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Relationships among caregiving, stress, and self-regulation in toddlers living in poverty

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ABSTRACT

Purpose: The Developmental Psychobiological Model of Experiential Canalization (DPMEC) proposes that conditions of poverty-related adversity influence child self-regulation through parental caregiving, stress hormones, and the child's genetics. However, empirical findings investigating these relationships with prolonged stress hormones are mixed. Further, the relationships among conditions of adversity with prolonged stress hormones have seldom been investigated in toddlers living in poverty. Guided by the DPMEC, we examined the relationships among maternal caregiving, prolonged stress, and self-regulation in toddlers living in poverty in the United States, to include examining whether toddler prolonged stress mediated relations between maternal caregiving and child self-regulation.

Design and methods: Participants were mothers and toddlers (20 to 24 months of age) living in poverty, who provided hair samples to measure four months of average cortisol concentration to estimate prolonged stress. We used observational measures to examine maternal caregiving and indirect report to measure children's self-regulation.

Results: Findings did not support the role of toddler prolonged stress in mediating the relationship between maternal caregiving and toddler self-regulation. However, multiple linear regression models showed that higher levels of maternal emotionally supportive caregiving significantly predicted better toddler soothability ($b = 0.90$; $p = .03$; 95% *CI* [0.10, 1.69]; partial correlation = 0.26).

Conclusions: This study adds partial support for the DPMEC to represent associations between maternal caregiving and toddler self-regulation for mothers and toddlers experiencing poverty.

Practice implications: While these data come from an observational study, pediatric nurses may consider assessing maternal supportive caregiving upon reports of poor toddler soothability.

Early and optimal self-regulation skills – a set of processes that helps one manage internal reactivity (Rothbart et al., 2011; Rothbart & Rueda, 2005) – provide a foundation for overall wellbeing later in life (Moffitt et al., 2011). Of concern is that a large body of research shows that young children living in poverty are at higher risk for having poor self-regulation skills than children living with more economic advantage (Howse et al., 2003; Kishiyama et al., 2009; Piotrowski et al., 2013). Drawing upon this body of research, the Developmental Psychobiological Model of Experiential Canalization (DPMEC) outlines how poverty-related adversity can affect emotionally supportive parenting, which in turn influences how children self-regulate stress physiology and behavior (Blair & Raver, 2012). However, this model has not been examined with mother-toddler dyads living in poverty in the United States with measures of prolonged physiologic stress, such as hair cortisol concentration. Thus, in this original study, we used the DPMEC as a guiding framework and examined the relationships among maternal caregiving, prolonged stress via hair cortisol concentration, and self-regulation in toddlers living in poverty in the United States.

The challenges of living in poverty can make it difficult for young children to optimize self-regulation skills, particularly because it may be more difficult for parents to buffer their children from poverty-related risks. For example, living in poverty increases a family's risk of

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failing to afford basic needs such as adequate and stable access to nutritious food, utilities, safe housing, and other key resources (Council on Community Pediatrics, 2016; Novakovic et al., 2014). Struggling to meet basic needs may displace a parent's mental and emotional resources necessary to model self-regulation skills for their young children during caregiving. In addition, living with the struggles of poverty also places mothers at higher risk for stress and depression (Roubinov & Boyce, 2017), which may impair a mother's ability to provide emotionally supportive caregiving to her child (Goodman & Gotlib, 1999; Shonkoff, 2010). Stress and depression may result in a higher incidence of harsh parenting (e.g., unpredictable, punitive, more negative, hostile, intrusive, and retaliatory behaviors with children), which is associated with adverse self-regulation skills in young children (Goodman & Gotlib, 1999; Kiss et al., 2014).

