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Skin-to-skin contact and infant emotional and cognitive development in chronic perinatal distress

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ABSTRACT

Objective: We examined whether the timing of maternal-neonate skin-to-skin contact (SSC) predicts infant emotional and cognitive development in the context of chronic maternal perinatal stress and depressive symptoms.

Study design: This secondary analysis included data from a group-based prenatal care clinical trial for 37 pregnant women with low household income. Mothers completed the Perceived Stress Scale (PSS), and the Center for Epidemiologic Studies Depression Scale (CES-D) during the third trimester and postpartum. After birth, they reported timing of SSC, and completed the Infant Behavior Questionnaire-Revised Very Short Form (IBQ-R VSF) (M = 51.7 weeks, SD = 4.2). Increased PSS or CES-D score from the third trimester to post-birth indicates chronic maternal perinatal stress or depressive symptoms compared to a decrease or no change. Using hierarchical regression models, we examined if the timing of SSC makes a unique contribution in predicting infant outcomes in the context of chronic maternal perinatal stress and depressive symptoms.

Results: Stress-exposed infants had less negative emotionality if SSC is provided immediately after delivery, less than 10 min after birth. The effect of SSC on effortful control in relation to chronic perinatal stress was not statistically significant. The impact of timing of SSC on negative emotionality or effortful control in relation to chronic perinatal depressive symptoms was not statistically significant.

Conclusion: This work implies that very early SSC may play a role in later infant emotion regulation process and could act as a protective factor in chronically stressed pregnant women.

1. Introduction

Infancy is a sensitive developmental period of rapidly growing neurological, physical, and cognitive, and emotional systems. While the link between maternal perinatal distress and adverse child outcomes and emotional and cognitive functioning is well established [1], the protective factors that ameliorate this risk remain unclear. A potential pathway is maternal-neonate skin-to-skin contact (SSC), and an ample body of evidence shows its positive impacts on infants whose mothers experience lower perinatal distress [2]. However, little is known about the effects of mother-neonate SSC on infants in the context of chronic maternal perinatal distress. In the current study, we highlight evidence for the impact of chronic maternal perinatal distress on infant outcomes and explore the role of maternal-neonate SSC in moderating this form of chronic maternal perinatal adversity on infant emotional and cognitive outcomes.

1.1. Maternal perinatal distress and infant emotional and cognitive development

Maternal perinatal distress predicts multiple risk factors and child vulnerabilities that increase the likelihood of developing a wide range of cognitive, socio-emotional, internalizing, externalizing behavioral problems, and general psychopathology [1,4]. This distress can be chronic or acute, and includes psychosocial stress and psychological symptoms such as anxiety and depressive symptoms occurring any time in pregnancy, birth or the postpartum period [3]. For this study, we will use the term “chronic maternal perinatal distress” to refer to repeated, and ongoing elevated maternal psychosocial stress and depressive symptoms both during pregnancy and the first year following the birth of the infant. Investigating chronic maternal perinatal distress is important because chronic exposure to determinants of perinatal distress has profound and persisting consequences for infant emotional and

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cognitive development [1,4].

Chronic maternal perinatal distress may affect the propensity of infants to develop later emotional and cognitive problems across the lifespan through several pathways such as negative emotionality and effortful control [5]. In this paper, we examine the role of two precursors of child self-regulation, infant negative emotionality and effortful control [6]. Infant negative emotionality describes individual differences in the propensity to experience and react with negative emotions (i.e., irregularity of mood, frequent crying), and infant effortful control refers to individual differences in the ability to exhibit control over actions (i.e., inhibitory control, duration of orienting) [6]. Individual differences in these abilities are the product of a variety of factors [7]. For instance, infants exposed to heightened maternal distress during pregnancy and the postnatal period have significantly more negative emotionality and poorer effortful control [1,4,5,8,9].

