often yields misleading results.

On the one hand, information about individual differences is lost in the process of dichotomizing continuous scores. The lost information, in turn, lowers the statistical power which is essential to detect a real effect.

On the other hand, Maxwell and Delaney (1993) found that when both independent variables are dichotomized, spurious interactions can occur. Furthermore, Bissonnette, Ickes, Bernstein, and Knowles (1990) demonstrated through a simulation study that dichotomization not only yields more spurious interactions but also shows a higher rate of false negative error when there is a moderation effect in the population. In short, the dichotomization approach is more likely to yield spurious findings due to an inflated Type I error and false negative conclusions due to low statistical power.

Takizawa et al. (2006) used ten binary items to assess perceived social support. Their sample was then divided into a high support group and low support group based on the dichotomized total score. Dumont and Provost (1999) dichotomized their participants as people with high levels of stress and people with low levels of stress. Although both studies reported a significant interaction between support and stress, the evidence may be spurious due to arbitrarily dichotomizing quantitative variables.

Taken together, dichotomization of continuous scales can lead to a variety of negative consequences, which include loss of information, loss of statistical power and the occurrence of spurious significant main effects or interactions. Consequently, empirical evidence that derived from studies with categorized social support, stress or depression may be faulty or misleading due to inappropriate analytical approaches.

Problems of cross-sectional designs.

As overviewed previously, among studies that investigated the stress-buffering effect of social support on depression, about half used cross-sectional designs while half used longitudinal designs. I argue that cross-sectional designs have inherent limitations in studying the moderation effect. In the stress-buffering theory, stress is conceptualized as a causal factor of depression. Three criteria are necessary to establish a causal relation between stress and depression: the first is that stress and depression must covary; secondly, the correlation must not be attributable to any other variables: a unique, independent association must persist after other variables are controlled. Thirdly, the supposed cause—stress—must precede or be simultaneous with the supposed effect—depression in time (Menard, 1991). In the language of statistics, the initial level of stress is expected to be associated with subsequent depressive symptoms after initial symptoms and other variables have been controlled for. Similarly, social support is

conceptualized to either directly influence depression in the main-effect theory or jointly influence depression with stress in the stress-buffering theory. The causal relation between social support and depression is implied in both theories. Through a cross-sectional design, evidence for the first two necessary conditions for a causal relation may be obtained, but temporal order from stress and support to depression requires a longitudinal design.

It is critical to understand that the three criteria are necessary but not sufficient conditions to establish a causal relation. Also, a longitudinal design is not unambiguous in determining the causal relation; it represents an improvement over cross-sectional data in this regard.

The high concurrent correlation but almost zero longitudinal association between stress and depression is not uncommonly seen in the literature. Zimmerman et al. (2000) reported a moderate effect size of correlation (r=.3) between initial levels of stress and depression, but a very weak one (r=.09) between the initial level of stress and depression measured six months later. The regressive coefficient of initial levels of stress on depression six-month post initial measurement is 0.07 after controlling for the initial level of depression. The study found a significant interactive effect using cross-sectional data but not with longitudinal data. Similarly, Pagel, Erdly, and Becker (1987) and Vinokur and Ryn (1993) also came to different conclusions from cross-sectional data and longitudinal data. Veiel (1987) conducted a simulation study and further demonstrated that a cross-sectional design could yield a spurious buffering effect when the effect of stress and social support are only additive, not interactive. The study also showed that a longitudinal design is more likely than a cross-sectional design to distinguish an interaction effect from other non-linear relationship between stress and depression. Taken together, the discrepancies in empirical findings by using cross-sectional data and longitudinal data and the

evidence from simulation studies demonstrate the limitation of cross-sectional designs and underscore the importance of longitudinal designs for testing a moderation effect.

Given that a longitudinal design is essential for testing a moderation effect, one caveat is that the lag between measurement occasions can be critical to whether a true effect can be detected. The effect of stress on one's psychological status takes time to unfold, so the measurement lag cannot be too short. On the contrary, the gap between two observations cannot be so long that researchers miss the window between which the effect can be detected (Little, 2013).

In the Burton et al. (2004) study, the number of adverse life events did not show a significant relation to adolescents' change of depressive symptoms over the two-year follow-up period: the regression coefficient was 0.01, and negative life events explained less than 1% of the variance in changes of depressive symptoms. Similarly, Manuel et al. (2012) used baseline depression, stress, social support and the interaction between stress and support to predict depression level at a two-year follow-up and concluded that there is no buffering effect of support between stress and depression. My argument is that a two-year lag may be too long and the window of detecting the effect of stress on depression was missed. In consequence, the possibility that the null findings are attributable to the long lags between measurement occasions cannot be ruled out.

Other issues that may limit statistical power.

Because of the complexity of the stress-buffering model, it requires a larger sample size to detect the effect. The sample sizes of studies that reported null findings ranged from 30 to more than 4500. Except for the Ortiz (2013) study (n=30) and the Monroe (1983) study (n=75),

other studies all had reasonably large sample sizes. The null findings of an interactive effect between stress and social support are probably not due to small sample sizes.

Summary of the Literature Review

Postpartum depression impacts about one out of eight new mothers, and it has a unique and pervasive impact on a woman, a child, and a family. To better help new mothers, their children and families, it is essential for researchers and healthcare providers to identify and understand factors that are associated with a higher risk of PPD.

Research has shown that social support has a positive effect on PPD. Social support was inductively defined by Lin (1986, p. 18) as "*the perceived or actual instrumental and/or expressive provisions supplied by the community, social networks, and confiding partners.*" Perceive social support is one's perception of social resources to be available if needed. Received social support is the actual social resources one obtained. Research has shown that perceived social support is a stronger predictor of depression; therefore, perceived social support will be analyzed in this study. Support from a new mother's mother (maternal support) and support from the baby's father comprise the core of her support system. The two sources of support can have different influences on new mothers. In consequence, the present study differentiated maternal support and support from the baby's father so that their interactions with stress and their influences on PPD were assessed separately. Two theories of social support on depression are dominant in the literature: stress-buffering theory and main-effect theory. The stress-buffering theory posits that the primary role social support plays in preventing depression is to attenuate the negative impact of stress. In other words, the effect of social support on depression is conditioned on the levels of stress. In contrast, the main-effect model proposes that regardless of the

presence of stressors, lack of social support, in and of itself, can directly cause depression.

Stress is clearly recognized as a risk factor for PPD. Different theories on stress drive the divergence in its operational definition and measurement in empirical research. Some studies adopted the stimulus-based definition of stress and measured stress as the number of adverse events a person experienced in a certain period of time. Many other studies, on the other hand, preferred the stimulus-response perspective of stress and took one's subjective evaluation of an external event into consideration. These differences in how stress was defined and measured contribute to the inconsistent empirical evidence for the stress-buffering model of social support.

There were also a variety of methodological issues in the published studies. First, some studies used measures with low reliability or validity, which can lead to inaccurate inferences about the relationships among social support, stress and depressive symptoms. Second, it is not uncommon to see in literature the dichotomization of a continuous score. The dichotomization leads to a variety of negative consequences, including loss of information in individual differences, lowered statistical power, and spurious findings of main effect and interactive effect. Third, more than half of stress-buffering studies employed cross-sectional designs, which are unable to test the temporal order between stress and depression and are liable to yield a spurious interactive effect. Last but not least, SEM is an advanced statistical method that explicitly models measurement error and enables us to investigate the relationships among latent constructs of interest more precisely. No existing study has applied SEM to examine the stress-buffering effect of social support on depression. In this study, inventories with high reliability and validity will be used to measure social support, stress, and depression in order to avoid random and systematic errors as much as possible. Furthermore, SEM will be applied to explicitly model

measurement errors and specific bias. Finally, a longitudinal design will be adopted so that the relationships among stress, social support and changes in depressive symptoms can be estimated.

Research Question and Hypotheses

There is ongoing disagreement on stress-buffering theory and main-effect theory of social support. Furthermore, considering that parenting stress is prevalent among new mothers and that it is a known predictive factor of PPD, it is essential to study stress, social support, and their interaction effect on depression among new mothers. Hence, the overarching goal of this study is to examine the mechanisms through which support influences postpartum depression. The research question in this study is: is social support a moderator that alleviates the negative effect of stress on postpartum depression?

H_1: After controlling for initial levels of depressive symptoms and demographic covariates, with higher perceived social support, the stress-depression association is smaller.

H_{2a}: After controlling for initial levels of depressive symptoms, perceived social support and demographic covariates, higher levels of stress precede and predict higher levels of depressive symptoms.

$H_{2b:}$ After controlling for initial levels of depressive symptoms, stress and demographic covariates, higher levels of perceived social support precede and predict lower levels of depressive symptoms.

Chapter 3 Methods

This chapter first introduced the secondary data used to test the research hypotheses. The instruments used to assess stress, social support, and depression were then described. Next, a

strategy on how to handle missing data was discussed, followed by a description of the procedure for statistical analysis.

The Secondary Data

Data from *Predicting and Preventing Neglect in Teen Mothers (2001-2007)* (Borkowski et al., 2013) were used to study the relations among stress, social support, and postpartum depression, The data were made available by the National Data Archive on Child Abuse and Neglect, Cornell University, Ithaca, NY, and have been used with permission. Funding for the original project was provided by the National Institute of Child Health & Human Development (cosponsored by Center for Disease Control and Prevention, National Institute of Drug Abuse, and Department of Education) (Award Number: HD-39456). The collector of the original data, the funder, NDACAN, Cornell University, and their agents or employees bear no responsibility for the analyses or interpretations presented in this study. The authors of this study did not interact with participants, only with their de-identified data. University of Houston Institutional Review Boards (IRB) approved the study (STUDY00001436).

Overview of the data.

Predicting and Preventing Neglect in Teen Mothers (2001-2007) project is a longitudinal study following first-time mothers from their last trimester of pregnancy to 36 months after childbirth. The purpose of the original study was to "assess the impact of varying degrees and types of neglect and poor parents on children's development during the first 3 years of life."(Borkowski et al., 2013, p. 2)

The study participants were recruited through hospitals, primary care facilities, social service agencies, and adolescent mothers' programs in four cities: the Kansas City, Kansas;

Birmingham, Alabama; South Bend, Indiana; and Washington D.C. Women were asked to participate in the project if they were about to give birth for the first time and if they were aged from 15 to 35. Expectant mothers were informed of the research by nurses, social workers, and project staff in a variety of ways: handouts and fliers were distributed during prenatal visits; advertisements were posted in lobbies; presentations were given to adolescent mothers at local schools (Smith, Akai, Klerman, & Keltner, 2010). In total, 682 women were recruited in the original study. A socially disadvantaged population of first-time mothers was sampled: The average age of the study sample was 21 years old (SD=5). Fifty-eight percent of the participants were adolescents, between the ages of 15 and 18 years. The median level of education was the 12th grade, and the average monthly household income was 1250 dollars. At 12 months postpartum, 74% of the women were receiving at least one of the following public aids: TANF, Social Security, Supplement Security Income, food stamps, public housing assistance, Medicaid, Medicare, and WIC.

The prenatal interview took place in a laboratory or clinic setting when the woman was in her last trimester of pregnancy, with following up interviews occurring when the child was 4 months, 6 months, 8 months, 12 months, 18 months, 24 months, 30 months, and 36 months. Demographic information was collected during the first interview and six months after childbirth. Interviews at the prenatal, 6, 12, 24, and 36-month visits primarily focused on parental information, such as peripartum depression, parenting stress, social support, parenting beliefs. Interviews at the 4, 8, 18, and 30-month were home visits and primarily collected data on parenting practice and home environment.

Data used in this study.

Table 1 showed the occasions when each construct was measured. For this study, the constructs of interest are stress, social support, and postpartum depression, therefore, stress measured at six months postpartum was used to predict the changes in depressive symptoms from six to 12 months postpartum. Social support measured at six months postpartum was used as a moderator between stress and depressive symptoms. Demographic information was obtained from the initial interview.

Table 1 Measurement occasions for constructs of interest

	Pregnancy	6 months	12 months
Demographic information	✓	✓	
Stress: Difficult Life Circumstances		✓	
Stress: Parenting Stress Inventory		✓	✓
Support: Social support Interview		✓	
Depression: BDI-II	✓	✓	✓

Measures

Stress.

Difficult Life Circumstances (DLC) (Barnard, 1988) Short Form was used to evaluate the existence of stressors around new mothers. DLC Short Form consists of 14 Yes/No questions (Table 2). The count of responses of "Yes" was used to represent the degree of difficult life circumstance a woman lives.

Parenting Stress Index-Short Form (PSI-SF) (Abidin, 1995) was used to assess parenting stress. PSI-SF consists of three subscales: parental distress, difficult child, and parent-child dysfunctional interaction. Parental distress is a disturbing or unpleasant emotional state related to the child, and this state often disrupts parents' life (Duchovic, Gerkensmeyer, & Wu, 2009). The

subscale of difficult child assesses a parent's perception of how difficult the child is to take care of. The subscale of parent-child dysfunctional interaction evaluates the extent to which a parent feels satisfied with the interactions with his/her child. Each subscale consists of 12 five-point Likert-response items (Table 3). The responses were later reversely coded, with higher scores representing higher levels of parenting stress.

Table 2 Questions in Difficult Life Circumstances (Barnard, 1988) Short Form

Questions (Responses are Yes or No)
1. Are you having regular arguments or conflicts with your present partner/steady boy/girlfriend?
2. Are you having some sort of problem with any one of your former spouses/partners?
3. Is your partner in jail?
4. Do you have problems with your credit rating—Do you get hassled pretty often by bill collectors or collection agencies?
5. Do you have trouble with your landlord? (No if own home)
6. Do you have trouble finding a place to live that is suitable and you can afford?
7. Do you feel that you do not have enough privacy?
8. Do you have people living with you - relatives or friends - that you wish weren't there?
9. Do you have neighbors who are really unfriendly or giving you problems?
10. Do you or someone in your household have a long-term illness?
11. Have you had frequent minor illnesses in the past year?
12. Have you been the victim of a crime in the past year?
13. Have you been hospitalized in the past year for any reason - accident or illness?
14. Are you without a phone at your present home or apartment?

Table 3 Question in Parenting stress index-Short form

Subscale	Question
Parent distress	1. I often have the feeling that I cannot handle things very well.
	2. I find myself giving up more of my life to meet my children's needs than I ever expected.
	3. I feel trapped by my responsibilities as a parent.
	4. Since having this child, I have been unable to do new and different things.
	5. Since having this child, I feel that I am almost never able to do things that I like to do.
	6. I am unhappy with the last purchase of clothing I made for myself.
	7. There are quite a few things that bother me about my life.
	8. Having a child has caused more problems than I expected in my relationship with my partner.
	9. I feel alone and without friends.
	10. When I go to a party, I usually expect not to enjoy myself.
	11. I am not as interested in people as I used to be.
	12. I don't enjoy things as I used to.
Dysfunctional interaction	13. My child rarely does things for me that make me feel good.
	14. Most times I feel that my child does not like me and does not want to be close to me.
	15. My child smiles at me much less than I expected.
	16. When I do things for my child, I get the feeling that my efforts are not appreciated very much.
	17. When playing, my child doesn't often giggle or laugh.
	18. My child doesn't seem to learn as quickly as most children.
	19. My child doesn't seem to smile as much as most children.
	20. My child is not able to do as much as I expected.
	21. It takes a long time and it is very hard for my child to get used to new things.
	22. I feel that I am:
	1. Not very good at being a parent; 2. A person who has some trouble being a parent; 3. An average parent; 4. A better than average parent; 5. A very good parent.
	23. I expected to have closer and warmer feelings for my child than I do and this bothers me.
	24. Sometimes my child does things to bother me just to be mean.

Difficult child	25. My child seems to cry or fuss more often than most children.
	26. My child generally wakes up in a bad mood.
	27. I feel that my child is very moody and easily upset.
	28. My child does a few things which bother me a great deal.
	29. My child reacts very strongly when something happens that my child doesn't like
	30. My child gets upset easily over the smallest thing.
	31. My child's sleeping or eating schedule was much harder to establish than I expected.
	32. I have found that getting my child to do something or stop doing something is:
	1. Much harder than I expected; 2. Somewhat harder than I expected; 3. About as hard as I expected; 4. Somewhat easier than I expected; 5. Much easier than I expected.
	33. Think carefully and count the number of things which your child does
	Numeric that bother you. For example: dawdles, refuses to listen, overactive, cries,
	interrupts, fights, whines, etc.
	1 10 +; 2 8-9; 3 6-7; 4 4-5; 5 1-3.
	34. There are some things my child does that really bother me a lot.
	35. My child turned out to be more of a problem than I had expected.
	36. My child makes more demands on me than most children

Note: Other than Q22, Q32, and Q33, the responses for other questions are: 1. Strong agree; 2. Agree; 3. Not sure; 4. Disagree; 5. Strongly disagree. The responses were later reversely coded; higher scores represent higher levels of stress.

Depression.

The Beck Depression Inventory II (BDI-II) (A. T. Beck, Steer, & Brown, 1996) was used to measure depressive symptoms. BDI-II consists of 21 items: 19 items score from zero to three, and two items score from zero to six. Higher scores indicate higher levels of the depressive symptom (Table 4).

Table 4 Questions in Beck Depression Inventory II

Questions	Responses
Sadness	0 I do not feel sad.
	1 I feel sad much of the time.
	2 I am sad all the time.
	3 I am so sad or unhappy that I can't stand it.
Discouraged	0 I am not discouraged about my future.
	1 I feel more discouraged about my future than I used to be.
	2 I do not expect things to work out for me.
	3 I feel like my future is hopeless and will only get worse.
Failure	0 I do not feel like a failure.
	1 I have failed more than I should have.
	2 As I look back, I see a lot of failures.
	3 I feel I am a total failure as a person.
Pleasure	0 I get as much pleasure as I ever did from the things I enjoy.
	1 I don't enjoy things as much as I used to.
	2 I get very little pleasure from the things I used to enjoy.
	3 I can't get any pleasure from the things I used to enjoy.
Guilt	0 I don't feel particularly guilty.
	1 I feel guilty over many things I have done or should have done.
	2 I feel quite guilty most of the time.
	3 I feel guilty all the time.
Punishment	0 I don't feel I am being punished.

	1 I feel I may be punished.
	2 I expect to be punished.
	3 I feel I am being punished.
Confidence	0 I feel the same about myself as ever.
	1 I have lost confidence in myself.
	2 I am disappointed in myself.
	3 I dislike myself.
Criticize	0 I don't criticize or blame myself more than usual.
	1 I am more critical of myself than I used to be.
	2 I criticize myself for all my faults.
	3 I blame myself for everything bad that happens.
Suicidal	0 I don't have any thoughts of killing myself.
	1 I have thoughts of killing myself, but I would not carry them out.
	2 I would like to kill myself.
	3 I would kill myself if I had the chance.
Crying	0 I don't cry any more than I used to.
	1 I cry more than I used to.
	2 I cry over every little thing.
	3 I feel like crying, but I can't.
Restless	0 I am no more restless or wound up than usual.
	1 I feel more restless or wound up than usual.
	2 I am so restless or agitated that it's hard to stay still.
	3 I am so restless or agitated that I have to keep moving or doing something.
Interest	0 I have not lost interest in other people or activities.
	1 I am less interested in other people or things than before.
	2 I have lost most of my interest in other people or things.
	3 It's hard to get interested in anything.
Decisions	0 I make decisions about as well as ever.
	1 I find it more difficult to make decisions than usual.

	2 I have much greater difficulty in making decisions than I used to.
	3 I have trouble making any decisions.
Worthless	0 I do not feel that I am worthless.
	1 I don't consider myself as worthwhile and useful as I used to.
	2 I feel more worthless as compared to other people.
	3 I feel utterly worthless.
Energy	0 I have as much energy as ever.
	1 I have much less energy than I used to have.
	2 I don't have enough energy to do very much.
	3 I don't have enough energy to do anything.
Sleep Pattern	0 I have not experienced any change in my sleeping pattern.
	1 I sleep somewhat more than usual.
	2 I sleep somewhat less than usual.
	3 I sleep a lot more than usual.
	4 I sleep a lot less than usual.
	5 I sleep most of the day.
	6 I wake up 1-2 hours early and can't go back to sleep.
Irritable	0 I am no more irritable than usual.
	1 I am more irritable than usual.
	2 I am much more irritable than usual.
	3 I am irritable all the time.
Appetite	0 I have not experienced any change in my appetite.
	1 My appetite is somewhat less than usual.
	2 My appetite is somewhat greater than usual.
	3 My appetite is much less than before.
	4 My appetite is much greater than usual.
	5 I have no appetite at all.
	6 I crave food all the time.
Concentrate	0 I can concentrate as well as ever.

	1 I can't concentrate as well as usual.
	2 It's hard to keep my mind on anything for very long.
	3 I find I can't concentrate on anything.
Fatigue	0 I am no more tired or fatigued than usual.
	1 I get more tired or fatigued more easily than usual.
	2 I am too tired or fatigued to do a lot of what I used to do.
	3 I am too tired or fatigued to do most of what I used to do.
Sex	0 I have not noticed any recent change in my interest in sex.
	1 I am less interested in sex than I used to be.
	2 I am much less interested in sex now.
	3 I have lost interest in sex completely.

Social support.

Social Support Interview (SSI) (Ramey) was used to assess new mothers' perception of social support. Perceived support from a participant's mother was assessed by seven questions (Table 5). In this study, the support from a participant's mother was defined as maternal support. Perceived support from the baby's father was also assessed by seven questions (Table 6). The responses were reversely coded so that higher scores represent higher levels of social support.

It should be noted that although almost 40% of participants did not have a partner (single, divorced, or separated) during the baseline interview, most of the women (93%) answered that they would like the baby's father to be part of the baby's life. All the participants were asked to evaluate their perception of support from the baby's father regardless of their marital status or their willingness to involve the baby's father in the baby's life.