In developing the DPMEC from a review of a large body of research, Blair and Raver (2012) suggested that children may develop adverse self-regulation while living in poverty-related adversity due to necessary environmental adaptation. Adaptation to harsher environments primes selective optimization of behavior to manage these ecological experiences. This adaptation could include heightened arousal and reactivity to perceived negative stimuli, which helps the child more quickly manage harsh environments such as resource depravity and harsh parenting (Blair & Raver, 2012). Heightened arousal and reactivity in early childhood could affect various aspects of self-regulation, including emotional regulation (e.g., self-soothing behaviors), executive function (e.g., working memory, ability to sustain attention), and a child's ability to control or inhibit behavior for specific contexts. Although the heightened arousal and reactivity may provide short-term benefits, there are long-term expenses that create "wear and tear" on the child, resulting in related self-regulation health disparities later in life (Moffitt et al., 2011). In contrast, emotionally supportive caregiving may help buffer the child from harsh environments associated with poverty-related adversity, helping the child practice optimal self-regulation skills that may be more appropriate for settings with more stable resources, such as classrooms.

Blair and Raver (2012) also propose in the DPMEC that one way the child manages harsh environments is by increasing reactivity and arousal through activating stress hormones, such as cortisol. Cortisol is an end-product of the hypothalamus-pituitary-adrenal (HPA) axis, which helps mobilize resources for fighting or fleeing from a perceived stressor. Cortisol found in hair is a unique way to measure prolonged physiologic stress over at least one month (Bates et al., 2017). Because hair generally grows about 1 cm each month (Loussouarn et al., 2016), each 1 cm of hair reflects the average cortisol output for an individual over one month, including cortisol used to regulate normal physiology, as well as that produced in response to perceived stressors (Russell et al., 2012). Hence, in line with the DPMEC and prior research with acute measures of stress biomarkers (Blair et al., 2011; Evans & English, 2002; Evans & Schamberg, 2009), we would expect that young children reared in poverty who experience higher levels of adverse caregiving would have higher levels of hair cortisol and poorer self-regulation than those experiencing more optimal caregiving.

The DPMEC model also proposes that stress reactivity likely has a genetic component (Blair & Raver, 2012), suggesting the importance of understanding parental stress reactivity as well. Although one study testing aspects of the DPMEC with a large sample of mothers and toddlers in Australia ($n \approx 400$ dyads) found null relationships among prolonged child stress (measured with hair cortisol), adversity, and emotionally supportive parenting (Bryson et al., 2020), they and others found that maternal and child prolonged stress were correlated. This relationship highlights the DPMEC's importance of understanding genetic effects of stress reactivity (Bates, Singletary, et al., 2020; Blair & Raver, 2012; Bryson et al., 2020).

The current study

Building upon prior research with acute measures of stress biomarkers and samples external to the United States, we tested associations proposed by the DPMEC model among levels of emotionally supportive caregiving, prolonged physiologic stress measured with hair cortisol, and self-regulation in toddlers reared in poverty in the United States. An adaptation of the DPMEC for this study, describing the relationships among poverty, emotionally supportive caregiving, prolonged stress in children, and child self-regulation, is shown in Fig. 1. We hypothesized that toddlers living in poverty who experienced lower levels of emotionally supportive maternal caregiving would have higher levels of prolonged physiologic stress and consequently lower levels of self-regulation. We also hypothesized that toddlers with higher levels of prolonged physiologic stress would have lower levels of self-regulation.

Methods

Design, participants, and procedure

The study used an observational, correlational design with data from the Kids in Columbus Study (KICS) when children were between 1 and 2 years of age. Mother-child participants in KICS ($n = 322$) were originally recruited from local Women, Infant, Children (WIC) clinics (Salsberry et al., 2016), and a subset of 94 participants provided samples of hair when children were between 20 and 24 months of age (September 2016–January 2018). Enrollment eligibility included that the mother was at least 18 years of age, eligible for WIC services at enrollment (e.g., earning <185% of the United States Federal poverty level), intended on residing in the target county during the study duration, had an infant without known severe medical problems (e.g., anoxia, epilepsy), and provided consent to participate. For participating, mothers were provided child care materials (e.g., diapers and wipes), a $10 gift card, and a children's book at each time point. Mothers were also provided an extra $10 gift card for participating in hair sampling. Data were primarily collected at the mother's home. The university's institutional review board (IRB) approved the study.