There are multiple interrelated pathways from maternal perinatal distress to infant negative emotionality and effortful control. One important pathway postulates a physiological relationship between maternal prenatal distress and the development of infants' negative emotionality and effortful control. Maternal distress exerts influence on fetal brain development via increased glucocorticoid exposure as consistently shown in the animal literature [10]. High levels of maternal cortisol pass through the placenta, produce elevations in fetal cortisol levels, and impair the developing nervous system [10]. In humans, in-utero exposure to cortisol is believed to interfere with the healthy development of the developing neural circuits in multiple areas of the brain which are involved in the regulation of emotion and cognitive control [7,11].

Another pathway model proposes that maternal distress during the postnatal period has additional negative impacts on the development of infant negative emotionality and effortful control through its detrimental impact on maternal-infant interactions [12]. Maternal distress is associated with less positive, more disengaged, less sensitive, and less responsive behaviors in mother-infant interactions [13]. The effects of distress may interfere with mothers' ability to provide attuned and responsive care that promotes optimal brain development, which can result in infants' emotional dysregulation and impaired cognitive development [12]. Furthermore, perinatal distress can have profound influences on mother-infant attachment [14]. Healthy patterns of attachment, exerting influence through psychobiologically attuned dyadic behaviors, minimize the infants' negative emotionality and maximize cognitive control [15]. Failure to engage in these behaviors can result in a loss of maternal regulators of the newborns' immature emotional, cognitive, and biological functions, which in turn relate to infants' difficulties in regulation [15]. Therefore, distressed mothers who tend to have difficulties in developing a secure attachment with their infants may contribute to dysfunctional emotional regulation and cognitive control [16].

Perinatal distress is higher among pregnant women exposed to social-contextual risk factors such as stressful life events and psychosocial stress [17]. However, protective factors may moderate the adverse effects of these stressors on infants' psychological and physical outcomes [18]. For infants born to mothers with high-risk conditions, increasing protective factors during the perinatal period may compensate for high levels of risk [19]. For example, social support has been linked with lower infant cortisol reactivity [18] and reduced distress to novelty among six to eight week old infants [20] in pregnant women with high-risk conditions, including high perinatal distress and low-income. In line with previously studied protective factors, maternal-neonate skin-to-skin contact is another protective factor that might have a buffering effect against the impact of perinatal distress to promote more favorable outcomes for infants.

1.2. Skin-to-skin contact

Maternal-neonate skin-to-skin contact (SSC) is the placement of the infant's bare chest directly on the mother's bare chest. According to Moore and colleagues' review [2], compared to infants who do not have SSC with their mothers, maternal-neonate SSC was associated with significantly reduced risk of mortality, severe infection/sepsis, and hypothermia, and more stable cardiorespiratory rates. Furthermore, maternal-neonate SSC was found to be positively associated with faster growth, more restful and organized sleep, less crying episodes, less pain from routine procedures, as well as better mother-infant attachment [2]. These studies provide evidence for the positive impact of maternal-neonate SSC on infants' neurophysiological development.

Several studies showed the effects of maternal-neonate SSC persist beyond the newborn period [21,22]. Feldman and colleagues [23,24] found that maternal-neonate SSC was associated with better regulation of negative emotions and efficient arousal modulation to novel stimuli at three months; higher mental functions at six months; higher sustained attention in toy exploration, and longer shared attention with mother at six months. In another study, infants who received maternal-neonate SSC demonstrated a greater ability to focus their attention and maintain an alert state and lower irritability and fussiness at six months [25]. Mother-infant SCC has been associated with better performance on overall infant development scales at 12 months compared to infants without such experience [23,25,32]. Although these studies did not directly assess infant negative emotionality and effortful control, the findings suggest that the effect of maternal-neonate SSC may have a lasting impact on these abilities in infants. Furthermore, there is limited knowledge about the timing of SSC and whether it achieves potentially positive impacts on infant outcomes.