Table 5 Social Support Inventory (SSI) questions of support from a participant's mother

Questions	Responses
1. Thinking about the last time you confided in your mother, how helpful was confiding in her?	1. Very helpful, to 4 not at all helpful.
2. When you talk to your mom/mother about your feelings, how much better do you feel?	1 Whole lot better, to 6 Not any better.
3. How good does your mom/mother make you feel about yourself or about "being you?	Responses: 1. Extremely good to 6 Not good
4. If you have a real problem (like you have done something wrong or that you are ashamed of) and you go to talk with your mom/mother about it, how helpful is she to you?	1. Extremely helpful, to 6. Not helpful
5. How good is your mom/mother at teaching you about how to be a good parent and how to take good care of your baby or giving you answers to your questions about being a new mother?	1. Extremely good to 6 Not good
6. When you go to your mom for help with doing things like taking care of your baby (such as diapering, feeding, or babysitting when you are busy or don't feel well), how helpful is she?	1. Extremely helpful, to 6. Not helpful
7. When you want to have a good time or just "hang out," and you do this with your mom/mother, how good of a time do you have with her?	1 Whole lot better, to 6 Not any better.

Note: The responses were later reversely coded; higher scores represent higher levels of support.

Table 6 SSI Questions of support from the baby's father

Questions	Responses
1. Thinking about the last time you confided in your baby's father, how helpful was confiding in him?	1. Very helpful, to 4 not at all helpful.
2. When you talk to your baby's father about your feelings, how much better do you feel?	1 Whole lot better, to 6 Not any better.
3. How good does your baby's father make you feel about yourself or about "being you?	1. Extremely good to 6 Not good
4. If you have a real problem (like you have done something wrong or that you are ashamed of) and you go to talk with your baby's father about it, how helpful is she to you?	1. Extremely helpful, to 6. Not helpful
5. How good is your baby's father at teaching you about how to be a good parent and how to take good care of your baby or giving you answers to your questions about being a new mother?	1. Extremely good to 6 Not good
6. When you go to your baby's father for help with doing things like taking care of your baby (such as diapering, feeding, or babysitting when you are busy or don't feel well), how helpful is she?	1. Extremely helpful, to 6. Not helpful
7. When you want to have a good time or just "hang out," and you do this with your baby's father, how good of a time do you have with her?	1 Whole lot better, to 6 Not any better.

Note: The responses were later reversely coded; higher scores represent higher levels of support.

Control variables.

It was reported in O'Hara and Swain's meta-analysis (1996) that low social status is a risk factor of postpartum depression. The correlations between depressive symptoms and the new mothers' age, education level, ethnicity, and marital status were tested, and indicators that were significantly correlated with the outcome were included as control variables.

Missing Data Analysis

Full Information Maximum Likelihood (FIML).

In longitudinal research, there are often two types of missingness. One type is that data are missing for a whole case in one or more times of measurement, which is defined in this study

as “missing a whole wave of data.” It indicates that a woman did not take part in a certain wave of interviews. For the participant, all the study variables measured in that wave were missing. The other type is missingness due to nonresponse, which means that a participant took part in the interview, but some questions in the protocol were not answered. Nonresponse missing data is also described as the within-occasions missing data.

For example, if a woman did not participate in the 6-month-postpartum interview, we did not obtain any of her responses for variables measured in 6-month postpartum. This case was then categorized as missing a whole wave of data. If a woman participated in the 6-month interview but did not answer the set of questions about depression, then the missing values in depression were categorized as within-occasion missingness.

Full Information Maximum Likelihood (FIML) was used to handle the missing data in this study. FIML is regarded as a state-of-the-art missing data technique because it yields unbiased parameter estimates with missing at random (MAR) data, whereas traditional methods (e.g., listwise deletion, pairwise deletion, single imputation methods) produce biased parameter estimates (Enders, 2010). When the data is missing not at random (MNAR), FIML yields biased estimates, but it is still superior because the bias from FIML “tends to be isolated to a subset of the analysis model parameters, whereas traditional techniques are more apt to propagate bias throughout the entire model”(Enders, 2010, p. 125). Taken together, FIML is a better option compared with traditional methods for handling missing data. Furthermore, compared with another advanced missing data technique — multiple imputations, FIML has higher statistical power when a lot of missingness (30%-40%) is presented (Enders & Mansolf, 2018). A dropout rate ranged from 30% to 40% is not uncommon in longitudinal studies. From this perspective, FIML is more suitable to handle missing longitudinal data than multiple imputations.

As mentioned earlier, FIML yields unbiased parameter estimates under the assumption of missing at random (MAR). Whether the MAR assumption is met depends on variables included in a model. An inclusive analysis strategy was therefore employed in this study to improve the chances of satisfying the MAR assumption(Enders, 2010). By including auxiliary variables into the missing data handling process, it increases the statistical power and reduces the nonresponse bias. According to Enders (2010, p.128), an auxiliary variable is "one that is auxiliary to the substantive research questions but is a potential correlate of missingness or a correlate of the missing variable." Auxiliary variables are not of substantive interest; having auxiliary variables in a model does not change the substantial relationship among constructs of interest.

A set of analyses of missing data (including missing a whole wave of data and within-occasion missingness) was undertaken to identify variables that are associated with missingness of constructs of interest.

The procedure to identify auxiliary variables.

Auxiliary variables were identified in a 3-step procedure. According to Enders (2008), including an auxiliary variable is of little benefit when more than 10% of its observations are concurrently missing together with analysis model variables. Therefore, the first step of identifying auxiliary variables in this study was to make sure the potential auxiliary variables and the study model variables were not missing more than 10% concurrently.

The second step to identify a variable that is correlated to missingness of study variables was to separate the missing and complete cases on a study variable and to examine their group mean difference on a potential auxiliary variable. The R package VIM (Kowarik & Templ, 2016)

also provided a nice visualization of this procedure and was therefore applied to identify auxiliary variables for each construct of interest, i.e., stress, social support, and depression.

The last but not least, including an auxiliary variable is helpful if its correlations with incomplete analysis variables are high (beyond ± 0.40). Only those who were highly correlated with study variables were retained as auxiliary variables (Enders, 2010).

In summary, a variable will be incorporated as an auxiliary variable if it meets the three conditions: the concurrent missingness of the variable and a study variable is less than 10%; the variable is predictive of the missingness of the study variable (including the missingness in whole wave of data and within-occasion missingness); the associations between the variable and the study variable was larger than 0.4 or smaller than -0.4.

Statistical Analyses

Structural Equation Modeling (SEM).

Structural Equation Modeling (SEM) was used for statistical analyses. As mentioned in Chapter 2, SEM is a powerful tool. A key feature of SEM is the explicit distinction between observed variables and latent variables. An observed variable is the responses that were collected from a questionnaire item. A Latent variable is a hypothetical construct that cannot be observed directly. The hypothetical construct is the common cause of a set of observable phenomena. For instance, participants' responses to questions regarding appetite change, suicidal ideations, and sleep pattern change are observed variables. These phenomena are hypothetically caused by a common underlying construct—depression. In a reflective model, an observed variable can also be called an indicator, meaning that the variable is an indirect measure of the unobserved construct. A latent variable is also called a factor, which is a statistical realization of the

unobserved construct. Because of the differentiation between latent variables and observed variables, the variance in an observed variable (indicator) can be partitioned into common variance explained by a factor and unexplained variance due to measurement error and specific bias (e.g., method factor) (Kline, 2016). By separating measurement error and other specific bias from the latent construct, it enables researchers to estimate the relationship between error-free latent constructs.

In this study, SEM was conducted following a two-step procedure. The first step was to establish a measurement model for each latent construct through confirmatory factor analysis (CFA). A measurement model represents the correspondence between the factor of interest and its indicators. After all the measurement models for latent construct were established, an overall measurement model including all constructs of interest was estimated with the structural part saturated (all the constructs are correlated with each other). The second step was to specify and estimate the relationships (direct and indirect) among study variables.

To build a structural equation model—either a CFA measurement model or a structural regression model—best practices recommended by Kline (2016) and McDonald and Ho (2002) were followed. A structural equation model was built by the following four steps: Model specification, model identification, model estimation, and model respecifcation.

Model specification.

Model specification is a step where the relationships among variables are specified based on the research hypotheses. A graphic conceptual model was used to provide a visual presentation of the hypothesized relationships among constructs of interest. A latent variable was represented by an ellipse, and an observed variable was represented by a rectangle. The

relationship between two variables can be hypothesized as a directional causal effect (→) or an unanalyzed association (represented by a curved line with two arrowheads).

I would like to emphasize that a directional causal effect specified in the model depends on the assumption in varying degrees depending on the research design. For a cross-sectional design, the causal inference is solely based on a researcher's assumption, and the assumption should be supported by a solid, substantive rationale why the causal direction is not the other way around. If a causal relation was to be specified in a concurrent model, the rationale of the directionality should be provided. For a longitudinal design, the causal inference can be bolstered since the temporal precedence can be established in longitudinal analysis (although it is not always the case (Kline, 2016)).

Model identification.

Model identification is the step to make sure the specified model is "theoretically possible for the computer to derive a unique set of model parameter estimates" (Kline, 2016, p.145). The model identifiability is the property of a model instead of data.

For a standard CFA model, a sufficient identification requires 1) a single-factor model with at least three indicators or 2) a multi-factor model where each factor has at least two indicators (Kline, 2016). For a structural regression model, according to Rule 7.1 by Kline (2016), the model is identified if it is a recursive structural model. A model is recursive if all causal effects are strictly unidirectional (no feedback loop) and disturbances are uncorrelated.

Model estimation.

In this step, the hypothesized model was fitted into the collected data, and the divergence between the model and the data was estimated. In SEM, all free parameters were estimated at

once, which is referred to as a simultaneous method. For the simultaneous method, two types of tests evaluate the model-data correspondence: global fit testing and local fit testing.

Global fit statistics measure the overall or average performance of the model-data correspondence. The two categories of global fit statistics are model test statistics and approximate fit indices. Generally, model test statistics are chi-square statistics that "test the exact-fit hypothesis that there is no difference between the covariances predicted by the model, given the parameter estimates, and the population covariance matrix" (p.265, Kline). The chi-square test of model fit is an accept-support test—the null hypothesis is that the model is correct. Like the dilemma faced by other accept-support tests, the significant difference between data and model could be neglected in small samples, yet trivial difference could be flagged in large samples. In other words, it is liable to yield false negative results in small samples and false positive results in large samples. Besides, Kenny (2015) mentioned that the chi-square test is "too liberal (i.e., too many Type 1 errors) when variables have non-normal distributions". It should be acknowledged that a rejected exact-fit hypothesis provides preliminary evidence against the model, but it must be evaluated along with other information from approximate fit indices and local fit testing (Kline, 2016).

The other category of global fit statistics is approximate fit indices, which provide a continuous measure of the model-data correspondence. Approximate fit indices are not calculated from significant tests, and therefore no binary decision about rejecting or retaining a null hypothesis can be made based on approximate fit indices. The most frequently used approximate fit indices are Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI). RMSEA is an absolute, badness-of-fit index, which indicates the average correlation residual in the population per

degree of freedom. SRMR is also an absolute, badness-of-fit index, representing the average correlation residual. CFI is a relative (comparing to the baseline model) fit index assessing goodness-of-fit.

As mentioned earlier, approximate fit indices concern the range of values that indicate acceptable or adequate model fit. Hu and Bentler (1999) proposed a set of thresholds for approximate fit indices as rules of thumb (Table 7). However, instead of being treated as rules of thumb, the thresholds were used by many researchers and reviewers as cutoff values or golden rules to make a binary decision. This is problematic. First of all, the thresholds were based on simulation studies with a very limited range of misspecifications (Marsh, Hau, & Wen, 2004). These small number of scenarios tested by no means reflect the wide range of misspecifications in real data. In addition to the varying degrees of mis-specifications, the behavior of approximate fit indices is also influenced by the model size, magnitudes of parameter values in the population, sample size, etc. (Yuan, 2005). Therefore, it is called for that researchers and reviewers use approximate fit indices as descriptive information instead of relying on them to make binary decisions (Marsh et al., 2004). Some details about the approximate fit indices need to be noted. Mplus 8 calculates CFI with a modified baseline model when auxiliary variables are included (Asparouhov & Muthen, 2008). Hence, the CFI can be used as is without adjustment. Also, when RMSEA of the null model is too low, the CFI is not informative. According to Kenny (2015), "the CFI should not be computed if the RMSEA of the null model is less than 0.158 or otherwise one will obtain too small a value of the CFI".

Global fit statistics indicate only average model fit. Since the discrepancies between data and the model are collapsed into one single measure of the overall fit (Steiger, 2007), it is possible that a model with an adequate global fit has considerable local mis-specifications. In

consequence, local fit statistics cannot be ignored for model estimation. As Kline (2016) suggested, any report of model estimations without information about local fit statistics is not complete.

Table 7 Hu and Bentler (1999) cutoff criteria for fit indices

Fit index	Rule of thumb for adequate fit
RMSEA	≤.06
SRMR	≤.08
CFI	≥.95

The local fit statistics used in this study are residuals (correlation residual and normalized residual for covariances), which in Mplus is defined as the observed minus the estimated. Therefore, a positive residual means the association between two variables is underestimated; on the contrary, a negative correlation residual indicates that the association is overestimated. That is how local fit statistics tell us the direction of misspecification. A normalized residual with an absolute value larger than two needs to be examined closely.

In summary, global fit testing indicates overall model fit, and local fit testing provides information on the direction, magnitude, and possible sources of a misfit. Regardless of the result of global fit testing, the local fit should always be examined. The following is the procedure that was applied in this dissertation for model estimation.

The first step was to report the model test statistic. If the model fails the exact-fit test (chi-square test), then I tentatively rejected the model. The second step was to report the

approximate fit indices (RMSEA, SRMR, and CFI). The third step was to report the pattern of correlation residuals and normalized residuals. Whether to retain the initial model was decided considering all the information derived from step one to step three. If the original model was respecified, the modifications and rationale for doing so were explained by discussing the diagnostic statistics and relevant theories.

Model respecification.

It is acceptable to respecify the model if the respecification is theoretically justifiable. The nature of a modification and the rationale for the modification should be explained; the number of respecifications should also be clearly stated in this step.

The four-step procedure was conducted and discussed for each measurement model and structural regression model in the following sections and Chapter Four. Model specification and identification were not related to empirical data, therefore were discussed in this chapter; model estimation and respecificaiton were related to fitting a model into the data, therefore were discussed in Chapter Four.

Measurement models.

It will be ideal if all the latent constructs of interest can be used in the full structural equation model. However, SEM requires a large sample size. Jackson (2003) described the **N:q** rule as a rough guideline about sample size requirement for SEM. The **N** represents the sample size, and the **q** represents the model parameters. A recommended ratio of the sample size to the number of model parameters (N:q) is 20; however, most analysists think this ratio is too high (Kenny, 2015). According to Bentler and Chou (1987), the lowest ratio should not be less than 5. The sample size for this study is around 500. According to the 5:1 rule, the maximum number of

free estimated parameters is about 100. If parenting stress, depression, and social support were all analyzed in latent-variable frameworks, about 142 parameters would need to be estimated. Too many parameter estimates can compromise the statistical power and in consequence yield false negative results. With this constraint, it may not be the best choice to analyze all the constructs of interest in latent-variable frameworks. The following sections described my strategy and rationale regarding using a manifest variable or a latent variable for each construct. How well established an instrument is, the number of indicators for a factor, and the role (i.e., as a predictor or an outcome variable) of a construct in the model were taken into consideration.

Social support.

Model specification.

In the original study, social support was measured by an unpublished instrument. The reliability and validity of the instruments were not reported. Because of the uncertainty of how precisely and accurately the perceived social support was measured by the scale scores, the constructs of social support were represented with latent variables. Perceived maternal support was the common factor that caused the covariance among the seven indicators related support from a participant's mother (Figure 3); Perceived support from the baby's father was the common factor that caused the covariance among the seven indicators related to support from the baby's father (Figure 4). The latent factors were standardized with the means as zero (zero represented the average level of social support) and the variances as one.

Model identification.

Each support model has seven items, which met the requirement for a model to be identifiable.

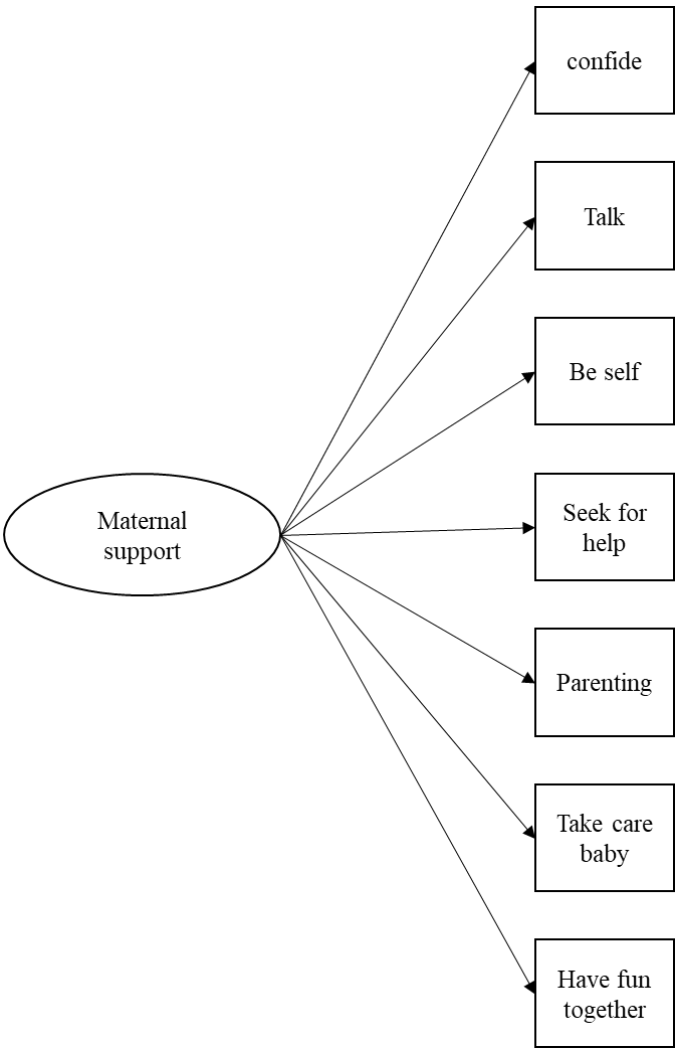

Figure 3 Specified measurement model for maternal support

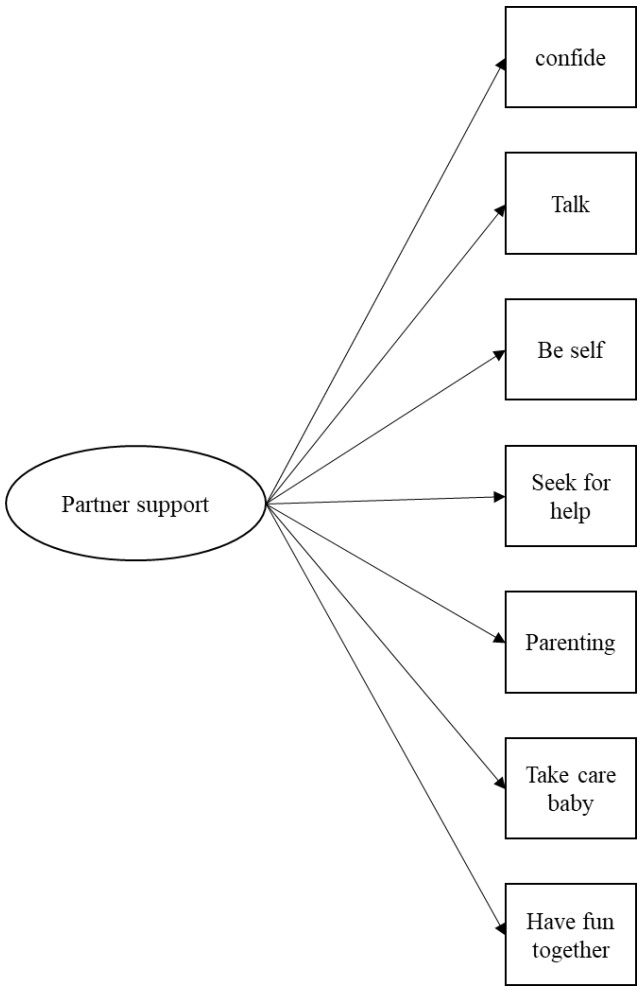

Figure 4 Specified measurement model for support from the baby's father

Parenting stress.

Model specification.

As mentioned in the measurement section, PSI-SF consisted of 36 items and was designed to measure three components of parenting stress: parental distress, difficult child, and parent-child dysfunctional interaction. Each factor was indicated by 12 items (Figure 5). The latent factors were specified to be correlated with each other and were standardized (mean=0 and variance=1).

Model identification.

Each factor for parenting stress has 12 indicators, which is far beyond the minimum requirement of model identification. In consequence, this model was identified.

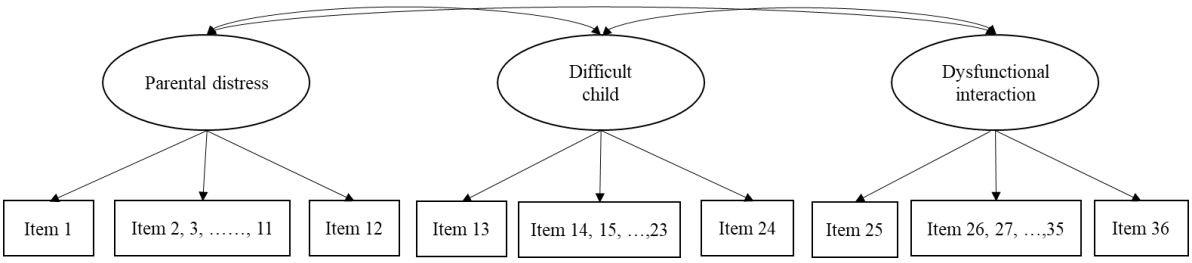

Figure 5 Specified measurement model for parenting stress

Model estimation.