Sample comparisons between the full KICS sample and the subsample who provided hair samples are described elsewhere (Bates, Salsberry, et al., 2020). Generally, there were fewer Black toddlers in the subsample as compared to those originally enrolled in KICS ($\chi 2 = 6.34$; $p = .012$), yet there were no significant differences by maternal education levels (Bates, Salsberry, et al., 2020).

The demographic statistics of the participants for this study are shown in Table 1. Nearly 80% of the sample were living with an income of less than $30,000 each year. For reference, 100% of the Federal Poverty Level in 2017 was $24,600 for a family of four (United States Department of Health and Human Services, 2017). While mothers reported income levels using $10,000 increment categories, descriptive

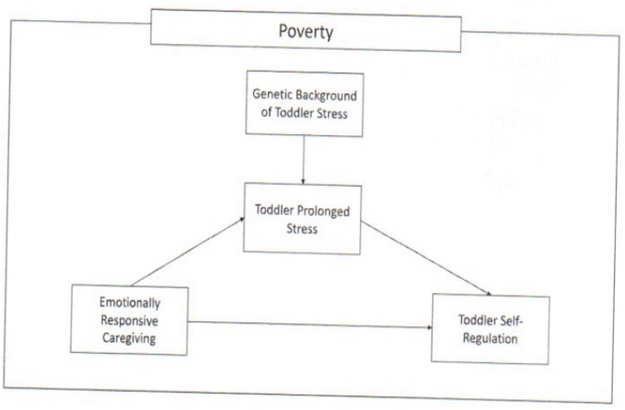

Fig. 1. Theoretical Model for Study.
Note. The theoretical model for this study is an adaptation of the Developmental Psychobiological Model of Experiential Canalization (Blair & Raver, 2012). The model posits that within poverty, low emotionally responsive caregiving characteristics can influence higher prolonged stress in toddlers, thereby influencing worse self-regulation. Toddler stress characteristics can also be influenced by the toddler's genetic background.

Table 1
Demographics and Descriptive Statistics.

Variable	*N*	%	*Min*	*Max*	*Mean*	*SD*
Toddler age in months[5]	94		19.8	25.4	22.58	1.39
Mother age in years[5]	94		20.00	42.00	28.50	5.37
Mother highest level of educational attainment[4]	85					
8th grade or less		3.5				
Some high school, no diploma		10.6				
High school graduate (diploma or GED)		36.5				
Some college, no degree		36.5				
Associate degree		4.7				
Bachelor's degree		8.2				
Annual household income in USD[4]	86					
≤ $10,000		31.4				
$10,001-20,000		26.7				
$20,001–30,000		19.8				
$30,001–$50,000		11.6				
>$50,000		10.5				
Todder race/ethnicity[1,2]						
Black	93	43				
White	93	55.9				
Asian	93	2.2				
Latino	94	11.7				
Toddler sex (% female) [2,3]	90	56.7				
Toddler cognition[5]	92		1	19	10.04	3.38
Maternal emotionally supportive caregiving[5]	94		1.00	6.00	5.03	1.36
Toddler prolonged stress (log10 hair cortisol pg/mg)[5]	71		−0.02	2.28	0.89	0.55
Mother prolonged stress (log10 hair cortisol pg/mg)[5]	75		−0.98	1.50	0.48	0.56
Toddler attention[5]	88		14	39	25.95	5.30
Toddler soothability[5]	87		12	33	24.74	4.67
Toddler inhibitory control[5]	88		8	40	23.37	6.60

Note. Superscripts indicate the time point of measurement ([1]TP1, [2]TP2, [3]TP3, [4]TP4, [5]TP5). *SD* = standard deviation. Mothers could select more than one race/ethnicity. Total sample size was 94, but some variables may have missing data hence the slightly different *n* for each variable.

statistics suggest that on average, family income was about 23% of the Federal Poverty Level (*SD* = 20%; Bates et al., 2021).

