Infant and Child Development
Inf. Child Dev. **21**: 537–554 (2012)
Published online 15 May 2012 in Wiley Online Library
(wileyonlinelibrary.com). DOI: 10.1002/icd.1759

Poverty and Single Parenting: Relations with Preschoolers' Cortisol and Effortful Control

Maureen Zalewski[a,*], Liliana J. Lengua[a], Philip A. Fisher[b], Anika Trancik[c], Nicole R. Bush[d] and Andrew N. Meltzoff[e]
[a]*University of Washington, Seattle, WA, USA*
[b]*Oregon Social Learning Center, Eugene, OR, USA*
[c]*Florida Center for Early Childhood, Sarasota, FL, USA*
[d]*University of California, San Francisco, CA, USA*
[e]*Institute for Learning and Brain Sciences, University of Washington, Seattle, WA, USA*

Poverty and single parent status, which often co-occur, have been shown to relate to lower effortful control, and this may be in part due to disruptions in hypothalamic–pituitary–adrenal (HPA) axis activity. Both poverty and single parent status may compromise parenting, which in turn may disrupt HPA axis activity and the development of effortful control. We examined whether parenting and HPA axis activity accounted for the effects of poverty and single parent status on the development of effortful control in preschool children (*N* = 78). Effortful control was measured at two time points, 6 months apart. Individually, poverty and single parent status were related to blunted HPA axis activity, characterized by low AM and PM cortisol. However, when examined together, the effects were present only for preschoolers whose parents were in poverty. Parental warmth and negativity accounted for the relations between poverty and blunted cortisol. Blunted cortisol was related to lower effortful control at Time 2. These results suggest a pathway through which poverty may impact children's developing effortful control through parenting, which in turn may shape HPA axis activity. Copyright © 2012 John Wiley & Sons, Ltd.

Key words: poverty; cortisol; single parent status; parenting; effortful control

Chronically stressful environments place demands on an individual's stress response system. Physiological adaptation to stress is necessary for survival, a phenomenon known as *allostasis*, defined as the maintenance of stability through

*Correspondence to: Maureen Zalewski, Psychology, University of Washington. E-mail: zalewski@u.washington.edu

change (McEwen, 1998). However, if this physiological adaptive process occurs for too long because of living in a chronically stressful environment, allostasis may ultimately be damaging to the individual's physical or mental health, a process termed *allostatic load*.

Living in poverty presents a chronically stressful context affecting millions of children in the USA each year (DeNavas-Walt, Proctor & Smith, 2010). As allostatic load would suggest that chronic stressors relate to poorer mental health outcomes, living in poverty is repeatedly shown to relate to greater adjustment problems in children (Ackerman, Brown, & Izard, 2004; Duncan, Brooks-Gunn, & Klebanov, 1994; Leventhal and Brooks-Gunn, 2011). Poverty, an environmental context defined by unpredictability and uncontrollability, impacts children's stress physiology, including the developing hypothalamic–pituitary–adrenocortical axis (HPA axis) and executive functioning systems (Blair, 2010). The context of poverty may tax children's stress physiology through compromised parenting, which results from parents challenged by the vast number of obstacles associated with living in poverty. In fact, compromised parenting, as measured by greater negative parenting behaviours and less positive parenting behaviours, has been shown to mediate the effects of poverty on children's adjustment (Scaramella, Neppl, Ontai, & Conger, 2008). Parenting may also mediate the effects of poverty on children's HPA axis and executive functioning systems. Importantly, families living in poverty are much more likely to be headed by single parents (Brooks-Gunn & Duncan, 1997), which also significantly impacts parenting (Dufar et al., 2010; MacKenzie, Fite, & Bates, 2004) and children's adjustment (Ehrensaft, Cohen, Chen, & Berenson, 2007; Gardner et al., 2009; Jackson, Preston & Franke, 2010). The effects of poverty might be most pronounced for children in single parent families given that those parents might be particularly compromised by the strains of poverty combined with the absence of a consistent support or buffer from an additional parent in the family. Early exposure to these risk factors might lead to greater adjustment problems in children, in part, through their contribution to disruptions in children's HPA system, as measured by cortisol and executive functioning, measured with effortful control. In this study, we tested whether the effects of poverty and single parent status on children's effortful control were accounted for by parenting and disruptions in cortisol patterns.