As mentioned earlier, SEM requires a large sample size, and the maximum number of model parameters that can be estimated is about 100. This measurement model introduces 75 (3 covariances, 36 factor loadings, and 36 residuals) parameter estimates. It is possible that using a latent framework to represent parenting stress may reduce the statistical power of the analysis. According to the American Psychological Association , the reliability and validity of PSI showed that the measure is useful across diverse populations, including poor rural and inner-city parents. In the present study, the three subscales demonstrated high internal consistency reliability. The Cronbach's alpha of *parental distress, difficult child, and dysfunctional interaction* were 0.855, 0.768, and 0.869 at 6-month postpartum and 0.848, 0.83, and 0.87 at 12-month postpartum.

If using the latent framework of parenting stress yields nonsignificant results, scale scores of parenting stress can be used instead. By comparing the results from the two approaches, we can gain some insights from this process into whether the nonsignificant results from latent moderated structural modeling were due to the lower statistical power.

Depression.

Depression was measured by BDI-II, one of the most widely used instruments to assess depression. In the present study, an EFA of the six-month-postpartum data showed that the 21 items are loaded on one factor, indicating the unidimensionality of the scale. Furthermore, the Cronbach's alpha of the 21 questions at the three measurements occasions was 0.86, 0.89, and 0.88, respectively, demonstrating good internal consistency reliability. Taken together, the total score of BDI-II was used to represent depression: the larger the total score, the higher the level of the depressive symptoms.

Overall measurement model.

Following the estimation of individual measurement models, an overall measurement model with all the constructs and covariates included was estimated to ensure its fit. The structural part was saturated, meaning that all the constructs of interest and covariates were correlated with each other, i.e., no directional effect assumed.

Structural regression model.

With the overall measurement model established, the structural part of the model was then specified, identified and estimated.

Model specification.

The structural regression models of parenting stress and social support was specified as Figure 6. After controlling for the depressive symptoms measured at 6-month postpartum, parenting stress and social support were both hypothesized to have a causal effect on depression at 12-month postpartum. Higher levels of parenting stress were expected to predict higher levels of depression (positive causal effect); higher levels of social support were expected to predict

lower levels of depression (negative causal effect). The interactions between parenting stress and social support were also specified. Social support was expected to attenuate the causal effect of parenting stress on depression (negative direction). The interaction term does not have a mean or a variance parameter. It does not have parameters for covariances with other variables either (B. O. Muthén & Asparouhov, 2015).

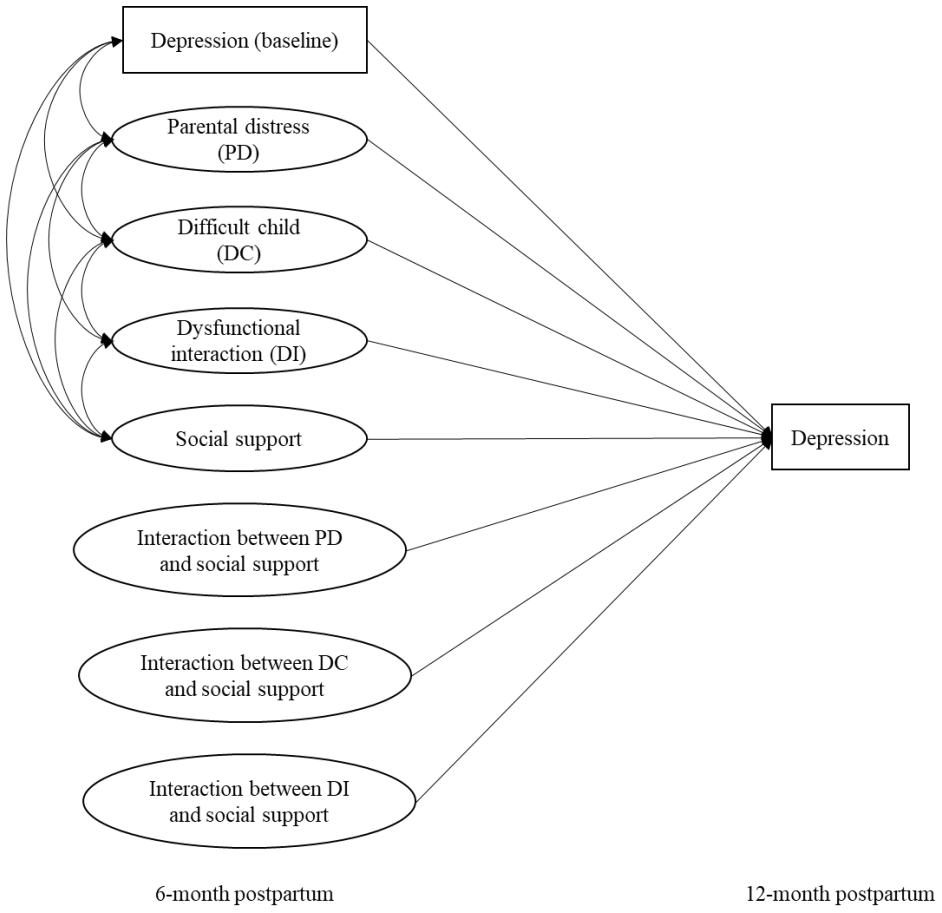

Figure 6 Specified structural regression model of parenting stress and social support

The structural regression models of difficult life circumstances (DLC) and social support was specified as Figure 7. After controlling for the depressive symptoms measured at 6-month postpartum, DLC and social support were both hypothesized to have a causal effect on

depression at 12-month postpartum. Higher levels of DLC were expected to predict higher levels of depression (positive causal effect); higher levels of social support were expected to predict lower levels of depression (negative causal effect). The interactions between DLC and social support were also specified. Social support was expected to attenuate the causal effect of DLC on depression (negative direction).

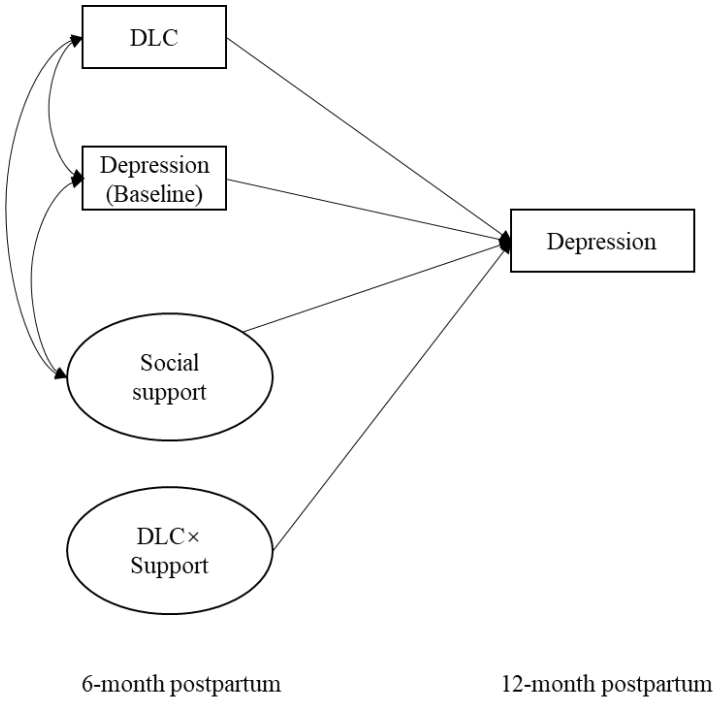

Figure 7 Specified structural regression model of DLC and social support

According to the literature (Aneshensel & Frerichs, 1982; Iles et al., 2011; Reid & Taylor, 2015), perceived social support and stress can influence each other or be caused by a common factor. Therefore, no causal effect between these two variables was hypothesized in this study and the relationship was specified as an unanalyzed association. The same principle was applied to the concurrent relationships between depression at 6-month postpartum and social support as well as depression and stress.

Model identification.

This model was specified as a recursive structural model, and there is no issue in identify a recursive structural model.

Model estimation.

Cham, West, Ma, and Aiken (2012) found that when the assumption of normal distribution for indicators was not severely violated, the latent moderated structural equations (LMS) approach yielded the most efficient estimates of the interaction effect with the highest statistical power. Nevertheless, the parameter estimates of the latent interaction effect were biased using the LMS approach when the indicators for the latent predictors were severely non-normal. In this circumstance, the Unconstrained Product Indicator (UPI) approach with maximum likelihood estimation may be a better option because they can produce unbiased estimates of latent interaction effect with a sample size larger than 500. In short, the choice between the two approaches depends on the degree of normality of observed indicators. As a result, skewness and kurtosis of each indicator for social support and parenting stress as well as their median skewness and median kurtosis for each factor were reported. If the items are not severely non-normal, LMS approach will be employed; otherwise, UPI approach will be used to analyze the latent interaction effect between parenting stress and social support. Either method can be implemented in Mplus 8.2 (L. K. Muthén & Muthén, 2019).

For the LMS approach, the latent interaction terms were estimated in two steps (Maslowsky, Jager, & Hemken, 2015). The first step was to estimate the structural model without the interaction terms and to obtain a good model fit. The second step was to add latent interaction terms into the model one at a time and test the significance of the regression

coefficients for the latent interaction terms using z-tests. A significant interaction term was further probed by plotting the interaction effect using the Johnson-Neyman technique (Johnson & Fay, 1950; Johnson & Neyman, 1936).

For a nonsignificant interaction term, it requires a proper procedure to decide whether or not the nonsignificant interaction term should be eliminated from a model. For example, if none of the interaction terms—parental distress × support, difficult child × support, and dysfunctional interaction × support—were significant, should the main-effect model or the interaction-effect model be retained? Aiken and West (1991) described this decision is about "the tradeoff between two desirable properties of statistical estimators: unbiased and efficiency." In a regression model, the bias primarily comes from a left-out-variable error. Eliminating an interaction term may result in larger bias and lower the precision of significant tests of the lower order effect (i.e., stress and social support), especially considering that the statistical power for testing interaction effect was already low. On the other hand, if a term did not have an effect in the population, then including unnecessary terms may result in lower efficiency of the analysis. Finney, Mitchell, Cronkite, and Moos (1984) and Aiken and West (1991, p. 105) provided similar recommendations when the test of an interaction effect is not significant:

In case in which there are strong theoretical grounds for expecting an interaction, the interaction, even if nonsignificant, should be retained in the final regression equation……However, in cases in which there is not a strong theoretical expectation of an interaction, step-down procedures should be used. The interaction should be dropped from the equation and the first order effects should be estimated……

Both of the two models tested in this study have strong theoretical grounds. Therefore, theoretical consideration may not be of much help in the decision-making process. This study

proposed to use likelihood-ratio test statistics to compare the model difference when none of the interaction terms were significant. If the interaction model did not fit the data significantly better than the main-effect model, then the main-effect model will be retained. Otherwise, the interaction model will be retained.

Chapter 4 Results

In this chapter, the study sample was first described, followed by a description of each construct of interest. For social support and parenting stress, measurement models were estimated and reported. Structural regression models were then estimated and reported in a three-step procedure.

The study sample

Descriptive information.

The sample size for this study was 512. The average age of the study sample during pregnancy was 21.3 (SD=5.3). The median age was 18.8. Majority of the participants were still in high school. Majority of the study participants are black women. Almost 40% of pregnant women did not have a partner (Table 8).

Table 8 Univariate Descriptive Statistics of Categorical Baseline Demographic Variables

Variables	Baseline	
	n	%
Current education level	508	99.2
High school	360	70.3
Community college or above	148	28.9
Partner	509	99.4
With spouse or partner	308	60.2
Without partner	201	39.3
Race	512	100
Black	322	62.9
White	182	35.5
Other	8	1.6

Attrition analysis.

Four attrition patterns were identified: 364 women participated both the six-month and 12-month follow-up interviews (did not drop out); 74 did not attend the six-month interview but attended the 12 -month interview; 74 participated in the six-month follow-up but dropped out before the 12-month follow-up; 100 women dropped out before the six-month follow-up (this group has no data on either six-month postpartum interview or 12-month postpartum interview, therefore was not included in this study).

Attrition analysis was conducted to examine the differences of baseline demographic characteristics and baseline study variables among the three scenarios of missing a whole wave of data—no dropout, did not attend the 6-month follow-up but attended the 12-month follow-up, and dropout at 12-month follow-up interview. Race and marital status were predictive of missingness of a whole wave of data. Black women or women without a partner were associated with more missingness of a whole wave of data. Black women had more whole-wave

missingness at 6-month follow-up, and Non-Black women had more whole-wave missingness at 12-month follow-up. Age, education, baseline maternal support, baseline support from the baby's father, and baseline depression levels did not differ significantly among the three groups.

Descriptions of the study variables

Depression.

Descriptive information.

Table 9 demonstrated a descending trend in depressive symptoms from pregnancy to 12-month postpartum. Table 10 showed that the correlations between baseline demographic characteristics and depression at 12-month postpartum were very weak. Therefore, the demographic variables were not used to predict depression at 12-month postpartum in the final models.

Table 9 Univariate Descriptive Statistics of Depression

Variables	n	Median	Mean	SD	Skewness	Kurtosis	Range
Depression measured at baseline	498	11	12.51	7.45	1.03	1.54	0-46
Depression at 6-month postpartum	384	7	8.74	7.78	1.76	5.51	0-50
Depression at 12-month postpartum	394	6	7.48	6.78	2.08	6.89	0-56

Table 10 Correlation Matrix of Depression and Baseline Demographic Variables

	Age	Marital status	Education	Race	BDI_6M	BDI_12M
Age	27.688					
Marital status	0.301					
Education	0.686	0.313				
Race	-0.188	-0.291	-0.107			
BDI_6M	-0.194	-0.123	-0.167	0.092	59.044	
BDI_12M	-0.027	-0.06	-0.025	-0.004	0.525	46.996

Note: numbers on the diagonal are variance; numbers below diagonal are correlations.

Missing data analysis.

As mentioned earlier, attrition analysis showed that Black women or women without partners were associated with more missingness of a whole wave of data measured at 6-month postpartum or at 12-month postpartum.

For depression measured at 6-month postpartum, the within-occasion missingness was 54. That meant that 54 participants provided data on other study variables at 6-month postpartum, but they did not respond to questions about depression. Women without a partner or women with lower education were associated with higher within-occasion missingness of depression measured at 6-month postpartum. The within-occasion missingness at 6-month postpartum was not significantly predicted by a mother's age, her race, the baseline levels of depression, and the baseline levels of social support.

For depression measured at 12-month postpartum, the within-occasion missingness was 44, indicating that 44 participants provided data on other study variables at 12-month postpartum but did not respond questions about depression. The within occasion missingness at 12-month postpartum was not predicted by any baseline demographic variables or baseline study variables.

In summary, race, marital status and education were associated with higher missingness of depression. However, race, marital status, and education were weakly associated with depression (<.2) (Table 10). Including these variables had little utility in handling the missingness of depression using full information maximum likelihood (Enders, 2010).

Social support.

Maternal social support.

Descriptive information.

As shown in Table 11, 335 to 361 out of 512 (about 68% of) participants responded to the questions related to maternal support (support from a participant's mother). The seven items were all negatively skewed, indicating that most participants perceived their mothers helpful. The univariate kurtosis showed that some items were leptokurtic and some were platykurtic. Item 6 (help take care of the baby) had the most skewed and leptokurtic data. Mplus provided Mardia's estimates of multivariate skewness and kurtosis. The multivariate skewness test of fit for this sample was 16.708, and the multivariate kurtosis test of fit was 101.530. For a multivariate normal distribution, multivariate skewness equals 0, and multivariate kurtosis equals $p\times(p+2)$, where p represents the number of variables. With seven items in this model, the multivariate kurtosis should be around $7\times(7+2) = 63$ if the variables followed a multivariate normal distribution. The sample values of multivariate skewness and kurtosis were both larger than the expected values, indicating that the data did not follow multivariate normality.

Mplus provides a chi-square test called maximum likelihood robust (MLR) that is more robust to non-normal continuous data. To yield more accurate chi-square test statistics, MLR was adopted for model estimation. Table 12 showed correlations among the seven items and their correlations with the baseline demographic variables.

Table 11 Univariate statistics of maternal support

Item	N	Mean (SD)	Skewness	Kurtosis
1. Confide	361	3.42 (0.75)	-1.358	1.748
2Talk	346	4.51 (1.55)	-0.838	-0.273
3.Be self	348	4.74 (1.47)	-0.914	-0.291
4. Seek for help	335	4.56 (1.55)	-0.888	-0.200
5. Parenting	347	5.06 (1.39)	-1.451	1.142
6. Take care of baby	340	5.26 (1.31)	-1.919	2.881
7. Have fun together	341	4.70 (1.52)	-1.054	0.107

Table 12 Correlation Matrix of Maternal Support and Baseline Demographic Variables

	Confide	Talk about feeling	Be yourself	Seek help	Parenting guidance	Take care of the baby	Hang out	Age	Marital status	Education	Race
1. Confide	0.57										
2. Talk about feeling	.665	2.461									
3. Be yourself	.516	.709	2.182								
4. Seek help	.503	.682	.685	2.457							
5. Parenting guidance	.485	.581	.598	.549	1.942						
6. Take care of the baby	.445	.429	.404	.385	.526	1.733					
7. Hang out	.475	.614	.602	.619	.476	.476	2.343				
Age	.146	.180	.190	.135	.057	.119	.175	27.688			
Marital status	.102	.163	.158	.168	.191	.087	.130	.301			
Education	.051	.122	.178	.085	.068	.121	.127	.686	.313		
Race	-.085	-.09	-.066	-.092	-.058	-.031	-.118	-.188	-.291	-.107	

Note: numbers on the diagonal are variance; numbers below diagonal are correlations.

Missing data analysis.

Attrition analysis showed that Black women or women without partners were associated with higher dropout at 6-month postpartum.

For the seven items of maternal support, the number of within-occasion missingness ranged from 77 to 103. That indicated that these new mothers participated in the 6-month follow-up, but 77 participants did not respond to the first item and 103 participants did not respond to the third item. The within-occasion missingness of the rest five items was between 77 and 103. Black women, women without partners, or women with lower education were associated with higher within-occasion missingness of the seven indicators for maternal support measured at 6-month postpartum. The within occasion missingness was not significantly predicted by a mother's age, baseline levels of social support, and baseline levels of depression.

In summary, race, marital status, and education were associated with the missingness of the seven indicators for maternal support. However, as shown in Table 12, they had weak

correlations (<.2) with the study variables. Incorporating these variables as auxiliary variables will have little utility in missing data handling using full information maximum likelihood (Enders, 2010). Therefore, no auxiliary variables were included in the measurement model of maternal support.

Model estimation.

The total sample size for this model was 373. This is the number of participants with data on at least one of the seven items for maternal support. The global fit statistics of the one-factor CFA model were: χ^2(df=14) = 45.959, p<.001, RMSEA=0.078, SRMR=0.038, CFI=0.953. The exact-fit test showed that the model is significantly worse than the saturated model. The approximate fit indices indicated in a continuous measure that the model fitted the data adequately. The normalized residuals and correlation residuals did not detect a local misfit with substantial magnitude: there was no significant covariance residual based on the output of the normalized residuals (all absolute values were less than 2); other than the correlation residual between the 5th and the 6th item was larger than 0.1 (equaled 0.138), the absolute values of other correlation residuals were less than 0.1. Considering the large sample size, the approximate fit statistics, and the local fit statistics, the significant result of the exact-fit chi-square test was probably flagged by trivial discrepancies. In consequence, the model was retained (Figure 8) and was used in full structural equation models. The latent variable distribution plot (Figure 9) of maternal support showed a non-normal distribution. It should be noted that it does not mean that the latent construct—perceived maternal support—is not normally distributed (it is assumed to be normal); the non-normality showed in the latent variable distribution plot is attributed to the indicators failing to capture the tails of the factor distribution (B. O. Muthén, 2006). In other words, because the indicators cannot discriminate the levels of perceived maternal support from

about one standard deviation(0.92SD) above average and beyond that point, the density beyond 0.92SD all stacked on the point of 0.92SD in the latent variable distribution (Figure 9). In this study sample, the indicators only captured the perceived maternal support ranging from negative three standard deviations (-3SD) up to one standard deviation (1SD).

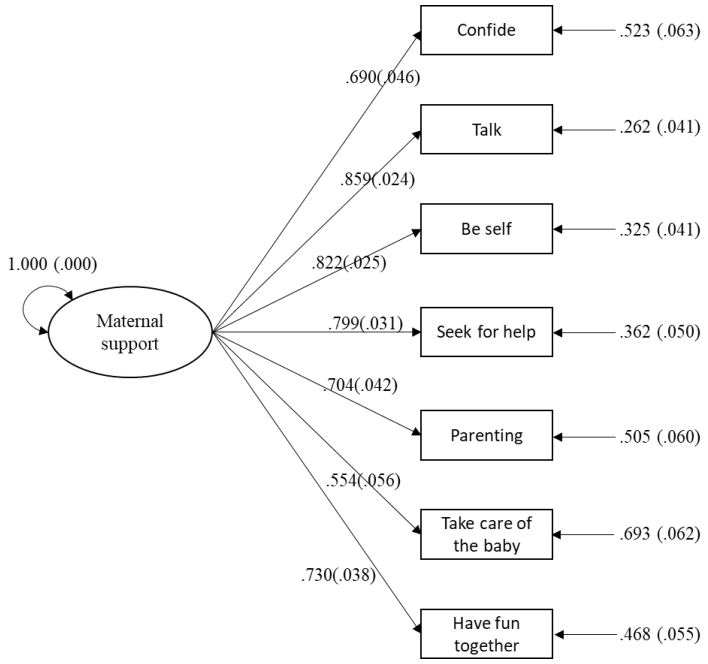

Figure 8 The CFA Model for Maternal Support

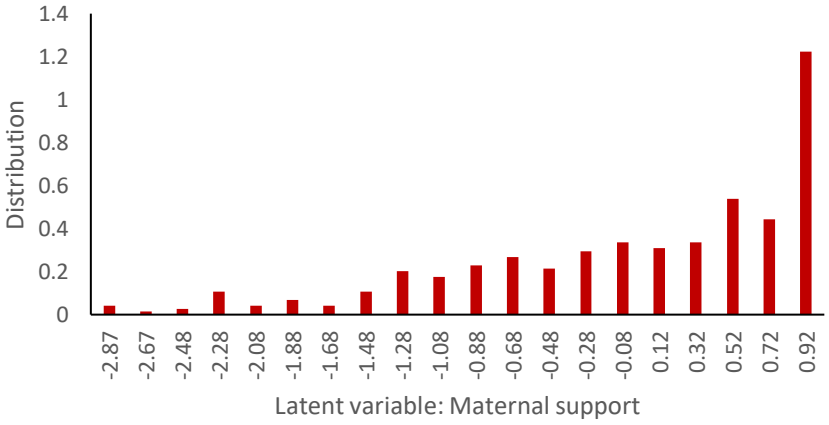

Figure 9 Density plot of the latent variable: maternal support

Support from the baby's father.