Measures

Toddler self-regulation

Toddler self-regulation was measured with maternal reports of child behavior frequency over the preceding two weeks using subscales from the Early Childhood Behavior Questionnaire-Short Form (ECBQ-SF; Putnam et al., 2006; Putnam et al., 2010; Putnam et al., 2008; Rothbart, 2006) when the child was 20–24 months old. The subscales included attention/duration of orienting (ability to sustain attention, here referred to as "attention" for conciseness), inhibitory control (ability to suppress inappropriate behaviors), and soothability (recovery from distress or arousal). Each subscale had six items. After following reverse scoring rules, each item was summed together to create the subscale scores. We found the reliability of these subscales to be acceptable: Cronbach's alpha for attention was 0.63, soothability was 0.63, and inhibitory control was 0.72.

Emotionally supportive caregiving

Emotionally supportive caregiving was measured by observing mother-toddler interaction over about 1.5–2 h at 20–24 months of age using the caregiving acceptance subscale of the Infant-Toddler Home Observation for Measurement of the Environment (IT-HOME: Caldwell & Bradley, 2003). The caregiving acceptance subscale measures how the primary caregiver avoids restriction and harsh punishment of the child. It has eight items, including, "Primary caregiver does not shout at child during visit," and, "Primary caregiver does not express overt annoyance with or hostility about the child." Items are scored 0 = *Yes* and 1 = *No*, with a possible range of 0–8. Higher scores mean more acceptance of the child. To improve alpha reliability of the subscale, we dropped two items ("Family has a pet" and "At least 10 books are present and visible"), making the subscale similar to the *lack of hostility* scale from Linver et al. (2004). After removing these two items, Cronbach's alpha for the remaining six items was 0.69.

Toddler and mother prolonged stress

Prolonged stress in mothers and toddlers was measured when children were 20–24 months of age using hair cortisol concentrations, representing an accumulation of cortisol over 4 months. Details of hair sampling are provided in Bates, Salsberry, et al. (2020). For both mothers and toddlers, hair was primarily sampled from the posterior vertex of the scalp. Cortisol content of 4 cm of hair, representing the prior 4 months of average cortisol output from the HPA axis (Wennig, 2000), was analyzed with enzyme-linked immunoassay following established methods (Meyer et al., 2014). Samples were washed twice with isopropanol, dried, minced, and ground to a powder with a Retsch 400 mill for 10 min. High-performance liquid chromatography methanol was added and then evaporated over 48 h. The final sample was reconstituted in assay buffer from Salimetrics®. Samples were assayed in duplicate, and valid results were determined by computing values with MyAssays® along a four-parameter logistic curve. Values were log-transformed to normalize the distribution. While 94 dyads provided hair samples, there were ultimately 71 valid child values and 75 valid mother values. Hair cortisol values did not differ by chemical straightening, hair coloring, location of hair sampling, or hair bleaching (all $p > .05$; Bates et al., 2021). Intra- and inter-assay CVs were conventionally acceptable (Salimetrics®, n.d.): the average child intra-assay coefficient of variability (CV) for the concentrations was 5.56%, the average mother intra-assay CV of the concentrations was 4.00%, and the average concentration inter-assay CV was 5.46%.

Covariates

Covariates included household income, maternal education, toddler sex, and toddler cognition. Household income and maternal education were used as controls of socioeconomic status within poverty. Household income was measured when toddlers were 15–19 months of age. Mothers were asked to report their income by $10,000 increments, from $0 to more than $60,000. Maternal education was reported by mothers based on their highest level of education on a scale from 0 to 8, with 0 = *8th grade or less* and 8 = *doctorate degree*. Given the characteristics of the sample, we merged education into three categories: no high school diploma (14.1%), high school diploma (36.5%), or attended at least some college (49.4%). Toddler sex was scored 1 = *female* and 0 = *male*, measured to account for potential differences in self-regulation characteristics by sex (Martin et al., 1997; Olino et al., 2013; Sorondo & Reeb-Sutherland, 2015).