Several factors may explain why maternal-neonate SSC in the newborn period has the potential to reduce infant emotionality and improve effortful control. First, the period after birth constitutes the early sensitive period for maternal contact in which tactile and proprioceptive stimulations are provided [24]. These sensations on the infants' skin are likely to impinge on infants' physiology and behavior regulation [26]. Such early physiological and behavioral regulation is essential to support infant development, which in turn could predict later emotional and cognitive functioning [23]. Maternal-neonate SSC may serve a way to reverse the adverse effects of chronic maternal perinatal distress in part linked to its direct physiological effects on physiological regulation, cortisol activity and oxytocinergic system, which are biological substrates of the long-term effects, as well as its indirect effects observed in changes in maternal behavior that can serve to initiate positive mother-infant interaction that may have long-term, albeit indirect, consequences [2,25,27]. Mothers experience maternal-neonate SSC tend to show increased behaviors of holding the infants, affectionate touch and spend more time with their infants during their first year [23]. Combining these results suggest that maternal-neonate SSC may reduce infant negative emotionality and promote effortful control directly by affecting behavioral and physiological regulation of infants as well as indirectly by promoting sensitive and responsive mother-infant interactions.

1.3. The current study

Given the fact that both risk and protective factors exert their effects most during sensitive periods of development, the present study includes adverse perinatal influences as a risk factor and maternal-neonate SSC as a protective factor in shaping infants' emotional and cognitive functions. Our aim is to evaluate the interactive influences of chronic maternal perinatal distress and the timing of maternal-neonate SSC on infant negative emotionality and effortful control at 1-to-5 months old in a sample of very low-income, high-risk women and infants. We hypothesize that very early maternal-neonate SSC would be associated with lower negative emotionality and higher effortful control in 1–5-month infants of mothers who had chronically high levels of stress and depressive symptoms.

Table 1
Demographic characteristics (N = 37).

Variable	N (%)
Maternal race/ethnicity	
American Indian/Alaskan/Native	3 (8%)
African American	3 (8%)
Latino(a)	23 (62%)
White	5 (14%)
Multiracial	3 (8%)
Primary language	
English	10 (27%)
Spanish	27 (73%)
Country of birth	
US	10 (27%)
Outside the US	27 (73%)
Maternal education	
Less than high school	17 (46%)
High school or GED	11 (30%)
Greater than high school	8 (21%)
Other	1 (3%)
Annual household income	
Less than $10,000	7 (19%)
$10,000 - $30,000	12 (32%)
More than $30,000	13 (35%)
Don't know	5 (14%)
Employment status	
Unemployed	33 (90%)
Working (full or part-time)	4 (10%)
Relationship status	
Single	5 (14%)
Dating or in a relationship	3 (8%)
Married or partnered	22 (60%)
Divorced or separated	2 (4%)
Other	5 (14%)
Other children in the home	
0	8 (22%)
1–3	12 (32%)
>3	17 (45%)

2. Methods

2.1. Participants

Participants were 49 pregnant women (M *age* = 26.4 years, SD = 3.4). This study is a secondary data analysis of a small clinical trial of pregnant women who had low household income and were receiving group-based prenatal care. Women in the intervention group received prenatal care through the Mindfulness-Enhanced Centering Pregnancy program (PI: Duncan K01AT005270); women in the control group received a standard childbirth preparation course. Eligible women in this study were above the age of 18, and fluent in English or Spanish. Exclusion criteria included medically high-risk pregnancy. Table 1 describes the participant demographics.

2.2. Data collection and procedure

The current study includes interview data from the late third trimester and postpartum (M = 12.67 weeks post-birth, SD = 4.50). Participants completed one-to-one interviews that included measures of perceived stress and depressive symptoms collected during the third trimester and postpartum. Participants also completed questionnaire assessments at the postpartum study visit (*Min* = 5.71 weeks, *Max* = 23.14 weeks), including items reporting maternal-neonate skin-to-skin contact and infant emotional and cognitive functioning. All participants gave signed consent for participation in research and provided signed Health Insurance Portability and Accountability Act of 1996 (HIPAA) authorization for complete medical record review.