Descriptive information.

As shown in Table 13, 317 to 346 out of 512 (about 63% of) participants responded to the questions related to support from the baby's father. The seven indicators for support from the baby's father were negatively skewed. The univariate kurtosis statistics showed that the kurtosis of the seven items was not severe. The multivariate skewness for this sample was 9.197, and multivariate kurtosis was 86.539. Robust maximum likelihood (MLR) was used to produce test statistics that are robust to non-normality. Table 14 showed the correlations among the seven indicators for support from the baby's father and their correlations with baseline demographic variables.

Table 13 Univariate Descriptive Information of Support from the Baby's Father

Item	Sample size	Mean (SD)	Skewness	Kurtosis
Confide	346	3.18 (0.96)	-1.026	0.068
Talk	323	4.42 (1.60)	-0.866	-0.244
Be self	325	4.79 (1.55)	-1.220	0.461
Seek for help	321	4.50 (1.67)	-0.907	-0.374
Parenting	327	3.55 (1.80)	-0.082	-1.283
Take care baby	324	4.69 (1.72)	-1.181	0.035
Have fun together	317	4.88 (1.59)	-1.379	0.743

Table 14 Correlation Matrix of Support from the Baby's Father and Baseline Demographics

	Confide	Talk about feeling	Be yourself	Seek help	Parenting guidance	Take care of the baby	Hang out	Age	Marital status	Education	Race
1. Confide	0.927										
2. Talk about feeling	0.725	2.817									
3. Be yourself	0.601	0.775	2.576								
4. Seek help	0.695	0.776	0.777	3.069							
5. Parenting guidance	0.568	0.64	0.597	0.638	3.303						
6. Take care of the baby	0.601	0.621	0.613	0.644	0.6	3.142					
7. Hang out	0.587	0.709	0.689	0.703	0.566	0.612	2.723				
Age	0.149	0.164	0.114	0.126	0.168	0.114	0.143	27.688			
Marital status	0.269	0.391	0.292	0.358	0.202	0.215	0.402	0.3			
Education	0.133	0.152	0.139	0.117	0.127	0.12	0.144	0.686	0.313		
Race	-0.176	-0.205	-0.129	-0.192	-0.054	-0.067	-0.2	-0.188	-0.29	-0.107	

Note: numbers on the diagonal are variance; numbers below diagonal are correlations.

Missing data analysis.

Attrition analysis showed that Black women or women without partners were associated with more missingness of a whole wave of data measured at 6-month postpartum.

For the seven items of support from the baby's father, the number of within-occasion missingness ranged from 92 to 121. That indicated that these new mothers participated in the 6-month follow-up, but 92 participants did not answer the first item and 121 participants did not answer the sixth item. The missingness of the rest five items was between 92 and 121. Black women, women without partners, or women with lower education were associated with within-occasion missingness of the seven items for support from the baby's father measured at 6-month postpartum. The within occasion missingness was not significantly predicted by a mother's age, baseline social support, and baseline depression.

Table 14 showed that age, education, and race had weak correlations (<.21). Incorporating these variables as auxiliary variables will have little utility in missing data

handling using full information maximum likelihood (Enders, 2010). For marital status, its correlations with three out of seven indicators for support from the baby's father were larger than 0.3, indicating that marital status can be a potential auxiliary variable. A measurement model of support from the baby's father with marital status as an auxiliary variable and a measurement model without auxiliary variables were separately estimated; model fit and parameter estimates were nearly identical in both models, so the model without auxiliary variables was retained for parsimony.

Model estimation.

The total sample size for this model was 432. This is the number of participants with data on at least one of the seven items for support from the baby's father. The global fit statistics of the one-factor CFA model with seven indicators were: χ^2(df=14) =25.815, p=.027, RMSEA=0.044, SRMR=0.021, CFI=0.992. The approximate fit indices indicated a close model fit. The normalized residuals and correlation residuals did not detect a local misfit with substantial magnitude. Although the exact-fit test showed that there were model-data discrepancies, it was likely to be trivial given the sample size, the approximate fit indices, and local model fit information. The one-factor CFA model with seven items was retained (Figure 10) to represent the latent construct of support from the baby's father. The latent variable distribution plot (Figure 11) of support from the baby's father showed that the indicators only captured the distribution of the latent variable from about negative two standard deviations (-2SD) up to one standard deviation (1SD).

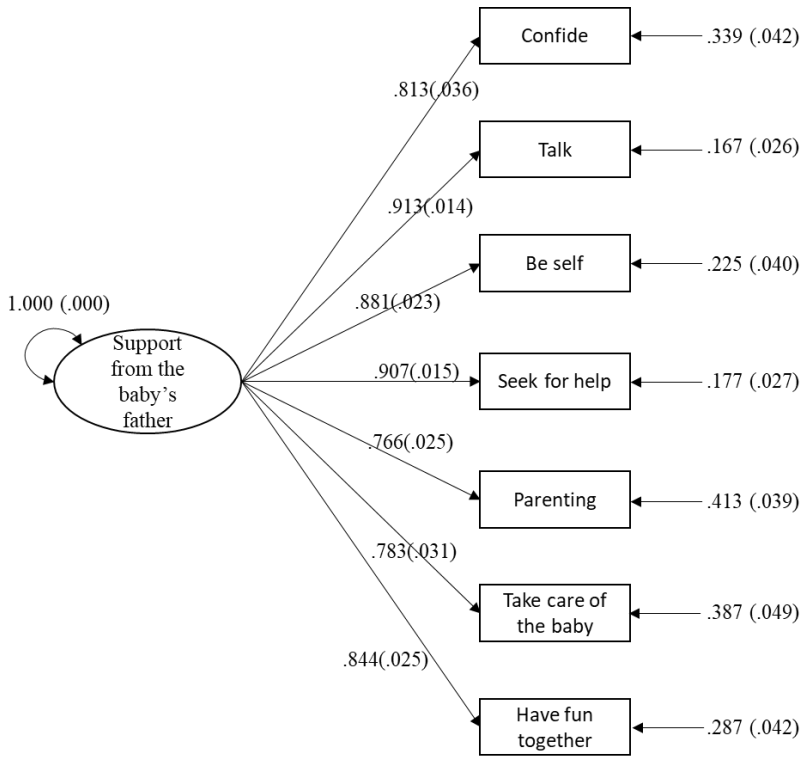

Figure 10 The CFA model for support from the baby's father

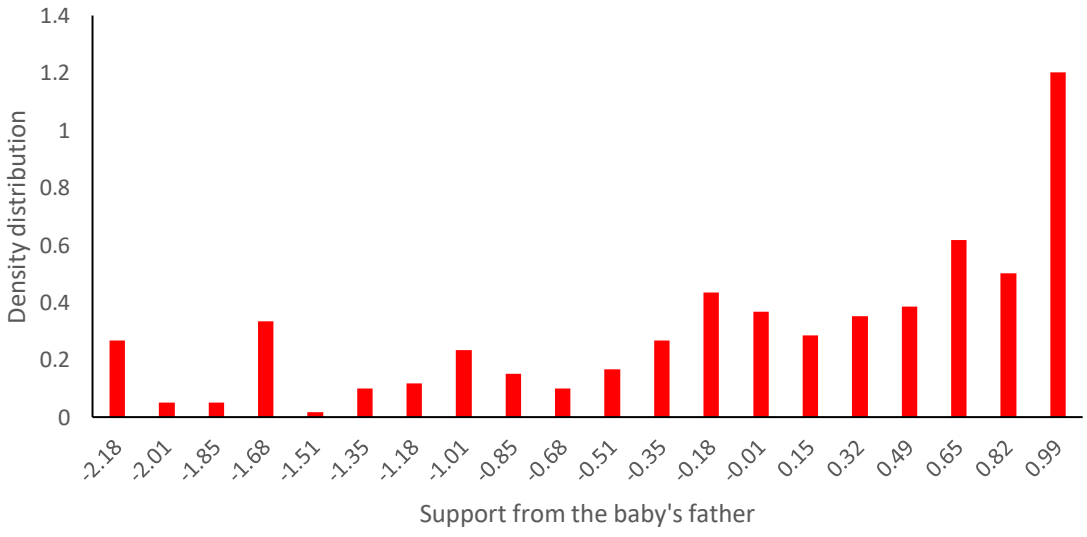

Figure 11 Density plot of the latent variable: support from the baby's father

Difficult life circumstances.

Descriptive information.

Difficult life circumstances (DLC) were represented by the total number of adverse life events experienced in the previous six months. The average number of adverse life events was 2 (SD=1.90). It ranged from zero to 10. The distribution of DLC was positively skewed, but the kurtosis was not severe: The skewness was 1.04, and the kurtosis was 0.90. Table 15 showed the correlations between DLC and baseline demographic variables.

Table 15 Correlation Matrix of DLC and Baseline Demographics

	Age	Marital status	Education	Race	DLC
Age	27.688				
Marital status	0.301				
Education	0.686	0.313			
Race	-0.188	-0.291	-0.107		
DLC	-0.237	-0.129	-0.205	0.138	3.788

Note: numbers on the diagonal are variance; numbers below diagonal are correlations.

Missing data analysis.

Attrition analysis showed that Black women or women without partners were associated with more missingness of a whole wave of data measured at 6-month postpartum.

For DLC measured at 6-month postpartum, the within-occasion missingness was 84. That meant that 84 participants provided data on other study variables at 6-month postpartum, but they did not respond to questions related to difficult life circumstance. Women with lower education levels or Black women were associated with higher within-occasion missingness of DLC. The within-occasion missingness at 6-month postpartum was not significantly predicted by a mother's age, her marital status, the baseline levels of depression, and the baseline levels of social support.

In summary, race, marital status and education were associated with higher missingness of DLC. However, race, marital status, and education were weakly associated with DLC (Table 15). Including these variables will have little utility in handling the missingness of DLC using full information maximum likelihood (Enders, 2010).

Parenting stress.

Descriptive information.

As shown in Table 16, 397 to 427 out of 512 (about 80% of) participants responded to the questions related to parenting stress. The univariate statistics showed that most of the items were positively skewed, indicating that most new mothers perceived lower levels of parenting stress. Item 33 ("Think carefully and count the number of things which your child does that bother you") had an excessively high value of kurtosis (16.109), indicating extreme non-normality of the data (Table 17). The multivariate skew test (sample value=428.484) and kurtosis test (sample value=1807.582) of fit showed that the sample was multivariate non-normal. Robust maximum likelihood (MLR) was used to produce test statistics that are robust to non-normality. Since the construct has 36 indicators, the correlation matrix will be too big to fit in this document. It is available upon request.

Table 16 Univariate statistics of parenting stress

Item	Sample size	Median	Mean	Std. Deviation	Skewness	Kurtosis
1	427	2.00	2.48	1.165	0.463	-0.880
2	425	4.00	3.18	1.353	-0.192	-1.303
3	422	2.00	2.15	1.099	1.024	0.301
4	425	2.00	2.57	1.274	0.432	-1.073
5	426	2.00	2.42	1.198	0.631	-0.769
6	426	2.00	2.23	1.156	0.894	-0.157
7	425	2.00	2.80	1.281	0.130	-1.300
8	419	2.00	1.89	1.040	1.343	1.310
9	422	2.00	1.95	1.046	1.132	0.536

10	422	2.00	1.95	1.011	1.154	0.906
11	427	2.00	2.55	1.271	0.371	-1.163
12	422	2.00	2.38	1.231	0.619	-0.821
13	427	1.00	1.90	1.225	1.275	0.433
14	426	1.00	1.43	0.736	2.278	6.388
15	426	1.00	1.72	1.077	1.676	1.999
16	426	1.00	1.54	0.797	1.929	4.457
17	424	1.00	1.48	0.775	2.178	5.742
18	427	1.00	1.48	0.742	1.930	4.779
19	427	1.00	1.41	0.648	1.968	5.147
20	427	1.00	1.49	0.736	1.749	3.342
21	424	1.00	1.64	0.893	1.508	1.836
22	406	1.00	1.70	0.913	0.890	-0.598
23	423	1.00	1.78	1.049	1.485	1.641
24	424	1.00	1.43	0.677	2.016	5.529
25	425	1.00	1.63	0.839	1.474	2.005
26	425	1.00	1.54	0.821	1.913	3.813
27	425	1.00	1.68	0.959	1.619	2.161
28	424	1.00	1.71	0.943	1.531	2.034
29	421	4.00	3.19	1.373	-0.386	-1.234
30	423	2.00	1.84	0.990	1.229	0.824
31	422	2.00	2.15	1.167	0.913	-0.220
32	405	3.00	2.64	1.038	0.064	-0.590
33	397	1.00	1.21	0.652	3.827	16.109
34	422	2.00	1.79	0.945	1.277	1.043
35	422	1.00	1.42	0.652	1.946	5.522
36	424	1.00	1.62	0.859	1.615	2.450

Table 17 Frequencies of item 33: “Number of things which your child does that bother you.”

Value	Label	Frequency (%)
1	1-3	346 (67.6)
2	4-5	31 (6.1)
3	6-7	12 (2.3)
4	8-9	3 (0.6)
5	more than 10	5 (1)

Missing data analysis.

Attrition analysis showed that Black women or women without partners were associated with more missingness of a whole wave data measured at 6-month postpartum.

For the 36 indicators for parenting stress, the number of within-occasion missingness ranged from 11 to 51. Black women, women without partners, or women with lower education levels were associated with within-occasion missingness of the 36 items for parenting stress measured at 6-month postpartum. The within occasion missingness was not significantly predicted by a mother's age, baseline social support, and baseline depression.

In summary, race, marital status, and education were associated with the missingness of parenting stress. However, the correlations between the study variables and the baseline demographics were low (absolute values smaller than .3). Incorporating these variables as auxiliary variables will have little utility in missing data handling using full information maximum likelihood (Enders, 2010). Therefore, no auxiliary variables were included for this measurement model.

Model estimation.

The total sample size for this model was 427. This is the number of participants with data on at least one of the 36 items for parenting stress. The chi-square test showed that the 3-factor CFA model was significantly worse than the saturated model (χ^2 (df=591) =1237.065, p<.001). The RMSEA=0.051, CFI=0.835, and SRMR=0.062. The RMSEA and SRMR indicated adequate model fit of the 3-factor model, but the CFI was very low. In this model, the RMSEA of the null model is 0.112 (smaller than 0.158), so the CFI will not be used as a model fit index.

Local fit testing was then examined to identify mis-predicted associations between two variables. Normalized residuals provided information about the significance of misfits. Almost 10% of the absolute values of the normalized residuals were larger than 2, indicating prevalent model-data discrepancies. The mis-predicted associations between item 22 and other items were widespread. Twelve out of 35 items had correlation residuals with item 22 larger than 0.1; eight out of 35 items had normalized residual larger than 2. Belonging to the subscale parent-child dysfunctional interaction, item 22 asked the mother to choose from five statements: 1. Not very good at being a parent; 2. A person who has trouble being a parent; 3. An average parent; 4. A better than average parent; 5. A very good parent. Its correlations with many items that belonged to the other two components of parenting stress were underestimated. For example, the correlations between item 22 and the following items were underestimated: "I feel trapped by my responsibilities as a parent", "Since having this child, I have been unable to do new and different things", "Since having this child, I feel that I am almost never able to do things I like to do", "There are quite a few things that bother me about my life", "My child reacts very strongly when something happens that my child does not like" and "My child turned out to be more of a problem than I had expected." The prevalent underestimated correlations were not surprising. The question was worded in a general way and evaluated a woman's overall perception and self-evaluation of being a parent. It did not evaluate a specific dysfunction between a parent-child dyad.

In addition to item 22, it was also noticed that the 3-factor model only explained 6.8%, 1.4%, and 4.2% of the variances in item 29, 32 and 33, indicating that the correspondence between these items and the latent construct were very weak. Furthermore, item 33 was extremely non-normal, with high skewness and excessive kurtosis.

Two correlation residuals showed to be large (>0.2): the correlation between item 4 and 5; the correlation between item 3 and item 23. Item 4 stated "since having this child, I have been unable to do new and different things," and item 5 stated, "since having this child, I fell that I am almost never able to do things that I like to do." These two items were worded similarly and assessed the capability of a mother to do things she liked. Item 3 was "I feel trapped by my responsibilities as a parent," and item 23 was "I expected to have closer and warmer feelings for my child than I do and this bothers me." Item 23 was supposed to measure the dysfunctional interaction. However, the phrase "this bothers me" also assessed parental distress caused by the dysfunctional interaction. It was not surprising that this double-barreled question had higher correlations with items that evaluated parental distress. In addition, because of the lack of closeness and warmth for her child, a mother may be more likely to regard parenting as a responsibility instead of joy and consequently feel trapped in that responsibility.

Model respecification.

Based on the model estimation, it was found that item 22 had prevalent mis-predicted correlations with items from the other two subscales, and three items (29, 32, 33) had very weak correspondence with the latent variable. In consequence, these four items were excluded from the upcoming respecified model. The residuals of item 4 and item 5 was allowed to be correlated as well as the residuals of item 3 and item 23 in the respecified model (Figure 12).

By deleting item 22, 29, 32, and 33, and adding two residual correlations, the global fit of the respecified model was slightly improved: χ^2 (df=459) =907.928, p<.001, RMSEA=0.048, SRMR=0.06. The RMSEA of the null model is 0.12, smaller than 0.158. Again, the CFI was not used as a model fit index. No correlation residual was larger than 0.2, and most of them were smaller than 0.1. The number of normalized residuals with absolute values larger than 2

decreased from 10% to 6.4% in the respecified model.

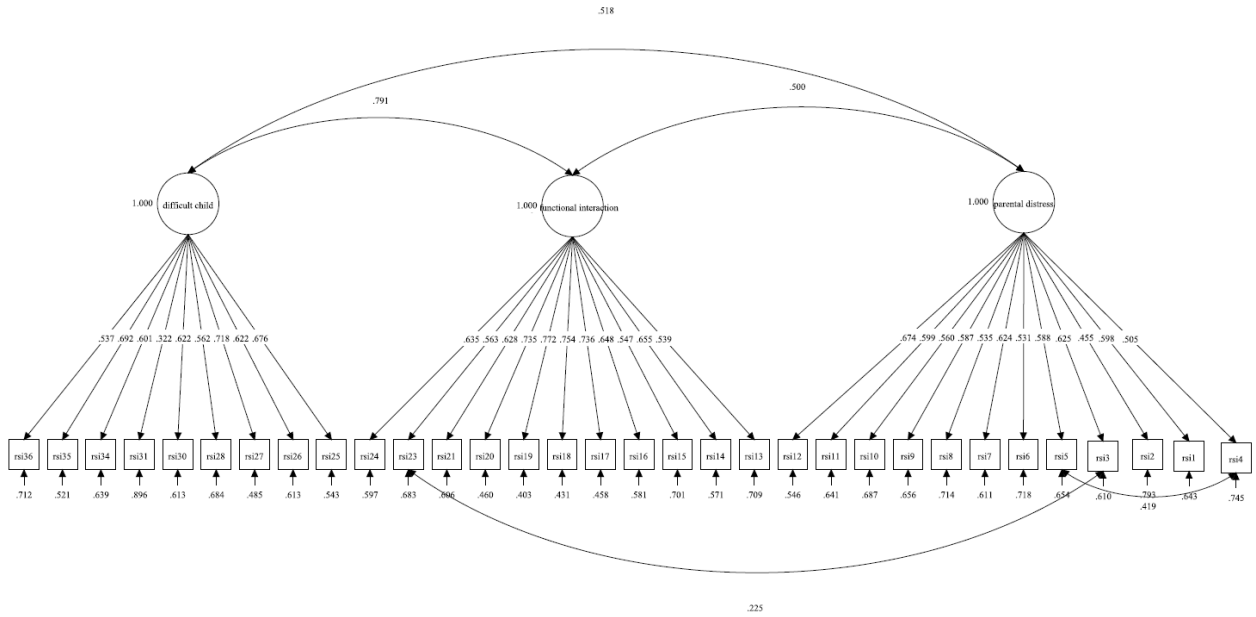

Figure 12 The CFA model for parenting stress

Figure 13 to 15 showed the distribution plots of each latent component of parenting stress. Parental distress (Figure 13) is close to a normal distribution, with a range from -1.7SD to 2.6SD. Dysfunctional interaction (Figure 14) and Difficult child (Figure 15) both showed that the indicators only captured the factor distribution ranging from -1SD to 3SD. The indicators failed to discriminate the varying levels of perceived dysfunctional interaction as well as difficult child which were below -1SD.