Given self-regulation in this study was measured with maternal report, we controlled for some aspects of toddler self-regulation by observing general toddler cognition with the cognitive subscale of the Bayley Scale of Infant and Toddler Development, 3rd edition (Bayley, 2006), a gold-standard measure of early childhood development, when children were aged 20–24 months. The tool measures some executive function aspects of self-regulation, such as attention and working memory. There are 91 items; each item is scored 0 or 1. The first item administered to the child is based on the child's age. Test administration stops when the child incorrectly performs five scale tasks in a row. Correct items are summed and then scaled to a population mean of 10 and standard deviation of 3 based on the child's age. Per the test manual, there is high reliability for the cognitive scale, with Cronbach's alpha of 0.91 (Bayley, 2006).

Analytic overview

Statistics were performed in SPSS 27. Patterns of missingness for the quantitative analytic variables were examined with Little's MCAR,

Table 2
Pearson Correlations between Study Variables with Multiply Imputed Data (N = 94).

	1	2	3	4	5	6	7	8	9	10	11	12
1. Maternal emotionally supportive caregiving	–											
2. Toddler prolonged stress	0.00	–										
3. Toddler attention	0.18	−0.01	–									
4. Toddler soothability	0.25*	−0.19	0.31**	–								
5. Toddler inhibitory control	0.26*	0.07	0.30**	0.37**	–							
6. Mother prolonged stress	−0.01	0.47**	−0.14	−0.04	0.04	–						
7. Mother not high school graduate	0.05	−0.04	0.09	−0.18	0.05	−0.02	–					
8. Mother high school graduate	0.00	−0.12	−0.06	−0.01	−0.02	−0.09	−0.23	–				
9. Mother completed some college	0.00	0.14	0.02	0.17	−0.04	0.13	−0.34*	−0.67**	–			
10. Household income	−0.14	−0.07	0.03	0.15	−0.03	−0.13	−0.18	−0.01	0.13	–		
11. Toddler sex female	0.24*	0.12	0.06	−0.06	0.08	0.12	−0.04	−0.05	0.11	−0.17	–	
12. Toddler cognition	0.30**	0.21	0.12	0.21	0.35**	0.08	−0.21	−0.05	0.24*	0.13	0.22*	–

Note. * $p < .05$. ** $p < .01$.

which was not significant ($\chi 2 = 103.84$; $p = .15$), indicating failure to reject the hypothesis that the quantitative data were missing completely at random. We then multiply imputed 20 datasets with fully conditional specification for dyads who participated in the hair collection for physiologic prolonged stress analysis ($n = 94$). We also analyzed data with descriptive statistics, correlations, and multivariable linear regressions to examine if child stress mediated the relationship between maternal caregiving and toddler self-regulation within the context of poverty-related adversity. We followed modern mediation analyses guidelines from Hayes (2013). Following recommendations of examining effect sizes rather than only *p*-values (e.g., Wasserstein & Lazar, 2016), we examined effect sizes with partial correlations and interpreted the magnitude of the effect sizes following Cohen's (1988) suggestions. According to calculations with G*Power (version 3.1.9.7; Faul et al., 2009; Faul et al., 2007), with a sample size of 94, two tails, and an alpha level of 0.05; a power of 0.80 could detect an effect as small as $f^2 = 0.09$ for any of eight predictors in a multiple linear regression.

Results

Preliminary results

Descriptive statistics of the raw data are shown in Table 1 and correlations between key study variables with pooled, multiply imputed data are found in Table 2. The direct correlations showed that maternal emotionally supportive caregiving had a significant moderate positive association with toddler soothability and inhibitory control but not with attention. Toddler prolonged stress was not significantly correlated with any measure of self-regulation. Toddler prolonged stress was also

Table 3
Mediation Total Effects: Caregiving Predicting Toddler Self-Regulation Outcomes, Controlling for Toddler Prolonged Stress (N = 94).