2.3. Measures

2.3.1. Chronic perinatal stress

Chronic maternal perinatal stress was assessed through the Perceived Stress Scale (PSS; Cronbach's α at Time 1 = 0.84; Time 2 = 0.86). The PSS is a 14-item self-report measure to assess "the degree to which situations in one's life are appraised as stressful" [28]. Specifically, the items are designed to measure the extent to which one's life is perceived as "unpredictable, uncontrollable, and overloading" [28]. Each item is rated on a 0–4 scale (0 = Never, 1 = Almost Never, 2 = Sometimes, 3 = Fairly Often, 4 = Very Often) and summed to create a total score. In the current study, increased PSS score from the third trimester to post-birth indicates chronic maternal perinatal stress compared to a decrease or no change in maternal stress from the third trimester to post-birth.

2.3.2. Chronic perinatal depressive symptoms

Chronic maternal perinatal depressive symptoms were assessed through the Center for Epidemiologic Studies Depression Scale (CES-D; Cronbach's α at Time 1 = 0.85; Time 2 = 0.90). CES-D is a 20-item self-report measure designed to assess depressive symptoms over the previous week [29]. Each item is rated on a frequency scale (0 = Rarely or None of the Time, 1 = Some or a Little of the Time, 2 = Occasionally or a Moderate Amount of Time, 3 = Most or All of the Time). Total scores can range from 0 to 60; higher scores represent more depressive symptoms. In the current study, increased CES-D score from third trimester and post-birth indicates chronic maternal perinatal depressive symptoms compared to a decrease or no change in maternal depressive symptoms from third trimester and post-birth.

2.3.3. Skin-to-skin contact

Mothers self-reported on a questionnaire for having skin-to-skin contact (SSC) with their babies right away/immediately, 5 to 10 min later, 10 to 20 min later, 20 to 30 min later, more than 30 min but less than 1 h, or 1 h or more after the birth. In the current study, early SSC indicates that SSC is done immediately after delivery, less than 10 min after birth, and late SSC indicates that SSC is done more than 10 min after birth.

2.3.4. Infant outcomes

Mothers completed the Infant Behavior Questionnaire-Revised Very Short Form [30] (IBQ-R VSF). It is a 37-item parent-report measure assessing infant emotional and cognitive functioning, including sadness, distress to limits, fear, duration of orienting, low-intensity pleasure, cuddliness, and soothability over the past seven days. The IBQ-R VSF has three subscales, Negative Emotionality, Effortful Control, and Surgency. Subscale items were summed (with some items reverse scored) on a scale ranging from to 1 (never) to 7 (always). We used Negative Emotionality subscale (α = 0.76) that includes items assessing sadness, distress to limitations, and fear; and Effortful Control subscale (α = 0.81) that includes items measuring control over action, duration of orienting and low intensity pleasure.

2.3.5. Analysis plan

Data analysis took place in two steps. First, the data were screened for outliers, out-of-range, and other inappropriate data. The twelve participants with missing data on one or more items and were dropped from analysis to allow for consistent samples across models. Selective attrition analyses revealed no statistical differences between retained and excluded participants on primary sociodemographic variables, such as maternal age, $t(46) = 1.07$, $p = 0.30$, maternal education, $\chi^2(3) = 3.10$, $p = 0.38$, relationship status, $\chi^2(4) = 1.82$, $p = 0.77$, annual household income, $\chi^2(3) = 1.99$, $p = 0.57$, and number of children, $\chi^2(2) = 0.24$, $p = 0.89$. This secondary analysis included data from a group-based prenatal care clinical trial; therefore, the

intervention condition was controlled in the analysis in order to control for potential confounding.

Second, to determine if the timing of skin-to-skin contact (SSC) made a unique contribution in predicting infant outcomes in the context of chronic maternal perinatal distress, hierarchical regression analyses were conducted. Hierarchical regression is an analysis to show whether newly added variables show a significant improvement in the proportion of explained variance in the outcome. In this line of research, our focus is on the timing of SSC as a predictor of the child outcomes rather than the whole model.