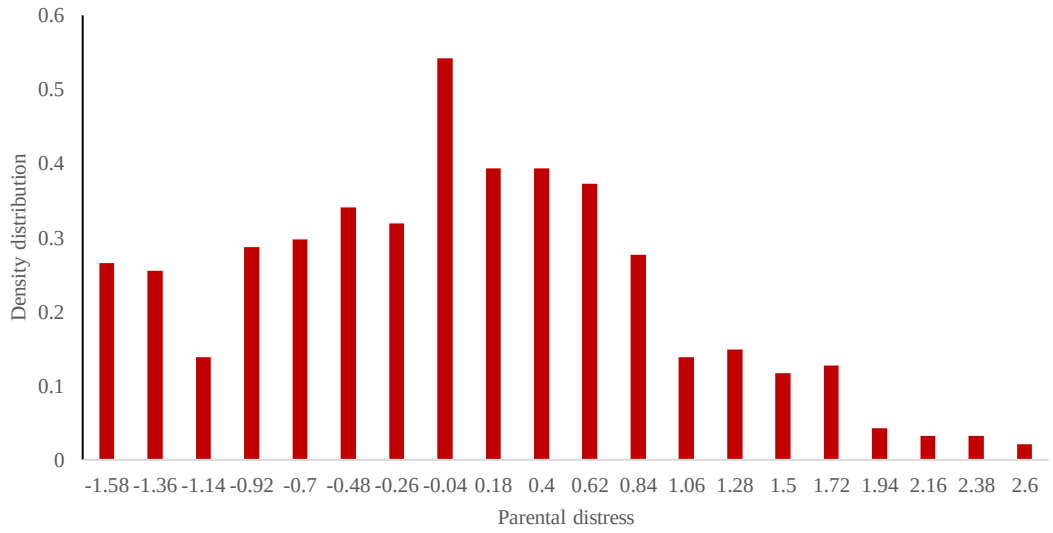

Figure 13 Density plot of the latent variable: parental distress

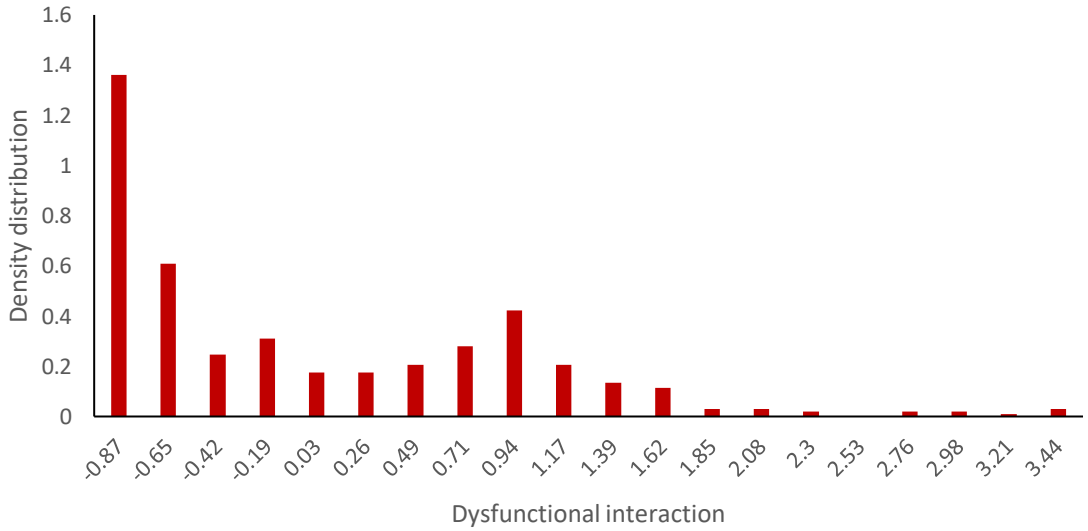

Figure 14 Density plot of the latent variable: dysfunctional interaction

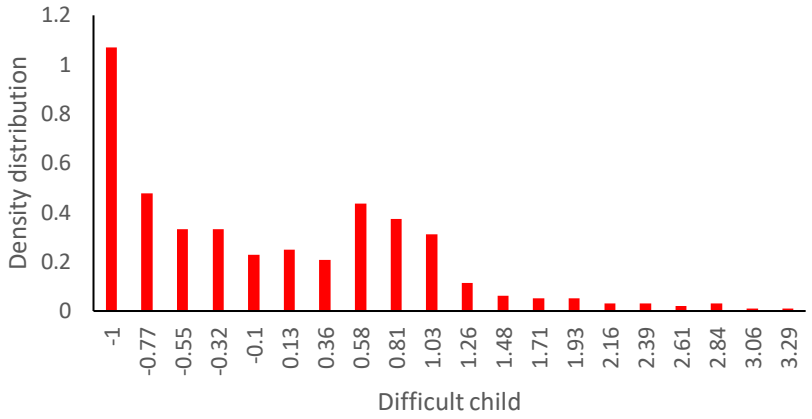

Figure 15 Density plot of the latent variable: difficult child

Structural regression models

For latent interaction modeling, the latent moderated structural equation (LMS) approach yields unbiased estimates of the latent interaction term and has the highest statistical power when the indicators for latent variables are normally distributed. Also, A. Klein and Moosbrugger (2000) found that LMS approach is robust to modest nonnormality (absolute value of skewness<0.5 and kurtosis <1): the estimate of a latent interaction effect is unbiased, but the standard error is underestimated. Cham et al. (2012) tested the robustness of LMS using more severely non-normal data with the median skewness of observed variables around 2 and median kurtosis around 6. Under this condition, the LMS overestimated the latent interaction effect and inflated Type-I error rates, whereas UPI approach yielded generally unbiased estimates of the latent interaction and slightly inflated Type-I error rates. In consequence, Cham et al. (2012) recommended UPI approach when data are severely non-normal.

Based on the tests of univariate normality and multivariate normality, the median skewness, and the median kurtosis of the observed indicators for each factor (Table 18), both

social support and parenting stress showed signs of non-normality: the median kurtosis of maternal support, support from the baby's father, and parental distress were small; difficult child and dysfunctional interaction had more severe leptokurtic distributions. The degree of non-normality of this data lies between the condition where the LMS was proven to be robust by A. Klein and Moosbrugger (2000) and Cham et al. (2012) (absolute value of skewness<0.5 and kurtosis <1) and the condition (skewness≈2 and kurtosis≈6) where the LMS was proven by Cham et al. (2012) to be biased. The choice between LMS and UPI became a trade-off between unbiased estimates (lower possibility of Type-1 error) and statistical power (lower possibility of Type-2 error). The LMS approach is more likely to yield overestimated parameter estimates and underestimated standard error; the UPI approach is more likely to fail to detect the true interaction effect. Considering that the statistical power of detecting interaction effect is already much lower in latent frameworks than using manifest variables, it is especially critical to pick an approach that has higher statistical power, from my perspective. In consequence, the LMS approach was chosen to examine the latent interaction effect between stress and social support on depression. Because of the higher risk of Type-I errors, extra scrutiny is warranted if there was a significant interaction effect.

The estimation for latent moderated structural equations (LMS) followed a three-step procedure. The first step is to fit a measurement model with all constructs of interest correlated with each other (a saturated structure). The purpose of this step is to make sure the overall measurement model fits the data well before exploring the relationship among constructs of interest. The second step is to estimate the structural model without the interaction terms (Model 1). The third step is to add the latent interaction terms one by one into the interaction model (model 2) and estimate the significance of the regression coefficient for each latent interaction

term. Since all the structural models in the second step were saturated, the global model fit statistics were the same with the overall measurement models; therefore, they were not reported repeatedly.

Table 18 Median skewness and kurtosis of the indicators for latent variables

	Median skewness	Range of skewness	Median kurtosis	Range of kurtosis
Maternal support	-1.106	-1.919, -0.838	0.302	-0.291, 2.881
Support from the baby's father	-1.17	-1.379, -0.082	0.326	-1.283, 0.743
Parental distress	0.667	-0.192,1.343	-0.368	-1.303, 1.31
Dysfunctional interaction	1.818	0.89,2.278	3.754	0.433-6.388
Difficult child	1.531	-0.386, 1.946	2.034	-0.22, 5.522

The interaction between support from the baby's father and parenting stress.

Figure 16 showed the overall measurement model for support from the baby's father and parenting stress. The sample size for this model was 503. The global model fit indices indicated an adequate fit of the overall measurement model for support from the baby's father and parenting stress: χ^2 (764) =1374.30, p<.001. RMSEA=0.04, SRMR=0.058. The RMSEA for the null model was less than 0.158. Therefore, the CFI cannot be used as a model fit index. Most of the correlation residuals were smaller than 0.1, and no correlation residual was larger than 0.2. About 5.2% of normalized residuals exceeded 2 in absolute values, but the magnitude was small (most were between 2 to 3).

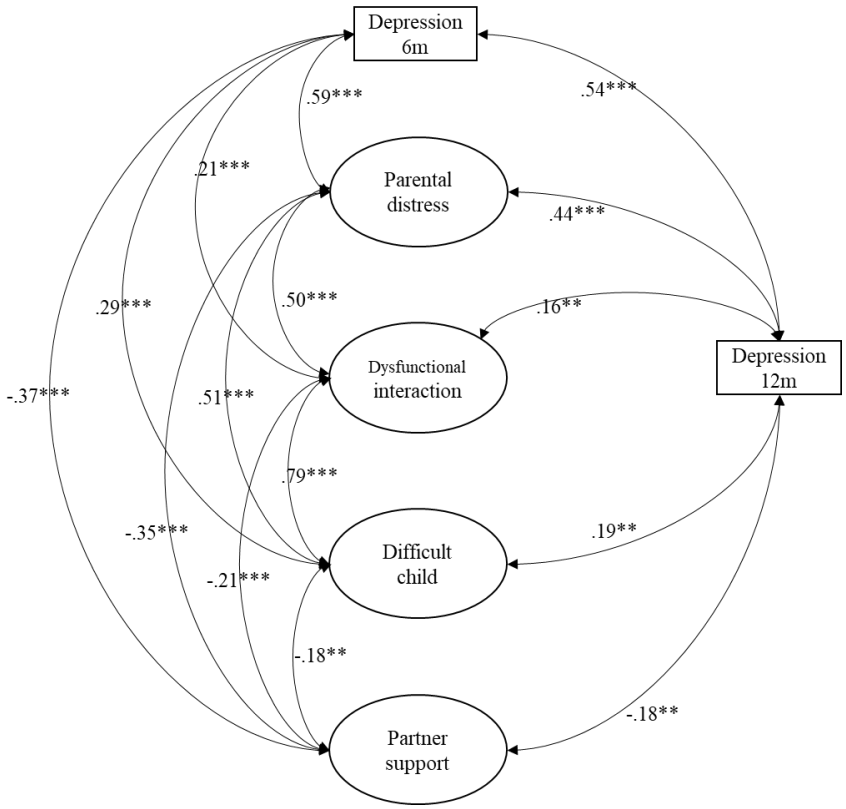

Figure 16 The overall measurement model for support from the baby's father and parenting stress (standardized coefficients)

A structural model that specified the causal directions among constructs of interest (model 1) was then estimated (Figure 17). Following model 1, three latent interaction terms—parental distress × support from the baby's father, dysfunctional interaction × support from the baby's father, and difficult child × support from the baby's father—were then added into the structural regression model one at a time. None of the interaction terms were significant. The nonsignificant interaction terms indicated that the amount of change in the regression slope of depression on parenting stress with a one-standard-deviation change in support from the baby's father was not significant.

The chi-square value of the difference test between model 1 and model 2 was 1.655 (df=3) with a *p*-value of 0.647. The interaction model did not fit the data significantly better than a linear model with all interaction parameters set to zero. In consequence, the main-effect model was retained to describe the relationship among support from the baby's father, parenting stress, and depression. Among the three components of parenting stress, only parental distress at 6-month postpartum had a direct causal effect on depression at 12-month postpartum, after controlling for depression, the other two components of parenting stress, and support from the baby's father. With one standard deviation higher of parental distress at 6-month postpartum, the depression was 0.21 standard deviation higher. The perceived support from the baby's father at 6-month postpartum had no significant causal effect on depression 12 months after childbirth. Concurrently, depression, parenting stress, and perceived support from the baby's father were all significantly correlated.

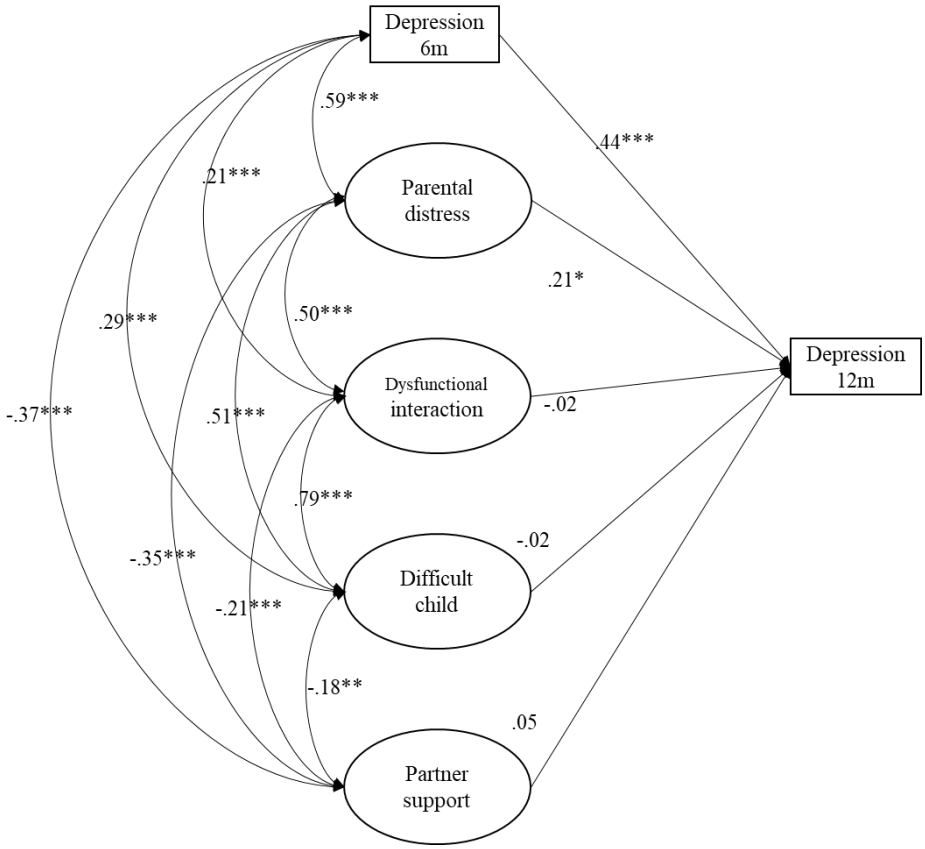

Figure 17 The main effect model of support from the baby's father and parenting stress (standardized coefficients)

The interaction between support from the baby's father and difficult life circumstances (DLC).

Figure 18 showed the overall measurement model for support from the baby's father and difficult life circumstances (DLC). The sample size for this model was 503. The global model fit indices indicated an adequate fit of the overall measurement model for support from the baby's father and DLC: χ^2 (32) =49.62, p=.024. RMSEA=0.033, SRMR=0.026, CFI=0.985. No correlation residual was larger than 0.1; no normalized residual was larger than 2.

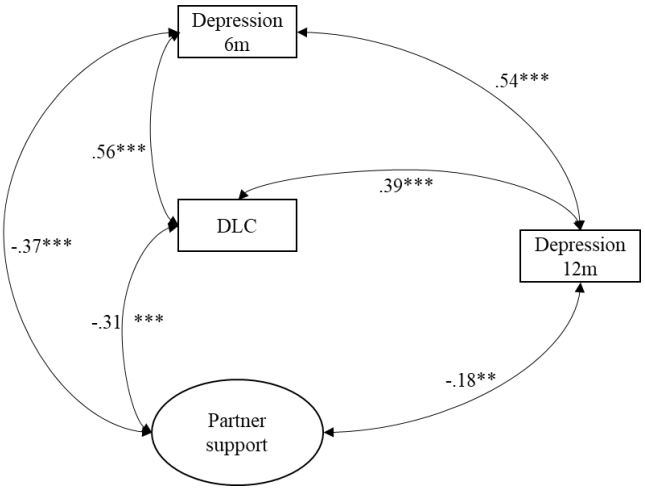

Figure 18 The overall measurement model for support from the baby's father and DLC (standardized coefficients)

A structural model that specified the causal directions among constructs of interest (model 1) was then estimated (Figure 19). Following model 1, an interaction term between DLC and support from the baby's father was then added into the structural regression model (model 2). The interaction term was not significant, indicating that the amount of change in the regression slope of depression on DLC with a one-standard-deviation change in support from the baby's father was not significant.

The chi-square value of the difference test between model 1 and model 2 was 1.391(*df*=1) with a *p*-value of 0.238. The interaction model did not fit the data significantly better than a linear model with the interaction parameter set to zero. In consequence, the main-effect model was retained to describe the relationships among support from the baby's father, DLC, and depression. The difficult life circumstances proceeded and significantly predicted the depressive symptoms at 12-month postpartum. With one more adverse event reported at 6-month postpartum, the depression at 12-month postpartum was 0.43 point higher (unstandardized

coefficient). The perceived support from the baby's father at 6-month postpartum was again not predictive of depression 12 months after childbirth. Concurrently, depression, difficult life circumstances, and perceived support from the baby's father were all significantly correlated.

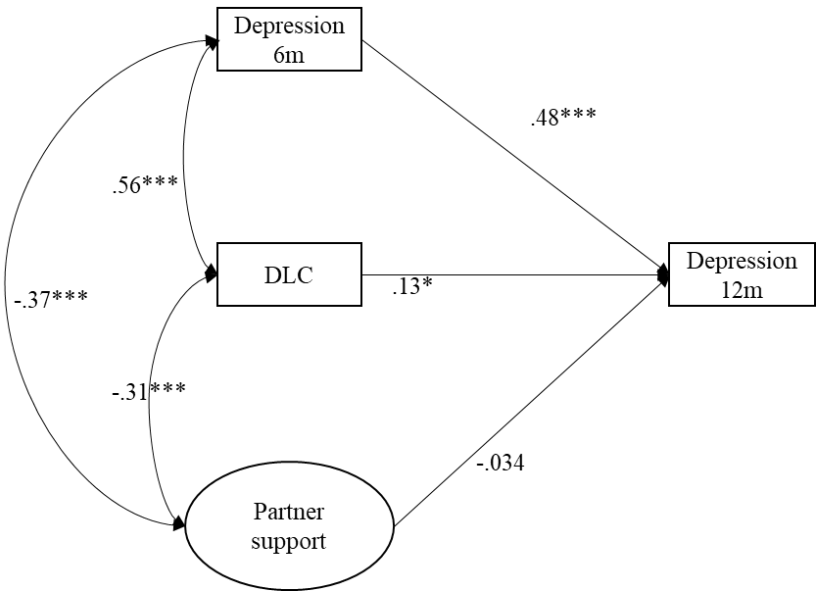

Figure 19 The main-effect model for support from the baby's father and DLC (standardized coefficients)

The interaction between maternal support and parenting stress.

Figure 20 showed the overall measurement model for maternal support (support from a participant's mother) and parenting stress. The sample size for this model was 503. The global model fit indices indicated an adequate fit of the overall measurement model for maternal support and parenting stress: χ^2 (764) =1405.567, p<.001. RMSEA=0.041, SRMR=0.06. The RMSEA for the null model was less than 0.158. Therefore, the CFI cannot be used as a model fit index. Most of the correlation residuals were smaller than 0.1, and no correlation residual was larger than 0.25. About 5.6% of normalized residuals exceeded 2 in absolute values, but the magnitude was small (most were between 2 to 3).

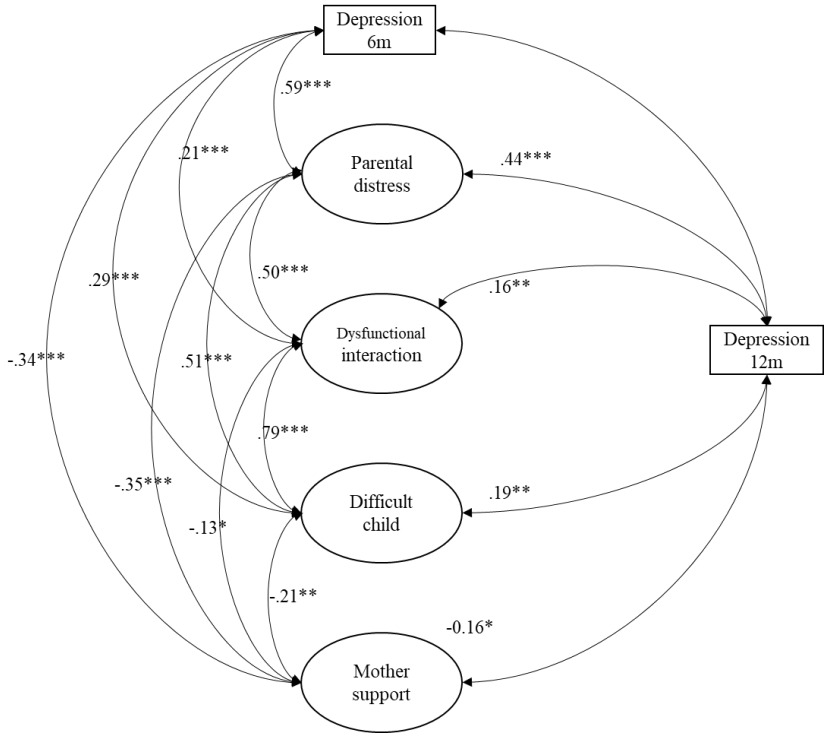

Figure 20 The overall measurement model for maternal support and parenting stress (standardized coefficients)

A structural model (model 1) that specified the causal directions among the constructs of interest was then estimated (Figure 21). Following model 1, three latent interaction terms—parental distress × maternal support, dysfunctional interaction × maternal support, and difficult child × maternal support—were then added into the structural regression model one at a time (model 2). None of the interaction models fitted the data significantly better than the linear structural model. The interaction between parenting distress and maternal support was not significant when it was the only interaction term in the interaction model, or when it was in the model with one of the other two interaction terms: dysfunctional interaction × maternal support or difficult child × maternal support. Nevertheless, when the three latent terms were in model 2 simultaneously, the latent interaction term parental distress × mother support became significant.

Given that the models with interaction term(s) did not significantly improve the model fit than the linear model and the results of the significant tests for the parental distress × mother support term were very unstable, the structural linear model was retained (Figure 21).

Among the three components of parenting stress, only parental distress at 6-month postpartum had a direct causal effect on depression at 12-month postpartum, after controlling for depression, the other two components of parenting stress, and maternal support. With one standard deviation higher of parental distress at 6-month postpartum, the depression was 0.22 standard deviation higher. The maternal support at 6-month postpartum had no significant causal effect on depression 12 months after childbirth. Concurrently, depression, parenting stress, and perceived support from a new mother's mother were all significantly correlated.