					95% CI		
	b	*SE*	*t*	*p*	*LL*	*UL*	Partial correlations
Outcome: Attention							
Intercept	22.45	3.07	7.32	0.00	16.43	28.47	
Maternal emotionally supportive caregiving	0.64	0.47	1.35	0.18	−0.29	1.57	0.15
Toddler prolonged stress	0.51	1.26	0.40	0.69	−1.97	2.99	0.05
Mother prolonged stress	−1.53	1.22	−1.25	0.21	−3.94	0.88	
Toddler sex	0.28	1.38	0.20	0.84	−2.43	2.99	
Mother high school graduate†	−1.29	2.33	−0.56	0.58	−5.94	3.35	
Mother completed some college†	−0.78	2.43	−0.32	0.75	−5.65	4.09	
Household income	0.08	0.38	0.22	0.83	−0.66	0.82	
Toddler cognition	0.12	0.21	0.56	0.58	−0.30	0.54	
Outcome: Soothability							
Intercept	18.41	2.62	7.04	0.00	13.26	23.57	
Maternal emotionally supportive caregiving	0.90	0.41	2.21	0.03	0.10	1.69	0.26
Toddler prolonged stress	−2.16	1.17	−1.86	0.07	−4.47	0.14	−0.24
Mother prolonged stress	0.63	0.95	0.66	0.51	−1.23	2.49	
Toddler sex	−1.31	1.11	−1.17	0.24	−3.50	0.88	
Mother high school graduate†	1.27	1.76	0.72	0.47	−2.22	4.76	
Mother completed some college†	2.30	1.80	1.28	0.20	−1.27	5.87	
Household income	0.26	0.32	0.81	0.42	−0.37	0.88	
Toddler cognition	0.21	0.19	1.12	0.26	−0.16	0.58	
Outcome: Inhibitory Control							
Intercept	14.74	3.63	4.06	0.00	7.61	21.88	
Maternal emotionally supportive caregiving	0.77	0.55	1.40	0.16	−0.31	1.85	0.16
Toddler prolonged stress	−0.04	1.63	−0.03	0.98	−3.25	3.17	0.00
Mother prolonged stress	0.28	1.48	0.19	0.85	−2.64	3.20	
Toddler sex	−0.35	1.49	−0.24	0.81	−3.27	2.57	
Mother high school graduate†	−2.02	2.69	−0.75	0.46	−7.37	3.34	
Mother completed some college†	−2.98	2.76	−1.08	0.28	−8.49	2.52	
Household income	−0.10	0.43	−0.24	0.81	−0.95	0.74	
Toddler cognition	0.72	0.25	2.87	0.00	0.23	1.21	

Note. SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit. Partial correlations provided for independent variables that aren't covariates in the analyses (maternal emotionally supportive caregiving and toddler prolonged stress). Analyses with pooled, imputed data.
† Education referent group is at least some college.

Table 4
Mediation: Indirect and Direct Effects (N = 94).

Model						95% CI	
Outcome		B	SE	t	p	LL	UL
Indirect Effects							
Toddler prolonged stress	Intercept	0.56	0.35	1.58	0.12	−0.14	1.27
	Maternal emotionally supportive caregiving	−0.03	0.06	−0.46	0.65	−0.14	0.09
	Mother prolonged stress	0.42	0.11	3.98	<0.001	0.21	0.62
	Toddler sex	0.03	0.14	0.21	0.83	−0.25	0.31
	Mother high school graduate†	−0.09	0.17	−0.51	0.61	−0.43	0.25
	Mother completed some college†	−0.01	0.19	−0.06	0.95	−0.38	0.36
	Household income	−0.01	0.03	−0.39	0.70	−0.08	0.05
	Toddler cognition	0.03	0.02	1.70	0.09	−0.01	0.07
Direct Effects							
Attention	Intercept	22.74	2.94	7.72	<0.001	16.96	28.52
	Maternal emotionally supportive caregiving	0.62	0.47	1.34	0.18	−0.29	1.54
	Mother prolonged stress	−1.31	1.08	−1.21	0.23	−3.44	0.82
	Toddler sex	0.30	1.36	0.22	0.83	−2.38	2.98
	Mother high school graduate†	−1.33	2.30	−0.58	0.56	−5.92	3.26
	Mother completed some college†	−0.77	2.41	−0.32	0.75	−5.59	4.05
	Household income	0.08	0.37	0.20	0.84	−0.66	0.81
	Toddler cognition	0.14	0.21	0.65	0.52	−0.28	0.55
Soothability	Intercept	17.22	2.46	7.02	<0.001	12.40	22.04
	Maternal emotionally supportive caregiving	0.95	0.40	2.35	0.02	0.16	1.74
	Mother prolonged stress	−0.26	0.88	−0.30	0.77	−2.00	1.47
	Toddler sex	−1.38	1.13	−1.22	0.23	−3.60	0.85
	Mother high school graduate†	1.46	1.75	0.83	0.41	−2.02	4.94
	Mother completed some college†	2.36	1.82	1.29	0.20	−1.26	5.97
	Household income	0.28	0.33	0.87	0.39	−0.36	0.93
	Toddler cognition	0.14	0.19	0.74	0.46	−0.23	0.50
Inhibitory Control	Intercept	14.67	3.44	4.26	<0.001	7.91	21.42
	Maternal emotionally supportive caregiving	0.78	0.54	1.44	0.15	−0.28	1.84
	Mother prolonged stress	0.26	1.24	0.21	0.83	−2.16	2.69
	Toddler sex	−0.35	1.47	−0.24	0.81	−3.24	2.54
	Mother high school graduate†	−1.98	2.66	−0.74	0.46	−7.29	3.33
	Mother completed some college†	−2.93	2.74	−1.07	0.29	−8.40	2.55
	Household income	−0.11	0.43	−0.25	0.81	−0.95	0.73
	Toddler cognition	0.71	0.24	2.94	0.00	0.24	1.19