The HPA system is a stress-sensitive system that is relevant to children's reactivity to challenge and stress and produces the hormone cortisol (Gunnar, 1994; Gunnar & Quevedo, 2007). In humans, cortisol follows a circadian pattern, generally peaking 20–30 min after awakening, decreasing throughout the day and reaching its nadir at midnight (King & Hegadoren, 2002). Of particular relevance to the current study, the diurnal pattern is typically obtained by sampling the values of an individual's awakening and evening cortisol levels. Disruptions to the HPA system might be indicated by the presence of either high or low levels of cortisol (Gunnar & Vazquez, 2001). Disrupted cortisol patterns are important to study because disrupted cortisol levels and reactivity have been related to behaviour problems in children (Alink et al., 2008).

It has been argued that acute or moderate stress may result in elevations in cortisol, whereas extreme and chronic stress might result in a blunting of HPA activity characterized by low levels of cortisol throughout the day (Boyce & Ellis, 2005; Miller, Chen, & Zhou, 2007). Given that the blunted diurnal HPA axis activity is more often associated with chronic stress and has been found in samples with foster care children (Fisher, Van Ryzin, & Gunnar, 2011; Gunnar & Vazquez, 2001), we expected that children living in poverty, which is likely to be experienced as chronic and pervasive strain, would be more likely to demonstrate a blunted

DOI: 10.1002/icd

diurnal pattern. Supporting this argument, one study examining preschoolers from extremely low income families in urban Mexico found these children had lower baseline cortisol levels (Fernald, Burke, & Gunnar, 2008). Another study found that financial strain was related to blunted basal cortisol levels (sample collected at 10 AM and 4 PM) in preschool children (Badanes, Watamura, & Hankin, 2011).

However, other findings examining income and cortisol actually suggest that children living in low income households have higher cortisol levels (Lupien, King, Meaney, & McEwan, 2001). Thus, it is possible that we might identify another group of children who exhibit high morning levels of cortisol. However, one study finding elevations in cortisol related to low income or poverty measured cortisol using 12-h overnight urinary samples (Evans & English, 2002; Evans & Kim, 2007), and others used measures reflecting cortisol reactivity at the start of a school day, taken between 8 AM and 9 AM (Lupien et al., 2000; Lupien et al., 2001). Similar to recent research suggesting that either high or low cortisol levels reflect disruption (Blair et al., 2011), the current study anticipated that there could be two groups of disrupted diurnal profiles, one in which children exhibit a blunted profile, starting low in the morning and staying low throughout the day, and one in which children start with higher than average levels in the morning.

Single parents are overrepresented among families in poverty (Brooks-Gunn and Duncan, 1997) and may be another important stressor that contributes to children's cortisol. No studies have examined the relation of single parent status to children's HPA axis activity. Both poverty and single parent status have been shown to relate to disruptions in parenting, which have been shown to account for their effects on children's adjustment problems (Middlemiss, 2003; Scaramella et al., 2008). Initial research regarding parenting and children's cortisol focused on attachment status, using the Strange Situation paradigm to classify children as being insecurely or securely attached. Two studies demonstrated that children with a disorganized attachment status classification had increased cortisol responses to the Strange Situation (Hertsgaard, Gunnar, Erickson & Nachmias, 1995; Spangler & Grossman, 1993). Building on the promising findings from the attachment status literature, there is increasing recognition that less extreme gradations in parental care also affect neurobiology (Hane, Henderson, Reeb-Sutherland & Fox, 2010). For example, maternal affection (Bornstein & Bradley, 2003), emotional withdrawal (Bugental, Martorell and Barraza, 2003) and unsupportive maternal behaviours (Fisher et al., 2007) were shown to relate to disrupted cortisol levels. These findings suggest that compromised parenting behaviours may partially explain how poverty and single parent status affect children's HPA axis activity.