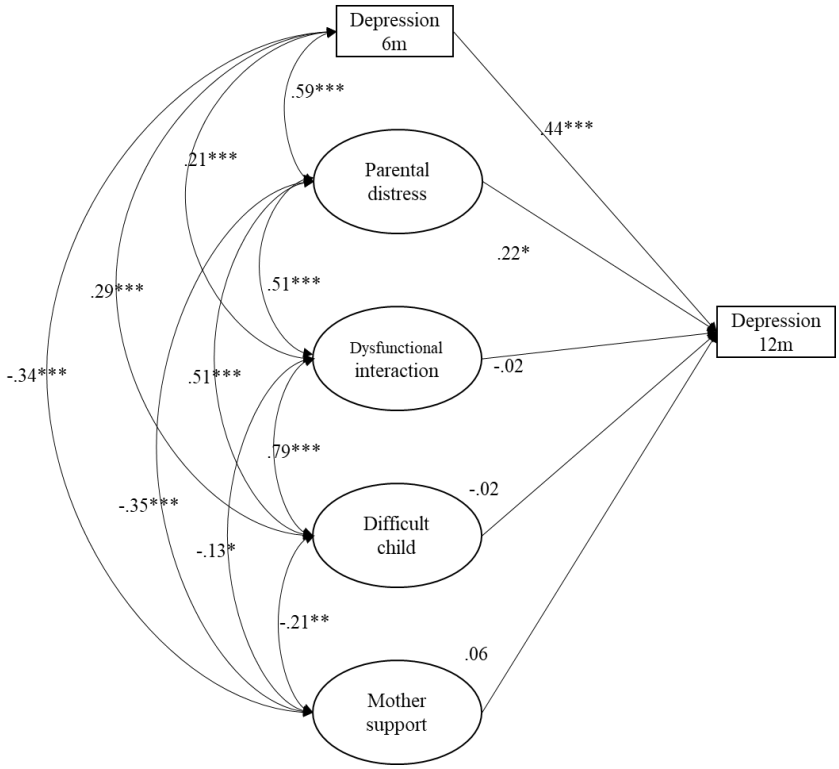

Figure 21 The main-effect model for maternal support and parenting stress (standardized coefficients)

The interaction between maternal support and difficult life circumstances (DLC).

Figure 22 showed the overall measurement model for maternal support and DLC. The sample size for this model was 503. The global model fit indices indicated an adequate fit of the overall measurement model for maternal support and DLC: χ^2 (32) =72.91, p<.001. RMSEA=0.05, SRMR=0.037, CFI=0.957. Only one correlation residual was larger than 0.1; no normalized residual was larger than 2.

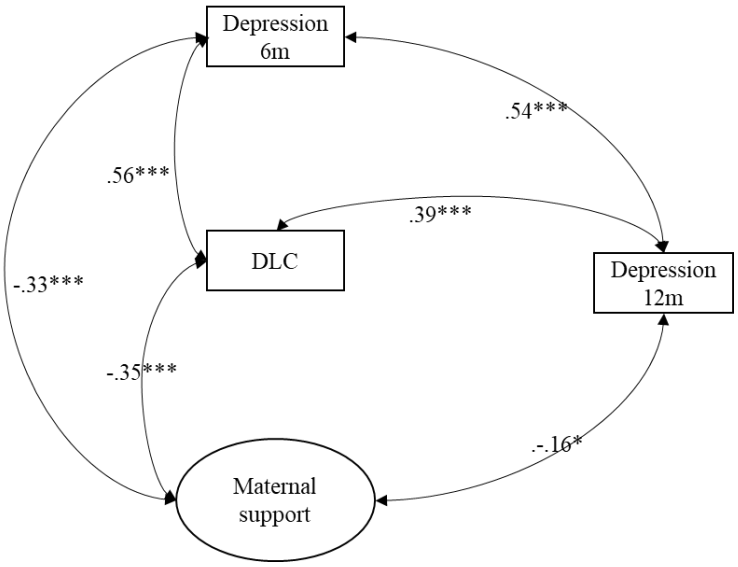

Figure 22 The overall measurement model for maternal support and DLC (standardized coefficients)

A structural model that specified the causal directions (model 1) was then examined (Figure 23). Following model 1, an interaction term between DLC and mother support was added into the structural regression model. The interaction term was not significant, indicating that the amount of change in the regression slope of depression on DLC with a one-standard-deviation change in maternal support was not significant.

The chi-square value of the model difference test was negative (-0.492). According to Mplus Discussion (Muthen, 2002), a negative chi-square value indicated that the difference test is not working and should not be interpreted. Considering the interaction term was not significant, the main-effect model was retained to describe the relationship among maternal support, DLC, and depression. The difficult life circumstances reported at 6-month postpartum preceded and predicted the depressive symptoms 12-month postpartum, after controlling for baseline depression and maternal support. With one more adverse event reported at 6-month postpartum, the depressive symptoms at 12-month postpartum were 0.48 point higher (unstandardized coefficient). The perceived maternal support at 6-month postpartum had no causal effect on depression 12 months after childbirth. Concurrently, depression, difficult life circumstances, and perceived support from the baby's father were all significantly correlated.

Summary of the results will be provided in the next Chapter.

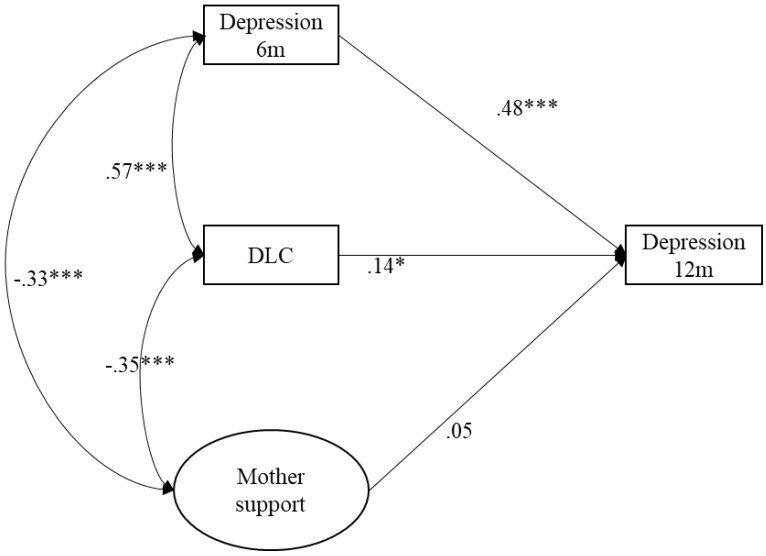

Figure 23 The main-effect model for DLC and maternal support (standardized coefficients)

Chapter 5 Summary, Discussion, Implications, and Conclusion

In this chapter, I firstly recaped the study briefly by summarizing the background, research problem and hypotheses, methods, and findings. Next, I explored and tried to explain some unexpected findings in the discussion section. Finally, implications for practice, research, and policy were provided.

Summary

Literature review.

Postpartum depression (PPD) impacts about one out of eight new mothers, and it has a unique and pervasive impact on a woman, a child, and a family. Research has demonstrated that perceived social support has a positive effect on PPD. Nevertheless, there has been disagreement on how social support influences depression. Two theories of social support on depression are dominant in the literature: stress-buffering theory and main-effect theory. The stress-buffering theory posits that social support buffers the influence of stress on depression. This relationship can also be expressed as that the influence of social support is conditioned on stress: The higher levels of stress, the more important is the social support on mental health. On the contrary, the main-effect model posits that social support has an independent influence on depression, regardless of the presence or the levels of stress. Lack of social support, in and of itself, can directly cause depression.

Stress-buffering theory of social support has been challenged because of the limited support from empirical studies. Many researchers concluded that the main-effect model is more valid than the stress-buffering model since a significant main effect of social support on depression was more frequently reported than the interaction effect between social

support and stress. This comparison is problematic. First of all, many studies that supported the main-effect model did not include stress in their analyses. A left-out-variable error occurs when a critical concept, in this case, the stress, was left out. The significant association between social support and depression can be spurious or inaccurate due to left-out-variable errors.

Furthermore, a significant main effect found from a study with stress left out is not sufficient to support the main-effect model: a significant association between social support and depression can also hold in a stress-buffering model. To endorse the independent effect of social support on depression, evidence that the magnitude of the association between support and PPD is not influenced by stress level is required. To get valid evidence for either the stress-buffering model or main-effect model, stress, social support, and depression have to be assessed and modeled simultaneously. In short, studies that did not include stress while examining the relationship between social support and depression cannot be counted as valid empirical evidence for or against either theory.

For studies that rightfully included stress, social support and depression, definitional issue and a variety of methodological issues were revealed.

Different theories on stress drove the divergence in the operational definition and measurement of stress in empirical research. Some studies adopted a stimulus-based definition of stress and conceptualized stress as the number of adverse events a person experienced in a certain period. Many other studies, on the other hand, preferred a stimulus-response perspective of stress which took an individual's subjective evaluation of an external event into consideration. The differences in how stress was defined and measured contribute to the inconsistent empirical evidence for the stress-buffering model of social support.

Other than definitional issues, methodological issues also lead to inconsistent conclusions about the two theories. The measurement issues revealed from current literature included using inventories with low reliability or low validity, categorizing continuous data, and applying cross-sectional designs. Using inventories with low reliability introduces measurement errors, which can bias the significance tests and lead to inaccurate inferences. Dichotomizing a continuous score loses information in individual differences, lowers statistical power, and is more likely to yield spurious findings. Cross-sectional designs are unable to test the temporal precedence among stress, social support, and depression. Also, a cross-sectional design is more vulnerable to spurious interactive effects.

In summary, without a rigorous research design or robust analyses, it is not tenable to claim that the main-effect theory is better supported than the stress-buffering model. This study was aimed to examine the research question— is social support a moderator that alleviates the influence of stress on postpartum depression— by using two different definitions of stress and following a rigorous procedure of research design and statistical analyses. This study answered the research question by testing three hypotheses:

H_1: After controlling for initial levels of depressive symptoms, with higher levels of perceived social support, the stress-depression association is smaller.

H_{2a}: After controlling for initial levels of depressive symptoms and perceived social support, higher levels of stress precede and predict higher levels of depressive symptoms.

H_{2b}: After controlling for initial levels of depressive symptoms and stress, higher levels of perceived social support precede and predict lower levels of depressive symptoms.

Methods.

Secondary longitudinal data were used to test the hypotheses. In total, 512 first-time mothers comprised the study sample. Stress measured at six months postpartum was used to predict the changes in depressive symptoms from 6 to 12 months postpartum and social support measured at six months postpartum was used as a moderator between stress and PPD. Two inventories—Difficult Life Circumstances (DLC) and Parenting Stress Index-Short Form (PSI-SF)— that reflect different theoretical underpinning in stress were used to assess the external adverse events and perceived parenting stress, respectively. Two key sources of social support were measured separately—perceived support from the baby's father and maternal support (support from a new mother's mother)—both with seven Likert-response items. Depressive symptoms were measured by BDI-II. Structural Equation Modeling (SEM) was adopted for statistical analyses. SEM is an advanced statistical method that separates unexplained variance (including measurement error and specific bias) and error-free latent constructs of interest. With error-free latent variables, the SEM approach yields more precise parameter estimates and significance tests. This study filled the methodological gap in the literature since no published study had applied SEM to examine the stress-buffering effect of social support on depression. Measurement models for perceived support from the baby's father, perceived maternal support and parenting stress were firstly established through confirmatory factor analysis (CFA).The error-free latent constructs of social support, parenting stress, and their interaction term(s) were then used to predict postpartum depression in structural regression models.

Results.

The interaction effect between stress and social support.

A significant interaction between parental distress and maternal support was found from the maternal support × parenting stress model when the other two interaction terms were in the

model simultaneously. However, the interaction models did not fit the data significantly better than the main-effect model, and the results of the significance tests of the interaction term were very unstable. Therefore, the interpretation of this significant finding with extra caution is warranted, which will be further discussed in the next subsection.

Other than the maternal support × parenting stress model, the other three models did not find any significant interaction term. The nonsignificant results indicated that with a one-unit change in social support, the amount of change in the magnitude of the relationship between stress and depression was not significant. Social support and stress did not show a joint influence on depression. In other words, social support was not found in this study to moderate the influence of stress on postpartum depression.

Main-effect models were retained in all the following models: parenting stress × support from the baby's father, DLC × support from the baby's father, parenting stress × maternal support, and DLC × maternal support.

The main effect of stress on depression.

The support from the baby's father × parenting stress model and maternal support × parenting stress model showed that parental distress preceded and predicted depression after controlling for baseline depression, social support and the other two components of parenting stress. Neither difficult child nor dysfunctional interaction had a causal effect on depression.

The support from the baby's father × DLC model and maternal support × DLC model both showed that difficult life circumstances preceded and predicted depression after controlling for baseline depression and social support.

In summary, the causal inference from parental distress to postpartum depression was bolstered by the two parenting stress models. The causal inference from difficult life circumstances to PPD was also supported by the two DLC models.

The main effect of social support on depression.

The support from the baby's father × parenting stress model and maternal support × parenting stress model showed that after controlling for baseline depression and parenting stress, neither support from the baby's father nor support from the participant's mother (maternal support) had a direct causal effect on depression.

Similarly, the support from the baby's father × DLC model and maternal support × DLC model showed that after controlling for baseline depression and DLC, neither support from the baby's father nor maternal support had a causal effect on depression.

In summary, a direct causal effect of perceived social support on PPD was not endorsed by any of the models.

Discussion

In this section, I primarily focused on unexpected findings and nonsignificant findings. By fully exploring and discussing plausible reasons for the outcome as it was, I tried to shed some light on the nature of the problems and contribute to the body of knowledge.

The effect of stress on postpartum depression.

Parenting stress.

Among the three components of parenting stress, parental distress measured at 6-month postpartum showed a unique, direct influence on depression at 12-month postpartum, after

controlling for the depressive symptoms at 6-month postpartum. This finding showed that parental distress is a distinctive construct that is different from depression and it has a long-lasting influence on postpartum depression. Deater-Deckard (2004) described the relationship between psychopathology and parenting stress as a bridge that influences traveling in both directions. This study adds another piece of evidence that parental distress can contribute to the emergence and development of depression among new mothers. This finding is in line with the report from Vismara et al. (2016), who found that parenting stress at the 3-month postpartum influence the depressive symptoms at 6-month postpartum. Huang, Costeines, Kaufman, and Ayala (2014) also found that the parenting stress (the total score of the three subscales of PSI-SF) preceded and predicted the maternal depression 6 months after childbirth.

On the contrary, neither dysfunctional interaction nor difficult child showed a direct effect on depression. When examining the literature, we expected that the difficult child and dysfunctional interaction affect depression. For example, Cutrona and Troutman (1986) found a significant concurrent association between infant temperament and postpartum depression. Huang et al. (2014) reported a significant longitudinal association between parenting stress and maternal depression. In their study, parenting stress was represented by the total score of parental distress, difficult child, and dysfunctional interaction. It indicated from my study that the three aspects of parenting stress might affect postpartum depression in different ways. Perhaps we don't see the direct association between PPD and dysfunctional interaction or the direct association between PPD and difficult child because dysfunctional interaction and difficult child influence a new mother's depressive symptoms indirectly through parental distress. For example, the main-effect models of support from the baby's father and parenting stress (see figure 17) showed that dysfunctional interaction and difficult child both were highly correlated with

parental distress (r=.50 and .51). A fussy child or a mother perceiving a lack of closeness and warmth for the baby may aggravate the mother's distress, which in turn leads to higher levels of depression. This speculation was be supported by previous studies. According to Ostberg and Hagekull (2000), a mother's perception of her child as fussy or difficult was associated with higher levels of parental distress. Listening to crying infants was demonstrated to be a potentially distressing experience (Zeskind, Sale, Maio, Huntington, & Weiseman, 1985) and dealing with an infant with difficult temperament every day can lead to long-lasting parental distress. Similarly, Beebe, Casey, and Pintomartin (1993) found that a mother who reported excessive crying was 5.7 times more likely to perceive the mother-infant interaction as dysfunctional.

Difficult life circumstances.

In this study, difficult life circumstances (for example, difficult interpersonal relationships, trouble with the landlord, inability to consistently pay bills, unstable housing, being a victim of a crime, being hospitalized, etc.) showed a significant direct effect on postpartum depression. Adverse life events that new mother experience from immediate after childbirth to 6-month postpartum had a long-lasting influence on depressive symptoms at 12-month postpartum. This finding was consistent with couple longitudinal studies that assessed stress using a checklist of adverse life events. Dubois et al. (1992) found that major life events and daily hassles both had a direct effect on psychological distress among adolescents. Russell and Cutrona (1991) also found that daily hassles influence depression longitudinally among the elderly. This study added a new piece of evidence that difficult life circumstances had a significant and enduring impact on new mothers.

As part of difficult life circumstance, material hardship plays an important role in the emergence and development of maternal depression. Abrams, Dornig, and Curran (2009)

reported that low-income mothers commonly perceived poverty as a cause of depression and described the core experience of postpartum depression as being overwhelmed by mothering in the context of a materially stressful situation. Sampson, Zayas, and Seifert (2013) also posited that the difficult life circumstances not only put a mother at higher risk for postpartum depression but also interacted with other risk factors such as low child birth weight and history of depression to jointly increase a mother's vulnerability to PPD.

The opposite direction of the interaction between maternal support and parental distress.

The interaction between maternal support and parental distress was positively significant when all other interaction terms were added into the model. However, I retained the main-effect model of maternal support and parenting stress because a) the interaction models did not fit the data significantly better than the main-effect model, b) the estimates of the interaction effect between parental distress and maternal support changed dramatically depending on whether the other two interaction terms were in the model: the interaction term was not significant when it was the only interaction term in the model or just with dysfunctional interaction, or just with difficult child. Only when the three interaction terms were in the model simultaneously, the parental distress × maternal support was significant. The inconsistent findings indicate that the models may not be stable. Although I retained the main-effect model in Chapter 4, it is important to take a closer inspection of the counterintuitive finding since the positive interaction between parental distress and maternal support implied a stress-exacerbating effect of maternal support. In other words, the model told us that with higher levels of perceived maternal support, parental distress has a worse influence on depression. This finding is in disagreement with the stress-buffering theory of social support, previous empirical evidence, and common sense. It is

necessary to examine whether a research design issue or methodological explanation might account for the outcome.

As mentioned in previous chapters, leptokurtic data can attenuate the standard error and consequently yield false positive results from significance tests. Although the median kurtosis of the indicators for maternal support was low (0.302), the sixth item (help take care of the baby) had a much higher leptokurtic value (3.162) than the other items. Also, it performed the worst in the measurement model, with the lowest factor loading and only 31% of variance explained by the common factor—maternal support. To test my hypothesis that the counterintuitive finding is caused by the leptokurtic data, I deleted the sixth item and reran the model. The interaction between parental distress and maternal support after deleting the sixth item became nonsignificant. The directions and magnitudes of the effect of maternal were very similar to the model of support from the baby's father × parenting stress.

By deleting an indicator with leptokurtic distribution, the interaction between maternal support and stress became nonsignificant. This provided evidence on how non-normality of the data can influence the parameter estimates and significance tests. As mentioned in Chapter 4, the choice of LMS over UPI was a compromise of unbiased estimates to higher statistical power. In this study, the LMS model yielded counterintuitive results, which attracted extra attention. What if the significant effect was in line with the hypothesis or common sense? It is not hard to imagine this methodological issue would be more likely to be overlooked and the significant interaction would be attributed to the "true" interaction effect in the population.

Because LMS and UPI (Unconstrained product indicator) approach each has advantage and disadvantage, I propose to check the maternal support × parental distress model with UPI approach and compare the results with the LMS approach. Also, A. G. Klein and Muthén (2007)

reported that a quasi-maximum likelihood estimation could handle non-normal data better than maximum likelihood estimation. Mplus 8.2 does not have the module to apply quasi-maximum likelihood estimation, but another software R provides a package named NLSEM (Umbach, Naumann, Brandt, & Kelava, 2017) in which the quasi-maximum likelihood estimation can be conducted. The maternal support × parental distress model will also be examined using NLSEM. A study that aimed to compare the performance of LMS, UPI, and Quasi-maximum likelihood estimation in handling non-normal data can be conducted in the near future.

It should also be noted that if the UPI approach was originally adopted in this study, it was highly likely that all the latent interaction effects were not significant. It would still be necessary to run the models with the LMS approach to confirm that the nonsignificant latent interaction effects were not due to the lower statistical power of the UPI approach.

The nonsignificant effect of social support on depression.

As mentioned in the previous subsection, the significant finding of the interaction between maternal support and parental distress was not stable and likely due to the non-normality of the indicators for maternal support (support from a new mother's mother) rather than a true stress-exacerbating effect in the population. I will assume for now (will be checked in the following study) that is the case, i.e., the interaction effect between maternal support and parental distress is not significant. Given this, not only the interaction effects between stress (parenting stress or DLC) and social support (support from the baby's father or maternal support) but also the main effects of social support (support from the baby's father or maternal support) on depression were not significant. Neither the stress-buffering model nor the main-effect model of social support was endorsed by this study. In the following subsections, I will turn over every

possible explanation for why social support at 6-month postpartum did not have any effect on depression at 12-month postpartum.

The statistical power problem caused by the latent framework.

Although the SEM approach corrects for measurement error and minimizes bias in parameter estimates, Cham et al. (2012) warned that given the same sample size, the statistical power of a significant test for a latent interaction was substantially lower than the statistical power based on using scale scores assuming that the constructs of interest were measured without error. Also, the sample size for the latent moderation models in this study was barely sufficient: The ideal ratio of sample size to the number of parameter estimates is 10 to 20, yet this study adopted a lower threshold of 5. Because of the large number of parameter estimates introduced by using individual indicators instead of total scores, the statistical power was lowered, and it is more likely to fail to detect a true effect in the population. To test my hypothesis, I used total scores instead of measurement models to represent the three subscales of parenting stress. The interaction models using scale scores showed that neither maternal support nor support from the baby's father had a significant interaction effect with parenting stress. The main effect of support was not significant either. In consequence, it is fairly safe to say that the nonsignificant influence of social support on depression was not due to the low statistical power of the SEM approach.

The psychometric quality of indicators.