Analyses were conducted using infant negative emotionality or infant effortful control as dependent variables. Maternal stress and depressive symptoms and each infant outcome were examined in a separate hierarchical regression model, resulting in four separate models. The first block of each model contained control (intervention condition and infant age) and main effects (prenatal stress or prenatal depressive symptoms) variables. Second block included the chronic perinatal stress x timing of SSC interaction term while controlling for the variables in block one. Similarly, in a separate hierarchical regression model, second block included chronic perinatal depressive symptoms x timing of SSC interaction term while controlling for the variables in block one. When the interaction term in the second block was significant we ran an additional subgroup analyses using only the control variables and timing of SSC to examine the subsets of mothers with high maternal chronic stress (N = 19) or high chronic perinatal depressive symptoms (N = 10) to determine whether the timing of SSC would buffer infants from experiencing elevated levels of negative emotionality or poor effortful control.

3. Results

The hierarchical regression model examining infant negative emotionality revealed that after entry of the main effect variables in the first block, the chronic perinatal stress x timing of SSC interaction term uniquely and significantly explained an additional 16% of the variation in infant negative emotionality (Table 2). Post hoc subgroup analysis revealed that timing of SSC was significantly associated with infant negative emotionality in mothers with chronic perinatal stress ($B = -2.72$, $p = 0.01$), but not mothers without chronic perinatal stress ($B = 0.37$, $p = 0.63$). Fig. 1 illustrates that mothers with chronic perinatal stress and early maternal-neonate SSC reported less infant negative emotionality compared with mothers with chronic perinatal stress and later maternal-neonate SSC. If mothers are stressed over a longer period during pregnancy and after birth and did not have earlier maternal-neonate SSC, they reported their infants as having significantly greater negative emotionality. However, in mothers without chronic perinatal stress, there were no significant differences in infant negative emotionality depending on the timing of SSC. For mothers who have chronic perinatal stress, the timing of maternal-neonate SSC was related to infant negative emotionality – the sooner maternal-neonate SSC, the lower infant negative emotionality.

The hierarchical regression model examining infant effortful control reveals that after entry of the main effect variables in the first block, the chronic perinatal stress x timing of SSC interaction term ($B = 0.47$, $p = 0.26$) was not statistically significant. Results suggest that the timing of SSC alone does not necessarily support infants' effortful control abilities in relation to chronic perinatal stress. The model examining infant negative emotionality reveals that after entry of the main effect variables in the first block, the chronic perinatal depressive symptoms x timing of SSC interaction term ($B = 2.05$, $p = 0.06$) was not statistically significant. The hierarchical regression model examining infant effortful control reveals that after entry of the main effect variables in the first block, the chronic perinatal depressive symptoms x timing of SSC interaction term ($B = -0.33$, $p = 0.66$) was not statistically significant (Table 2).

Table 2
Summary of regression analysis for variables predicting infant outcomes.

Effect	Estimate	*SE*	95% CI		*p*	ΔR^2
			LL	*UL*		
Infant negative emotionality						
Block 1						0.09
Intervention Condition[a]	−0.29	0.44	−1.19	0.61	0.51	
Infant Age	−0.09	0.04	−0.19	0.01	0.06	
Prenatal Stress	0.07	0.04	−0.18	0.15	0.07	
Chronic Perinatal Stress[b]	2.73	0.96	−0.01	4.70	0.01*	
Timing of SSC[c]	0.16	0.61	−1.09	1.42	0.79	
Block 2						0.16*
Chronic Perinatal Stress*SSC	−2.73	0.99	−4.76	−0.69	0.01*	
Total ΔR^2						0.25*
Infant effortful control						
Block 1						−0.01
Intervention Condition[a]	−0.33	0.34	−1.03	0.36	0.33	
Infant Age	0.01	0.04	−0.06	0.08	0.80	
Prenatal Stress	−0.07	0.03	−0.13	−0.01	0.03*	
Chronic Perinatal Stress[b]	−1.32	0.74	−2.84	0.19	0.09	
Timing of SSC[c]	−0.15	0.47	−0.82	1.12	0.76	
Block 2						0.03
Chronic Perinatal Stress*SSC	1.05	0.77	−0.52	2.62	0.18	
Total ΔR^2						0.02
Infant negative emotionality						
Block 1						0.15
Intervention Condition[a]	−0.28	0.44	−1.18	0.62	0.53	
Infant Age	−0.08	0.05	−0.18	0.01	0.08	
Prenatal Depressive Symptoms	0.05	0.02	0.01	0.09	0.03*	
Chronic Perinatal Depressive Symptoms[b]	−1.73	0.92	−3.62	0.14	0.07	
Timing of SSC[c]	−0.97	0.56	−2.12	0.17	0.09	
Block 2						0.08
Chronic Perinatal Depressive Symptoms*SSC	2.06	1.04	−0.07	4.18	0.06	
Total ΔR^2						0.23*
Infant effortful control						
Block 1						0.12
Intervention Condition[a]	−0.46	0.32	−1.12	0.19	0.16	
Infant Age	−0.00	0.03	−0.07	0.07	0.97	
Prenatal Depressive Symptoms	−0.04	0.01	−0.07	−0.01	0.01*	
Chronic Perinatal Depressive Symptoms[b]	−0.35	0.67	−1.73	1.02	0.60	
Timing of SSC[c]	0.41	0.41	−0.43	1.24	0.33	
Block 2						−0.03
Chronic Perinatal Depressive Symptoms*SSC	−0.33	0.76	−1.89	1.22	0.67	
Total ΔR^2						0.09