Note. SE = standard error; CI = confidence interval; LL = lower limit; UL = upper limit. Analyses with pooled, imputed data.
† Education referent group is at least some college.

not correlated with markers of socioeconomic status (household income and maternal education; for an extensive discussion on the relation of mother and toddler prolonged stress and socioeconomic status, see Bates et al., 2021)

Caregiving and stress in the context of adversity on toddler self-regulation

We performed a series of multivariable linear regressions to determine if prolonged toddler stress mediated the relationship between caregiving and toddler self-regulation (i.e., attention, soothability, and inhibitory control) within the context of poverty-related adversity while controlling for toddler sex, maternal education, household income, and toddler cognition. The models showing total effects (caregiving and toddler prolonged stress predicting toddler self-regulation, controlling for covariates) are shown in Table 3. The models showing indirect (maternal caregiving predicting toddler prolonged stress, with covariates) and direct effects (maternal caregiving predicting toddler self-regulation, with covariates and no toddler prolonged stress) are shown in Table 4.

We found no evidence that prolonged toddler stress significantly mediated the relationship between caregiving and any aspect of toddler self-regulation. In the total effects models, we saw no significant relationships with the key independent variables (maternal emotionally supportive caregiving and toddler prolonged stress) predicting attention and inhibitory control. However, we found that higher maternal emotionally supportive caregiving predicted better toddler soothability, with a moderate effect size, even when controlling for prolonged toddler stress ($b = 0.90$; $p = .03$; 95% *CI* [0.10, 1.69]; partial correlation = 0.26).

Discussion

This is one of the first studies of which we are aware to examine the DPMEC model with a sample of mothers and toddlers living in poverty in the United States who provided hair samples as an estimate of physiologic prolonged stress. We found partial support for the DPMEC model. While we did not find evidence that child prolonged stress significantly mediated the relationship between emotionally supportive caregiving and self-regulation, we found that emotionally supportive caregiving directly and significantly predicted better child soothability, with moderate effects.

These findings add partial support to the DPMEC model, such that within the context of poverty, emotionally supportive caregiving is associated with important indicators of child self-regulation. As soothability indicates how quickly a child recovers from distress (Putnam et al., 2008), emotionally supportive caregiving may be particularly important in helping a child learn to regulate self-soothing behaviors. These findings are consistent with Mills-Koonce et al. (2012) who showed that lower maternal sensitive parenting was associated with later child affective problems for children lower in observed soothability. The researchers explained that when caregivers are not emotionally responsive, a child may exhibit low soothability, which serves as an adaptive mechanism to help the child elicit the caregiver's attention for warmth and comfort (Mills-Koonce et al., 2012). Low soothability may also be a sign of increased arousal for the child, which provides the child with energy to mobilize resources to react and gain the parent's attention. While this strategy may be helpful for toddlers to solicit attention from caregivers who they may perceive as emotionally distant, this strategy may undermine the optimal development of self-regulation activities over time (Mills-Koonce et al., 2012).