As shown in Figure 9 and 11, the indicators for social support failed to capture the right tail of the distribution of the latent variables. In other words, the indicators cannot distinguish participants whose levels of social support were one standard deviation above average and beyond. Similarly, Figure 14 and 15 showed that the indicators for difficult child and

dysfunctional interaction failed to capture the left tail of the distribution of the latent variables. In the language of Item Response Theory (IRT), these items showed a low level of discrimination because they did not effectively distinguish individuals who differ on a latent variable.

Because the indicators only reflected a restricted range of the corresponding latent variables, the variability of the latent variables and the regression coefficient estimates were underestimated. In other words, the lost information due to the low psychometric quality of the indicators lowers the statistical power which is essential to detect a real effect that exists in the population.

The long lag between measurement occasions.

Another possibility of the non-significant results is that the lag between measurement occasions was too long. It is true that the influence of stress and social support on depression take time to unfold. However, the gap between two observations cannot be so long that the window in which an effect can be detected was missed. Given this, it is important to revisit the time points of when data were collected. The measures of support were obtained at 6-month postpartum, and depression was measured at 12-month postpartum. The model is only showing us how the amount of support a mother perceived at six months was affecting her depressive symptoms six months later. Perhaps no significant effect was found because the support a mother perceived at 6-month postpartum has little influence on how the mother feels six months later. Nevertheless, the influence of social support may have shown in a shorter period. Similarly, stress may have shown a larger causal effect on depression if the second measurement occurred earlier. The moderation effect of social support could've been detected when the influence of stress on depression is at its peak.

Previous longitudinal studies on the support-depression relationship provided empirical support on my hypothesis. Studies that used shorter lags between measurement occasions detected a significant effect of social support on depression, either directly or jointly with stress. Greco et al. (2014) reported that in cardiovascular disease patients, social support preceded and predicted depression measured two months later, after controlling for baseline depression. Saltzman and Holahan (2002) found that social support preceded and predicted depression measured five weeks later among a sample of 300 college students. Cutrona and Troutman (1986) reported that social support during pregnancy was significantly associated with depressive symptoms measured at 3-month postpartum among 55 women. Payne (2010) reported that low social support was a vulnerability factor for schoolchildren in a longitudinal 6-week study. Also, he found that social support network size was a protector of depression among college students in another longitudinal 6-week study. The lag of measurement occasions in the aforementioned studies ranged from 5 weeks to 3 months, and they all reported a significant effect of social support.

On the contrary, Burton et al. (2004) reported that perceived peer social support showed a significant unique relation to subsequent increases in depressive symptoms measured two years later. However, the significant effect was small in magnitude. Parental social support did not show a significant relation to subsequent increases in depressive symptoms. Furthermore, no moderation effect of either kind of social support was found in their study. The two-year lag may attribute to the nonsignificant findings because it might be too long to detect a causal effect between support and depression.

In the original study, the study variables were not measured within a shorter time framework to enable me to confirm my speculation on the association between nonsignificant

results and the length between measurement occasions. However, we can still see some evidence from the concurrent relationships among stress, social support, and depression. The perceived support from the baby's father and maternal support both showed considerable associations with depression concurrently; parenting stress and DLC both showed much larger associations with depression concurrently than longitudinally. To examine if it is possible that the effects of support are immediate and perhaps not long lasting, I performed a set of cross-sectional analyses to test the concurrent interaction effects between stress and social support on depression using the data collected in 6-month postpartum. In the original study, depression during pregnancy was measured. Therefore the concurrent influence of stress and support on depression was investigated after controlling for the baseline level of depression. In the concurrent analyses, the 74 cases that did not participate the 6-month follow-up did not have any data on depression, social support, and parenting stress at 6-month postpartum, therefore, these cases were excluded from the following analyses. The total sample size for the current analyses of the interaction effects was 438.

Before discussing the findings of the concurrent relationships among stress, social support, and depression, I'd like to reiterate the advantage of a longitudinal study and the limited implication of findings from cross-sectional designs, from a perspective of model specification and estimation. SEM yields the same model fit with two study variables correlated in the following different ways: unanalyzed correlation (A with B), causal effect from A to B, and causal effect from B to A. If two variables were measured at different occasions, say A was measured prior to B, then the directional effect from B to A can be excluded. However, in a cross-sectional design, neither possibility can be excluded by design element, and the directionality is not verifiable in SEM analysis. The directional effect between A and B has to be

specified solely based on assumption. In other words, the directional effect from A to B is a prerequisite that had been decided in the step of model specification.As a result, even when the regression of B on A is significant, the model did not tell us that A had a causal effect on B. A longitudinal design cannot confirm the causal effect either, but it is superior to a cross-sectional analysis because it can establish the temporal precedence of A to B, which is a necessary condition of the causal relation. Also, a common assumption made in cross-sectional models and longitudinal models when specifying a directional effect is that the association between A and B was not due to a common cause that was left out of the model.

The longitudinal models in this study did not make directional assumptions. For variables that measured at different occasions, the direction was from a variable measured earlier to a variable measured later, i.e., from stress, social support, and depression at 6-month postpartum to depression at 12-month postpartum. For variables that measured at the same time, i.e., the associations among stress, social support, and depression at 6-month postpartum, their relationships were identified as unanalyzed correlations.

In comparison, in the cross-sectional analyses, the effect directions among stress, social support, and depression will have to be specified based on assumptions, and the assumptions were made based on theories and empirical evidence. The longitudinal analyses in this study provided fresh evidence that parental distress and DLC at 6-month postpartum preceded and predicted of depression at 12-month postpartum. For temporal relations that were not endorsed by the longitudinal analyses—from difficult child, parent-child dysfunctional interaction, and social support to depression—the directional assumptions were made based on extant literature (O'Hara & Swain, 1996). With the directionalities among the study variables decided, the specified models were shown in Figure 24 and Figure 25.

In the following sessions, I will briefly report the model estimations for the concurrent interaction effects between support from the baby's father and parenting stress, support from the baby's father and DLC, maternal support and parenting stress, and maternal support and DLC, respectively.

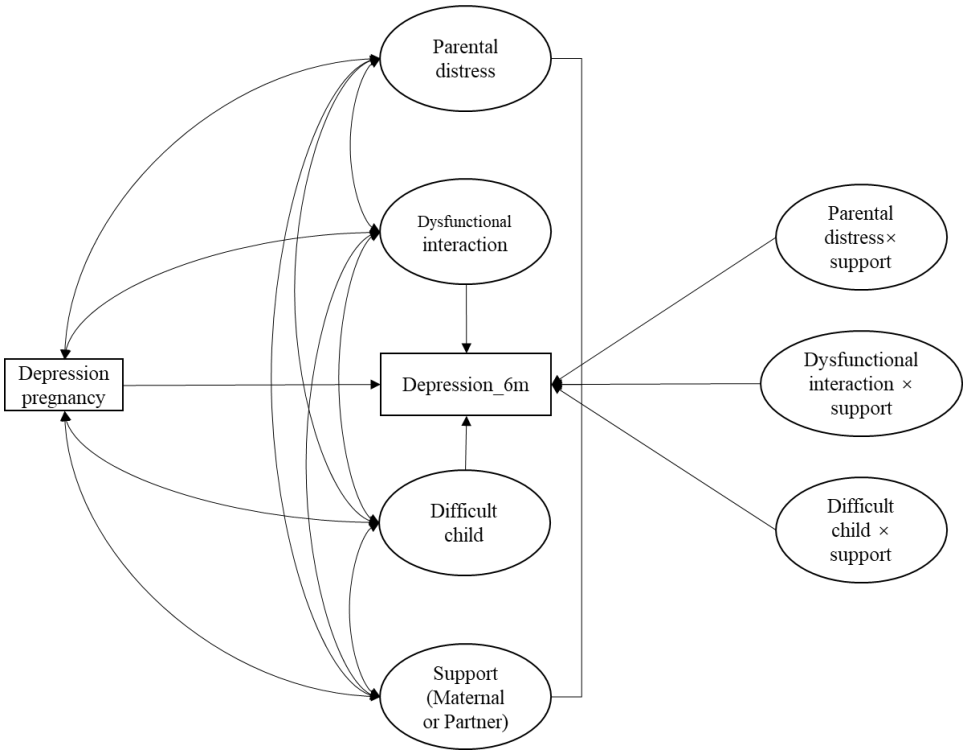

Figure 24 Specified cross-sectional model for social support and parenting stress

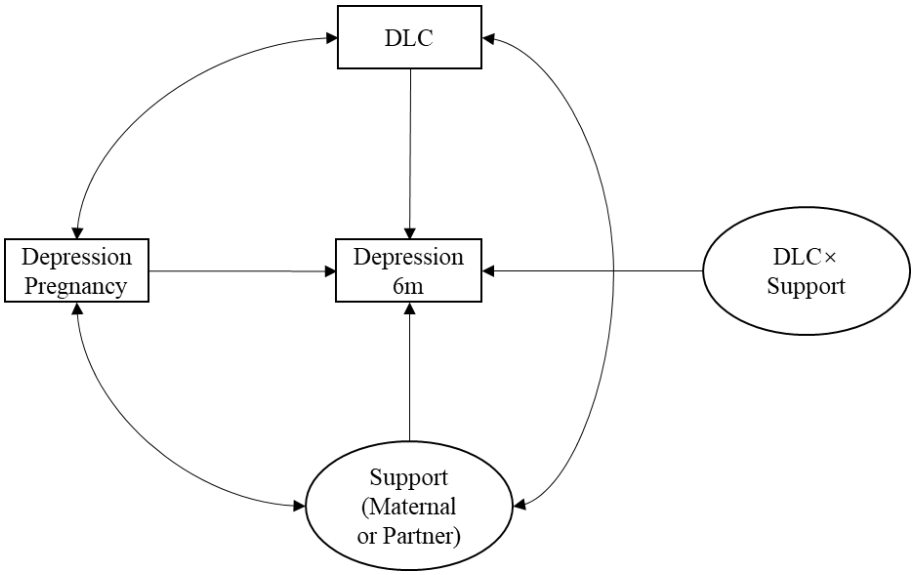

Figure 25 Specified cross-sectional model for social support and DLC

The interaction between support from the baby's father and parenting stress at 6-month postpartum.

The latent interaction model was estimated following the two-step procedure described in Chapter 3. The sample size for this model was 438. A linear structural model was first estimated, and the model showed an adequate model fit: χ^2 (764) =1363.155, p<.001. RMSEA=0.042, SRMR=0.058. The RMSEA for the null model was less than 0.158. Therefore, the CFI cannot be used as a model fit index. Most of the correlation residuals were smaller than 0.1, and no correlation residual was larger than 0.25. About 5.8% of the absolute values of the normalized residuals were larger than 2. Three latent interaction terms: parental distress × support from the baby's father, dysfunctional interaction × support from the baby's father, and difficult child × support from the baby's father were then added into the interaction-effect model one by one. Likelihood ratio test showed that the interaction model with parental distress × support from the baby's father fitted the data significantly better than the linear regression model (χ^2 (1)

=7058.125, p<.001). The parental distress × support from the baby's father model was also not significantly worse than interaction models with any two interaction terms or the interaction model with all three interaction terms in it. In consequence, the parental distress × support from the baby's father interaction model was retained (Figure 26). The interaction between parental distress and support from the baby's father was significant. Johnson-Neyman plot showed that with higher levels of support from the baby's father, the strength of the positive association between parental distress and depressive symptoms became weaker (Figure 27).

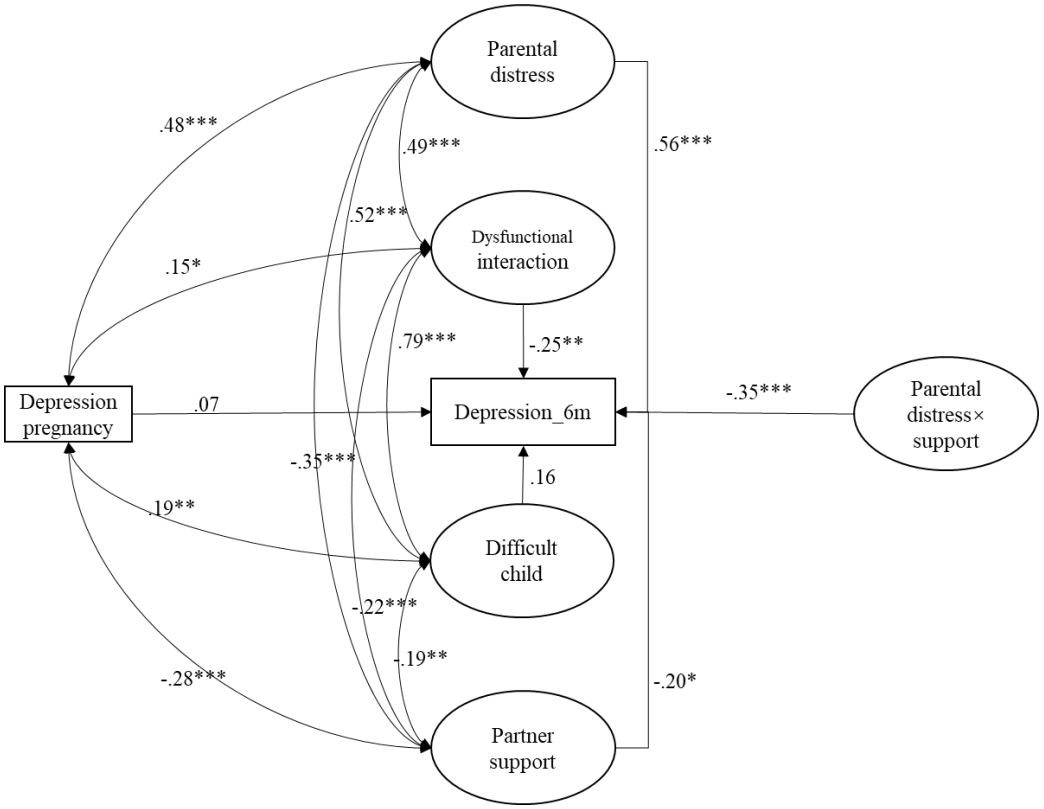

Figure 26 The interaction-effect model for the interaction between parental stress and support from the baby's father at 6-month postpartum

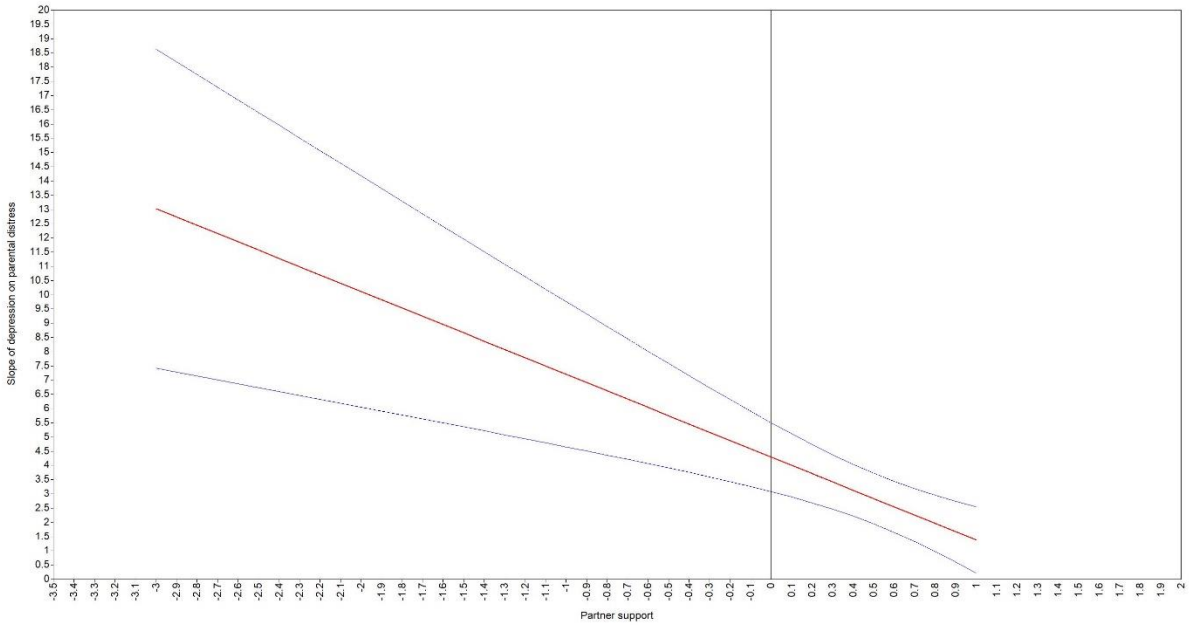

Figure 27 Johnson-Neyman plot for the interaction between parental distress with support from the baby's father

The interaction between support from the baby's father and DLC at 6-month postpartum

The sample size for this model was 438. A linear structural model was first estimated, and the global model fit indices showed an adequate model fit of the linear regression model of support from the baby's father and DLC on depression: χ^2 (32) =47.423, *p*=.04. RMSEA=0.033, SRMR=0.025, CFI=0.987. No absolute value of correlation residual was larger than 0.1, and no absolute value of normalized residual was larger than 2. An interaction term between DLC and support from the baby's father was then added into the structural model. The interaction model fitted the data significantly better than the linear model (χ^2 (1) =150.467, *p*<.001), and the interaction was significant (Figure 28). Johnson-Neyman plot showed that with higher levels of support from the baby's father, the strength of the association between DLC and depression at 6-month postpartum became weaker (Figure 29).

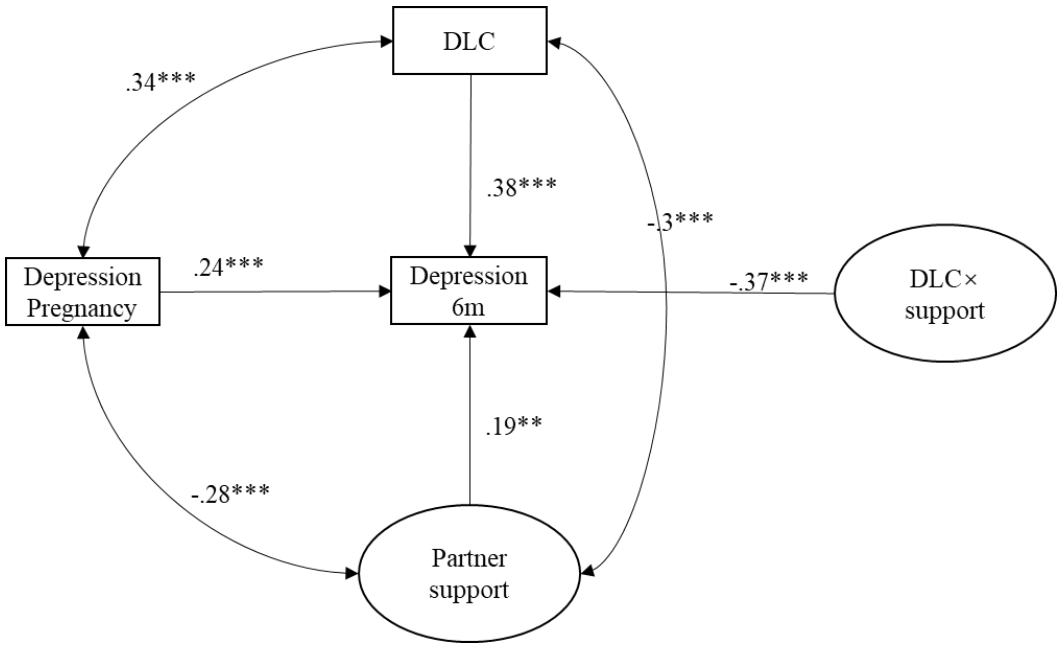

Figure 28 The interaction-effect model for the interaction between DLC and support from the baby's father at 6-month postpartum

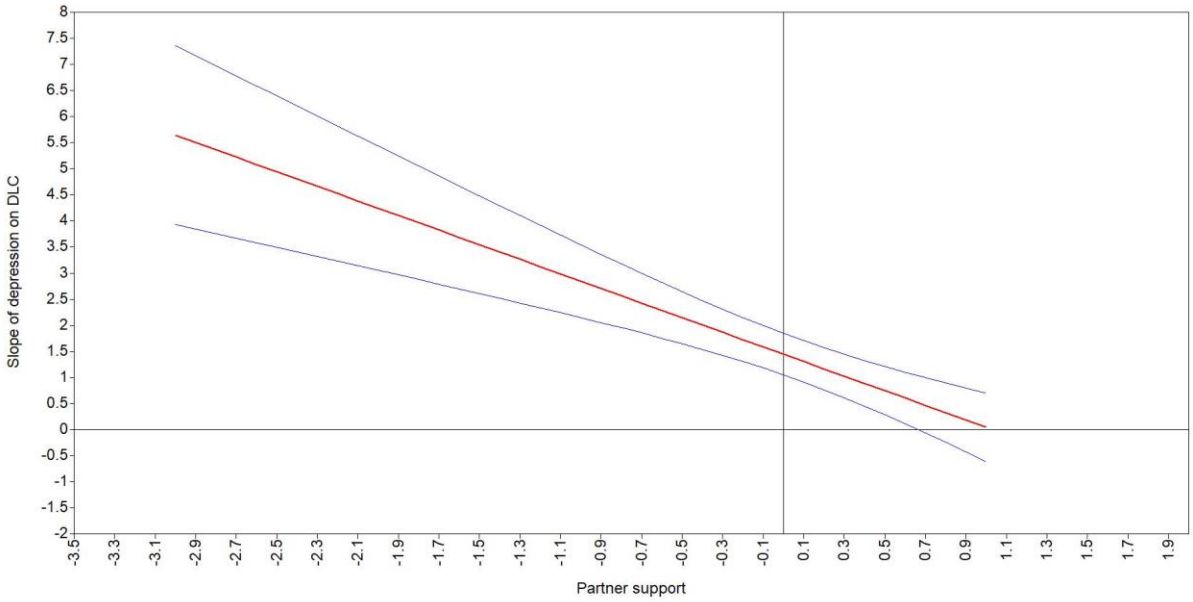

Figure 29 Johnson-Neyman plot for the interaction between DLC and support from the baby's father

The interaction between maternal support and parenting stress at 6-month postpartum.