Note. $N = 37$; $^*p < 0.05$; CI = confidence interval; *LL* = lower limit; *UL* = upper limit.
[a] 0 = Control Group, 1 = Intervention Group.
[b] 0 = No, 1 = Yes.
[c] 1 = Less than 10 min, 0 = More than 10 min later.

4. Discussion

Infant development is particularly vulnerable to the influences of perinatal distress in low-income pregnant women who often experience the stressors of chronic poverty [17]. High maternal stress is detrimental for the baby during the prenatal and postnatal periods; therefore, high-quality prenatal and postnatal interventions are essential. The emergence of maternal-neonate skin-to-skin contact (SSC) as a predictor of infant negative emotionality in high-risk mothers of infants is noteworthy, and provides preliminary evidence that maternal-neonate SSC might protect against infant negative emotionality in the

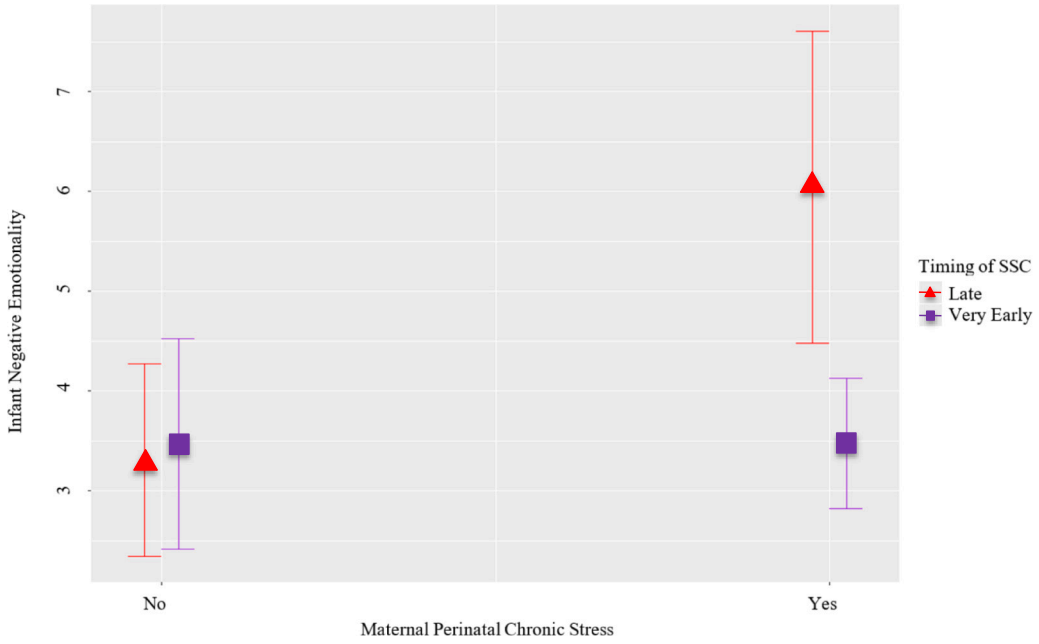

Fig. 1. Interaction effect of timing of SSC on the association between the perinatal chronic stress and infant negative emotionality.

context of chronic maternal stress.