Interestingly, we did not find significant relationships between emotionally supportive caregiving and toddler stress or attention. This finding contrasts with other studies where significant relationships with caregiving on other aspects of self-regulation, such as executive function, were found (Blair et al., 2011). For example, Blair et al. (2011) found that in a large low-income sample of young children in the United States, the effects of positive parenting on higher toddler executive function was partially mediated by lower salivary cortisol. In our study, we did not find that toddler prolonged stress, estimated by hair cortisol, mediated the relationship between emotionally supportive caregiving and any aspect of toddler self-regulation. Our findings are in line with those of Bryson et al. (2020), who also found null relationships among adversity, emotionally supportive parenting, and child stress. Bryson et al. (2020) suggested that child stress was probably more influenced by genetic effects, as the mother and child stress was strongly associated, which was also the case in this analysis and reported and discussed in our prior research (Bates et al., 2021).

As a correlational, observational study, there are limitations to this study. First, we cannot draw causal claims about the relationship between emotionally supportive caregiving and soothability, as unmeasured variables may account for this finding. Second, while we used observed measures of caregiving and child stress, we measured child self-regulation with maternal report. While maternal report of child self-regulation is valuable, it should be supplemented by observations. Future work should address these limitations to continue advancing science. Nevertheless, our study provides new evidence about the association of emotionally supportive caregiving on toddler soothability, providing partial support for the DPMEC model and highlighting areas for intervention.

Practice implications

While our data are observational, our results suggest that pediatric nurses may consider assessing maternal supportive caregiving upon reports of poor toddler soothability. Opening a conversation on maternal beliefs and practices surrounding supportive caregiving of a toddler could help the nurse assess maternal reports of caregiving and provide an opportunity for evidence-based education on parenting and developing strong self-regulation skills in children. This is important because in early childhood, there is still time to intervene to help guide child behavioral trajectories towards more optimal development of emotionally supportive caregiving and child emotional outcomes and stress responses. There are several types of caregiving programs available that show promising results in optimizing emotionally supportive caregiving, reducing child stress, and improving child self-regulation for children of different environments (e.g., Brotman et al., 2003; Fisher et al., 2007; Mortensen & Mastergeorge, 2014; Olds et al., 2014; Peacock-Chambers et al., 2017). There is even some evidence that community-based poverty-alleviating programs may reduce stress levels in children (e.g., Fernald & Gunnar, 2009).

Conclusion

The findings from this study suggest that within the context of poverty, emotionally supportive caregiving predicted better toddler soothability, but that prolonged physiologic stress did not mediate the relationship between emotionally supportive caregiving and toddler self-regulation. This study is one of the first studies to add partial support to the DPMEC model with a sample of mothers and toddlers living in poverty who provided hair samples to estimate physiologic prolonged stress. More research is needed to build on the current study, including by addressing its limitations, to consider the potential associations among caregiving, prolonged stress, and toddler self-regulation for those living in poverty-related adversity.

CRediT authorship contribution statement

Randi A. Bates: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. **Jodi L. Ford:** Funding acquisition, Investigation, Resources, Software, Supervision, Visualization, Writing – review & editing. **Laura M. Justice:** Funding acquisition, Investigation, Project administration, Resources, Supervision, Writing – review & editing. **Rita H. Pickler:** Funding acquisition, Investigation, Resources, Supervision, Writing – review & editing. **Britt Singletary:** Methodology, Writing – review & editing. **Jaclyn M. Dynia:** Investigation, Project administration, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors have no known conflicts of interest. The data supporting the findings of this study are available from the corresponding author upon reasonable request. The study was approved by The Ohio State University Institutional Review Board and conforms to ethical standards of the Declaration of Helsinki.

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