As discussed in Chapter 4, the sixth item for maternal support was excessively non-normal. In the upcoming analysis, the sixth item was excluded from the measurement model of maternal support. The main-effect model without interaction terms showed adequate model fit: χ^2 (725) =1313.36, p<.001. RMSEA=0.043, SRMR=0.056. The RMSEA for the null model was less than 0.158. Therefore, the CFI cannot be used as a model fit index. Most of the absolute values of correlation residuals were less than 0.1, and only one was larger than 0.2. About 6.3% of the normalized residuals were larger than 2, and none of them had an absolute value larger than 4. Three latent interaction terms: parental distress × maternal support, dysfunctional interaction × maternal support, and difficult child × maternal support were added into the interaction-effect model one by one. Likelihood ratio test showed that the interaction model with parental distress × maternal support term fitted the data significantly better than the linear regression model (χ^2 (1) =63.631, p<.001). The parental distress × maternal support model was also not significantly worse than interaction models with any two interaction terms or the interaction model with all three interaction terms in it. In consequence, the parental distress × maternal support interaction model was retained (Figure 30). Johnson-Neyman plot showed that with higher levels of maternal support, the strength of the positive association between parental distress and depressive symptoms became weaker (Figure 31).

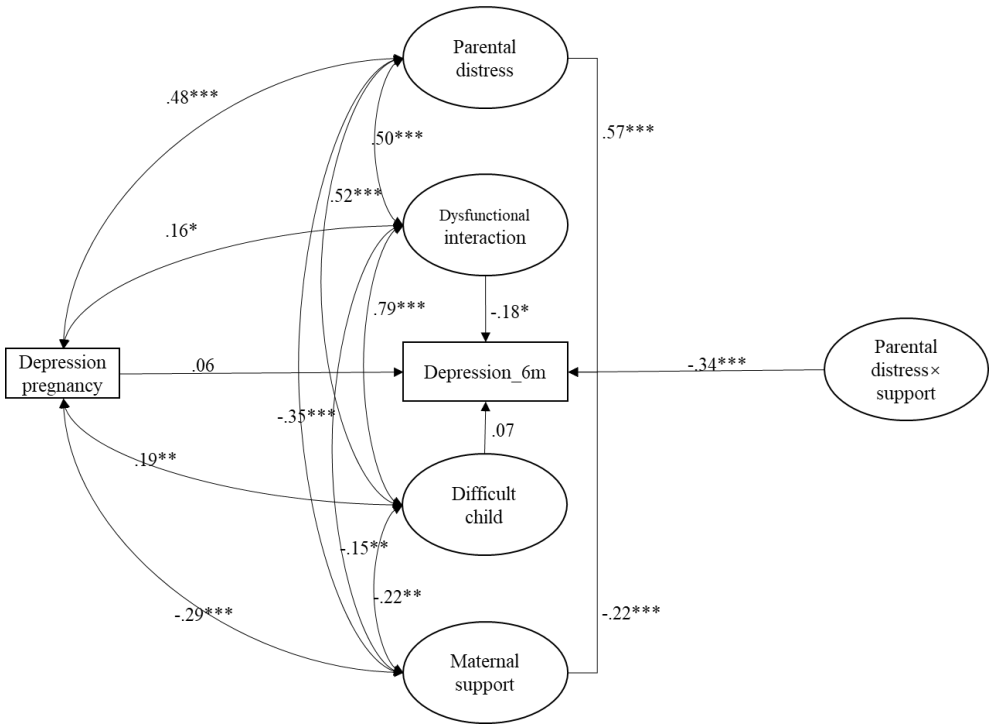

Figure 30 The interaction-effect model for the interaction between parental distress and maternal support at 6-month postpartum

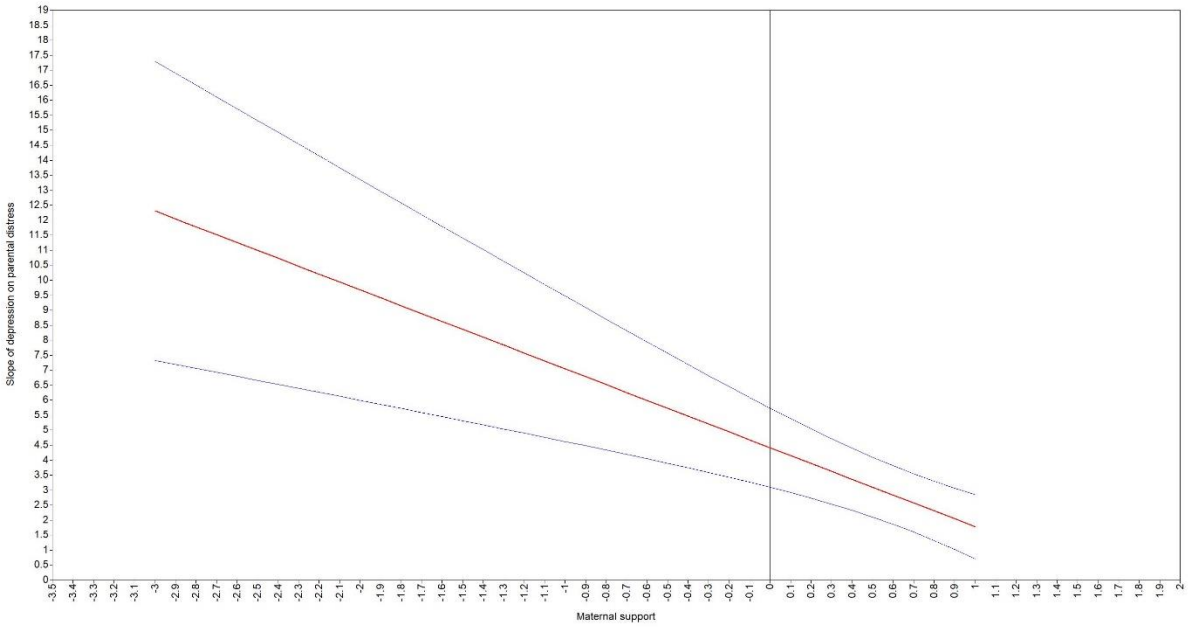

Figure 31 Johnson-Neyman plot of the interaction between parental distress and maternal support

The interaction between maternal support and DLC at 6-month postpartum.

The global model fit indices showed an adequate model fit of the structural linear regression model of DLC and maternal support: χ^2 (24) =35.153, p<.001. RMSEA=0.03, SRMR=0.03, CFI=0.987. No correlation residual had an absolute value larger than 0.1; no normalized residual had an absolute value larger than 2. An interaction term between DLC and maternal support was then added into the structural model. The interaction model fitted the data significantly better than the linear model (χ^2 (1) =7.864, p=.005), and the interaction was significant (Figure 32). By plotting the interaction effect, it showed that with higher levels of maternal support, the strength of the association between DLC and depression at 6-month postpartum became weaker (Figure 33).

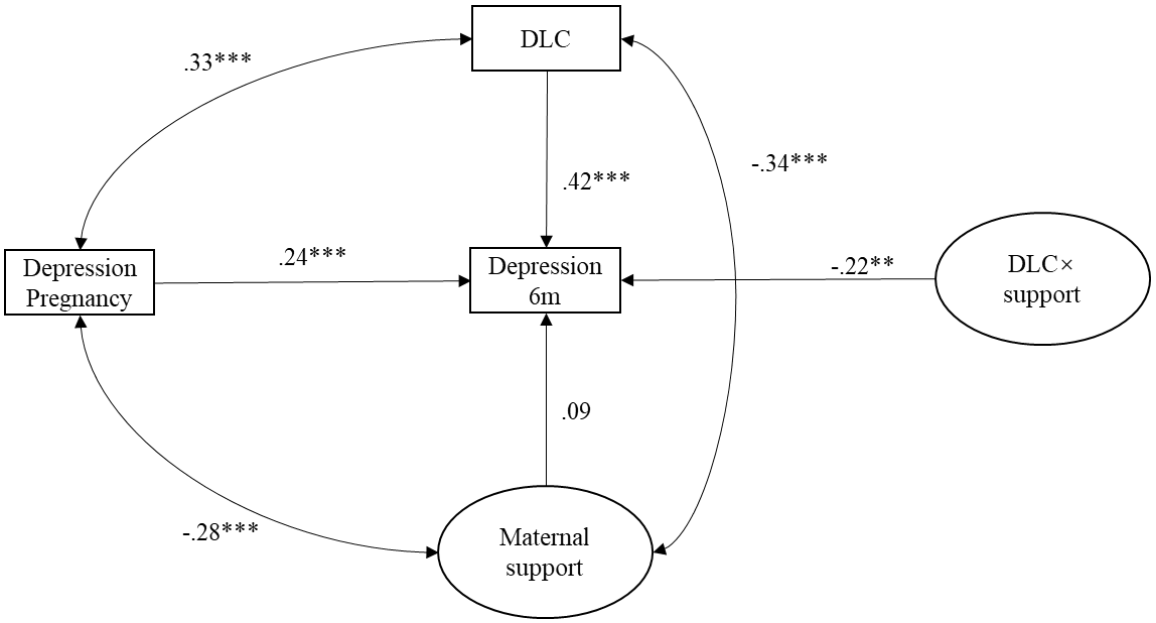

Figure 32 The interaction-effect model for the interaction between DLC and maternal support at 6-month postpartum

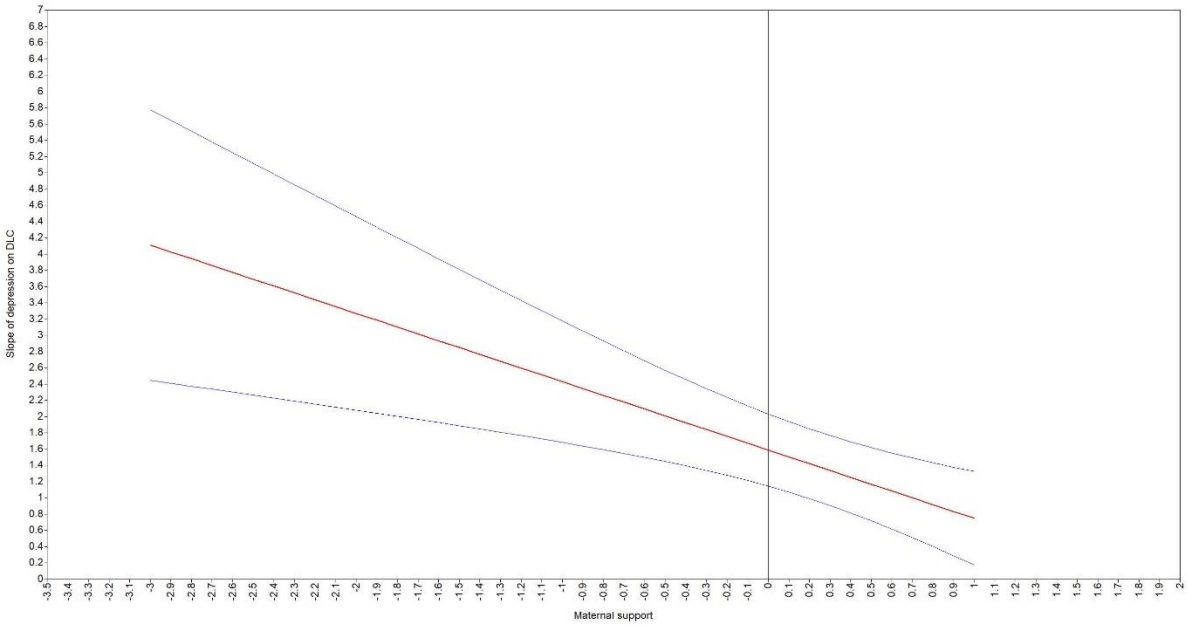

Figure 33 Johnson-Neyman plot for the interaction between DLC and maternal support

Summary.

To examine if it is possible that the effects of support are immediate and perhaps not long lasting, I performed a set of cross-sectional analyses. In the aforementioned analyses (see figure 26 to 33), it was observed that social support not only had a direct effect on depression, but it also had a strong joint effect with stress (parental distress and difficult life circumstances) on depression. Social support × parental distress models indicated that both support from the baby's father and maternal support lessened the association between parental distress and depression. Social support × DLC models also showed that both support from the baby's father and maternal support ameliorated the influence of difficult life circumstances on depression.

Completely different conclusions were drawn from the longitudinal analyses and cross-sectional analyses in this study. This tremendous discrepancy echoed with the study of Zimmerman et al. (2000) where a significant interactive effect was found from cross-sectional

data but not form a longitudinal design with a 6-month lag between measurement occasions. In their study, the magnitude of the association between stress and depression measured six months later was very weak (regression coefficient = 0.07). It is possible that the nonsignificant moderation effect was due to the weak association between the predictor and the outcome.

With the inconsistent findings of the longitudinal interaction effects and the concurrent interaction effects in my study, I am more confident to infer that the effects and social support on postpartum depression take place between zero to six months postpartum. These findings, again, demonstrated the importance of choosing an optimal lag between measurement occasions in longitudinal studies (Little, 2013).

The significant joint effect of social support and stress on depression found in cross-sectional data should be interpreted with caution. Indeed, it provided some evidence to the hypothesis that the stress-buffering effect of social support takes place between immediately after childbirth to 6-month postpartum. However, it by no means proved the stress-buffering effect. According to Veiel (1987), a cross-sectional design can yield a spurious moderation effect. Veiel (1987) proposed a threshold model where lack of social support and stress were both accounted as adversities, and when the number of adversities reaches a threshold, the depressive symptoms aggravate dramatically. In other words, the threshold model posits that depression develops in a non-linear way. Under the threshold model where the effect of support and stress on depression are additive and independent from each other, cross-sectional data can yield a spurious significant interaction effect between social support and stress. Veiel (1987) pointed out that a time-series design that measures stress, social support and depression at sufficiently numerous points may be able to distinguish an interaction effect from the proposed threshold pattern.

Implications

Implications for further research.

The non-normality of the data for maternal support considerately biased the parameter estimates and the significance tests. It demonstrated the shortcoming of the LMS approach in handling non-normality. I have planned to estimate the same model using UPI approach and quasi-maximum likelihood estimation. By comparing the results from three different approaches, more insights can be gained into the magnitude and nature of the interaction between maternal support and parental distress.

Psychometric studies on the quality of indicators for social support and parenting stress are warranted, given the low differential capability of the items shown in this study. Item response theory (IRT) is recommended because IRT models enable researchers to assess the difficulty and discrimination capability of an item.

The longitudinal analyses in this study did not find any significant effect of social support on depression. However, the cross-sectional analyses in this study showed that not only social support was directly associated with PPD, but also moderated the association between stress and PPD. It indicated that the effect of social support on depression is more likely to be immediate rather than long-lasting. In other words, social support may be most helpful right when it is needed. This finding echoed the report from Hoekstra-Weebers, Jaspers, Kamps, and Klip (2001), who found that there were no lasting effects of social support on parental adjustment. Future research is warranted to examine at which point support is most useful to a mother's mental health.

One limitation of this study is that secondary data were used. The lag between measurement occasions was not decided based on the objective of testing the two theories of

social support. It was shown that the lag chosen in the original study was not the optimal lag to answer my research question. As Little (2013) emphasized, timing is everything when using fixed time intervals to assess the longitudinal relationship; determining the optimal lags between measurement occasions is extremely critical. Given the important assumption that the lag chosen in a longitudinal study is optimal to detect the effect of interest, Little (2013) recommended conducting a distributed lag study to find the optimal lags between measurement occasions. The distributed lag study models the magnitude of the effect of social support on depression as a function of time; it enables researchers to detect when an effect begins and when an effect ends.

Implications for social work practice.

This study found that increased parental distress has a unique and long-lasting influence on a new mother's depressive symptoms. Deater-Deckard (2004, p. 140) believed that parenting stress "is as much about coping as it is about distress." Parents need to learn how to cope with distress on a daily basis in order to function well physically and psychologically. It is critical to form a benign circle in which experience of successfully coping with parental distress promotes a mother's resiliency, and the resiliency, in turn, enables her to handle future distress better.

Considering the influence of parental distress on postpartum depression, when dealing with new mothers who show depressive symptoms or express stressful feelings, it is important for social workers to bear in mind that new mothers may need some coping strategies in the transition to parenthood. The more strategies we can teach new parents, the more likely they will cope the parenting stress well. It was reported that problem-focused coping strategies were linked to better adaptation and healthier outcomes (Aldwin, 2007; Kohn, 1996). According to a cross-sectional study, higher levels of parental distress were strongly associated with lower levels of self-mastery (Farmer & Lee, 2011). It is possible that by applying problem-focused

strategies, new mothers perceived a certain degree of personal control. With increased self-efficacy and self-mastery, they can identify the stressors more efficiently and make a plan of action to eliminate the influence of the stressors (Weinstein, Husman, & Dierking, 2000). Deater-Deckard (2004) also recommended that to create a lasting effect of reduced parental distress, an intervention must "lead to new ways of thinking that create a lasting change in the parent's self-efficacy and use of effective coping strategies" (Deater-Deckard, 2004, p. 156). Social workers can teach new parents some problem-solving skills and tools (Sampson, Villarreal, & Rubin, 2014; Sampson, Yu, & Mauldin, 2017) to help new parents better handle parenting stress and difficulties faced in daily life. It is also helpful to overcome parental distress by being proactive in terms of goal setting and planning.

The characteristics of a child do influence his/her parent's distress and difficulties in parenting (Bates, Pettit, Dodge, & Ridge, 1998), but learning how to respond to their children's personal characteristics and how to interact with their children can alleviate the influence of the difficult temperament. Parents can seek out education on how to practice emotional regulation and manage their distress without responding in a negative manner.

It should also be noted that more than half of our study participants were adolescents. According to Taylor and Kemper (1998), teenage mothers were more likely to struggle with increased parental distress in the transition to parenthood. Therefore, it is critical to intervene in parental distress and prevent the long-term impact on new mothers' mental health, especially among teenage mothers.

As concluded by Abrams and Curran (2009, p. 359), many mothers "clearly framed their experiences of PPD within their larger social contexts and attributed their depression to their social circumstances." Our study further showed that difficult life circumstances have a

considerable and long-lasting impact on new mother's mental health. It is essential for social workers to be cognizant of the barriers and to proactively help new mothers—especially teenage mothers or low-income mothers—release some of the external stressors and ameliorate the life circumstances. For example, social workers can provide resources of workforce reentry training, affordable child care services, and affordable healthcare services. The concrete assistance may also motivate a new mother to keep close contact with the social worker and stick to the PPD treatment plan.

Furthermore, integrated healthcare models that use home visits are recommended. Home visitations make mental and primary health service more accessible for the socially disadvantaged population. Current literature showed that home visiting interventions have high retention rates (> 90%) (Sampson et al., 2014; Tandon, Leis, Mendelson, Perry, & Kemp, 2014) and contribute to successful treatments in peripartum depression among low-income women (Hansotte, Payne, & Babich, 2017).

The cross-sectional analyses in this study showed that not only social support is directly associated with PPD, but also moderate the association between stress and PPD. When we look at the type of social support, both perceived support from a partner and from a new mother's mother have a positive effect on depression. This finding makes an important contribution to the literature because in the maternal depression literature there are more studies that focused on support from the baby's father (Akincigil, Munch, & Niemczyk, 2010; Alves, Martins, Fonseca, Canavarro, & Pereira, 2018; Clout & Brown, 2016; Feeley, Bell, Hayton, Zelkowitz, & Carrier, 2016; Iles et al., 2011; Misri, Kostaras, Fox, & Kostaras, 2000) but far fewer on the effects of maternal support. This is a relationship that could be focused on by practitioners. For example, if a social worker is aware that support from a new mother's mother is important for her positive

outcome in mental health, then s/he may help foster a positive relationship between the new mother and her mother.

Implications for policy.

Progress has been made in universal screening for postpartum depression in the past several years. Universal PPD screening was recommended by the U.S. Preventive Services Task Force in 2016. In light of the progress made in early detection of PPD, it is imperative that new mothers struggling with PPD are promptly provided efficient and effective assistance.

This study showed that difficult life circumstances have an enduring impact on new mothers' mental health. It is especially influential to socially disadvantaged women such as teenage mothers and mothers with low income. Even with one adverse life event eliminated, it can help improve a new mother's depressive symptoms. Policymakers may consider providing new mothers more information and resources on part-time jobs where can be a good start for new mothers to build a new life-work balance. Work-Reentry training may also help new mothers make better plans at work and mobilize available resources to take care of the baby.

This study also found that parental distress has a lasting influence on postpartum depression. Policy can also be aimed at enhancing the knowledge and understanding of parenting stress among parents-to-be. By providing education on the nature of parenting stress and a variety of coping strategies, parents-to-be become more resilient and can respond better to parenting stress and daily hassles.

Conclusion

This study had the overall goal to provide more methodological context to our understanding the associations among social support, stress and postpartum depression. After

implementing a longitudinal analysis and SEM approach, it was found that parental distress and difficult life circumstance had a long-lasting influence on postpartum depression. This finding encourages social workers to be mindful of the impact of parenting stress and difficult life circumstances on new mothers' mental health. Problem-solving tools, interventions that aimed to improve new parents' self-mastery and self-efficacy are recommended to help new mothers be more resilient and deal with parenting stress and daily hassles.

Another important finding is that neither the stress-buffering theory of social support nor the main-effect model of social support was endorsed by the longitudinal analyses. However, when examining their associations concurrently, it showed that with higher levels of social support, the association between stress and postpartum depression became weaker. The findings indicate a need for researchers to explore the short-term effect of social support on depression.

Considering that postpartum depression and other mental health issues in postpartum are the number one complication of childbirth (Gavin et al., 2005), it is imperative that we continue to study the mechanism of social support to understand better when, where and how to intervene to prevent PPD and the negative effects of it going untreated.

Glossary of Acronyms

CFA	Confirmatory factor analysis
CFI	Comparative Fit Index
DLC	Difficult life circumstances
FIML	Full information maximum likelihood
IRT	Item Response Theory
LMS	Latent moderated structural equations
MAR	Missing at random
MLR	Robust maximum likelihood
MNAR	Missing not at random
PPD	Postpartum depression
RMSEA	Root mean square error of approximation
SEM	Structural equation modeling
SRMR	Standardized root mean square residual
UPI	Unconstrained Product Indicator

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