Repeated assessment of psychological indicators of maternal distress in both the prenatal and postnatal periods was a significant strength of this study as we were able to examine the chronic impact of these prenatal and postnatal factors on infant development. Another strength of the study was that pregnant women who reported very low income were represented in the sample. The majority of participants in previous studies had relatively few sociodemographic risk factors as the majority were White, had university-level education, and had middle-class household annual income [2]. Therefore, their findings may not be generalizable to lower socioeconomic status or non-White populations. Thus, the higher sociodemographic risk sample in this study contributes valuable insights into the developmental processes for those infants with greater exposure to sociodemographic risk factors.

While chronic maternal stress in the presence of high social-contextual risk increases the risk associated with higher infant negativity, which is also implicated in developmental risk processes [1,4,17], early maternal-neonate SSC was revealed as a protective factor associated with reduced infant negativity that has implications for more positive social and behavioral adjustment in children [6]. Various mechanisms may contribute to associations between maternal-neonate SSC and infant negative emotionality in a sample of chronically stressed mothers. The benefits of maternal-neonate SSC to infants' physiological adjustment to postnatal life, such as reduced crying, optimal sleep organization patterns, and autonomic regulation, might be influential in reducing infant negative emotionality [25,31]. In addition, maternal-neonate SSC has been associated with more positive maternal feelings toward the infant, positive perceptions of their infants, and more sensitive maternal caregiving behavior [27,32]. Better quality of maternal caregiving behavior, therefore, might be related to reduced infant negative emotionality [33]. Consequently, results of the present study suggest that these infants of mothers with high-risk appeared to have less negative emotionality as they experienced direct and indirect protective influences of early maternal-neonate SSC in buffering the adverse effects of chronic maternal perinatal stress.

The causal mechanisms are important, although beyond the scope of this study. Thus, it remains unclear whether the biological and relational differences underlying maternal-neonate SSC are part of the cause of decreased infant negative emotionality. For example, maternal-neonate SSC has been related to oxytocin and cortisol levels, which can affect infant physiological regulation as well as mothers' parenting [2,34,35]. Therefore, decreases in cortisol levels and increases in oxytocin levels in response to maternal-neonate SSC may be potential underlying biological processes that promote infant physiological regulation as well as parenting, which in turn influence infant negative emotionality [27,36–39]. Establishing this knowledge is a condition necessary for labeling maternal-neonate SSC as a protective mechanism, and it remains a goal for future studies.

On the other hand, in our sample, there was no significant moderation effect of maternal-neonate SSC on infant effortful control. This may be because infants' effortful control abilities at this age may not have matured enough for the expected relations [40]. Although this age range allowed us to examine infant effortful control as it first emerges, associations with these risks might become more pronounced at later ages when infants get older, and thus deficits might be more evident. Future longitudinal research is needed for understanding how the effect of chronic maternal perinatal stress on infant effortful control may change over time. It is possible that as children grow older, and longer exposures could become more evident for infant effortful control skills that are better established.

Our nonsignificant findings for depression was likely reflects sample size limitations. Nevertheless, the small, yet nonsignificant effect size may warrant further investigation. This effect may be driven, in part, by social-contextual risk factors such as stressful life events, single-parent household, low socioeconomic position, racism, and violence [17]. Given the pervasiveness of these risks, it likely that SSC, alone, cannot ameliorate the impact of perinatal depressive symptoms on infants' emotionality and effortful control in high-risk samples. This knowledge is important when considering only maternal-neonate SSC programs in health care settings without other interventions that could influence the effect of maternal-neonate SSC in high-risk mothers. This study highlights the importance of support for a positive influence of providing early maternal-neonate SSC for infant emotion regulation process in chronically stressed pregnant women at-risk, as well as offers information that such an experience alone may not be necessarily enough in chronically depressed pregnant women when associated with the accumulation of risk factors.

5. Limitations

Limitations to the analyses should be considered. First, the number of subjects in our sample was small (n = 37). It was difficult to find direct effects with such a small sample because we could not control for important background characteristics such as income. However, all of the mother in the sample were from low income homes, and the small sample size due to the level of attrition of participants in this study is consistent with similar types of longitudinal research with high-risk samples [2]. Selective attrition analyses suggested minimal differences between retained and excluded participants with no systematic patterns to the missing data, and no statistically significant differences between retained and excluded participants on primary sociodemographic variables. Another limitation in the research examining SSC is the reliance on maternal self-report, as confirmatory medical record data were unavailable, however maternal reports have been used as valid indicators of SSC in the previous research [34]. Moreover, the Infant Behavior Questionnaire-Revised Very Short Form is a widely used measure of infant negative emotionality and effortful control, designed to minimize biases in parental reports, and it has demonstrated convergent validity with observational measures [30].

6. Implications and future directions

These findings have implications for future research despite the study limitations. For example, the relation between maternal-neonate SSC and infant emotional and cognitive development in the context of chronic maternal perinatal distress requires a replication with a larger sample and to investigate the specific mechanisms of maternal-neonate SSC. Larger sample sizes would allow for investigation of factors that constitute maternal-neonate SSC, such as other birth experiences (i.e., medical complications, preterm birth), might affect infant negative emotionality through the quality of the parenting. The relations of the chronic maternal perinatal distress to parenting and infant negative emotionality hint at some of these specific associations.

This research informs both the targets and content of prevention. The first major practical contribution of the present research is that it serves to inform both the targets and content of prevention-focused interventions. Interventions that integrate direct efforts to promote earlier maternal-neonate SSC may have potentially important implications for the development of infants' emotional development and thus, their resilience and adaptive functioning. Current evidence suggests that early maternal-neonate SSC improves infant negative emotionality, and should therefore be encouraged in clinical practice. If the infant emotion regulation process can be improved by the introduction of very early maternal-neonate SSC for chronically stressed pregnant women at-risk, there is potential for positive influences on mental health care costs, family burden, and reduction of interventions.

In combination with other intervention effort and policy approaches aimed at maternal-infant health, these findings point to very early maternal-neonate SSC as a potential low-cost and high-impact intervention aimed at improving the developmental outcomes of infants of high-risk mothers. This work has implications for future studies examining optimal duration of SSC during the birth and postnatal period needed to be effective. In the future, it will be essential to examine the specific effects of maternal-neonate SSC and potential mechanisms of those effects.

7. Conclusion

This study indicated the role of maternal-neonate SSC in moderating this form of chronic maternal perinatal adversity to infant emotional and cognitive outcomes. It constitutes a valuable complement to previous literature on the long-term effect of maternal-neonate on infant negative emotionality outcomes in high-risk mothers. From an evidence-based perspective, this study shows that very early maternal-neonate SSC can buffer the adverse effect of chronic maternal perinatal stress on infant negative emotionality. However, as the findings of high-risk mothers with chronic perinatal depressive symptoms, cautions should be taken for planning or performing early maternal-neonate SSC, when various social-contextual risk factors exist. Such information could contribute to a better understanding of the high-risk mothers and their infants within neonatal care.

CRediT authorship contribution statement

Saliha B. Selman: Conceptualization, Methodology, Data Analysis and Interpret, Manuscript Preparation. Janean Dilworth-Bart: Conceptualization, Critical Feedback, Data Interpretation. H. Sule Selman: Conceptualization, Manuscript Planning. Joseph Cook: Data Management and Curation, Technical Support. Larissa G. Duncan: Senior Researcher, Designer and Director of Mindfulness-Enhanced Centering Pregnancy Intervention, Critical Feedback.

Declaration of competing interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter or materials discussed in this manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.earlhumdev.2020.105182.

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