Examination of the physiological response to stress in preschoolers living in poverty is of particular interest given the biology of the stress response system (Blair, Granger, & Razza, 2005). Demonstrated primarily with nonhuman models, chronic activation of the HPA axis has been shown to adversely affect the development of brain structures and neural systems known to be important for the executive regulation of the stress response, including the prefrontral cortex (Blair, 2010; Francis et al., 1999). The prefrontal cortex subserves executive or cognitive control processes (Rothbart, Sheese, & Posner, 2007; Posner & Rothbart, 2000). Effortful control refers to the attentional and inhibitory control mechanisms that facilitate the suppression of an undesired response or the inhibition of a dominant response for a preferred or correct nondominant response (Rothbart & Rueda, 2005). Effortful control develops rapidly between the ages of 3 and 6 years, continues to develop throughout middle childhood (Diamond & Taylor, 1996) and has been

DOI: 10.1002/icd

shown to be a robust predictor of children's adjustment problems (Lemery-Chaifant, Doelger & Goldsmith, 2010; Lengua, 2003; Lengua et al., 2008) and social competence (Eisenberg et al., 2001; Eisenberg et al., 2003).

Effortful control has been shown to be related to both patterns of cortisol dysregulation, having either low or elevated cortisol responses. In one study of kindergarteners from a middle-income sample, lower scores on attention and inhibitory control tasks were associated with lower baseline and laboratory reactivity cortisol levels (Davis, Bruce & Gunnar, 2002). However, in other studies, elevated levels of cortisol were shown to interfere with effortful control (Donzella, Gunnar, Krueger, & Alwin, 2000; Lupien, Gillin, & Hauger, 1999).

Children from families with lower incomes are also consistently lower in effortful control than children from higher income families (Lengua, 2012). However, few if any studies have examined the potential mechanisms through which poverty may relate to lower effortful control. It is plausible that poverty decreases positive parenting behaviours and increases negative parenting behaviours, which in turn might disrupt HPA axis activity and impact children's developing effortful control.

In the present study, we tested a series of hypotheses. First, we hypothesized that poverty and single parent status would be related to blunted diurnal HPA axis activity, indexed by a flat slope from AM to PM levels. An exploratory aim sought to determine if it was poverty or single parent status that predicted the blunted diurnal cortisol pattern. Second, we hypothesized that the effects of poverty on disrupted cortisol patterns would be accounted for by less positive and more negative parenting. Finally, we hypothesized that disrupted diurnal HPA axis activity would be related to lower levels of effortful control.

METHODS

Participants were 78 preschool children and their mothers who participated in two assessments separated by 6 months (Time 1 mean age = 36.6 months, *SD* = 2.69, range = 32–44; Time 2 mean age = 42.0 months, *SD* = 2.99, range = 37–50). Families were recruited from preschools, co-ops and daycares and were selected to represent the demographic characteristics of the urban area surrounding the university in the Pacific Northwest at which the study was conducted. Only one child in the target age range per family was permitted to participate. Children with developmental disabilities and families who were not fluent in English were excluded from the study to ensure adequate comprehension of the procedures. A female primary caregiver was required to participate. All study procedures were approved by the Institutional Review Board at the university conducting this study.

At Time 1, the sample consisted of 103 children. Ninety-eight families returned for a second assessment approximately 6 months after the first assessment. Of those families who participated in both assessments, 20 were missing data on Time 1 parenting variables (three), Time 2 effortful control (three) and cortisol (17). A portion of the missing data was due to problems in task administration or completion, or video equipment failures, but was not due to participant attrition. The largest portion of missing data was due to incomplete cortisol data. Participants missing any data at either time points were compared with those missing no data on maternal education, family income, single parent status and Time 1 study predictors. There were no significant differences between participants with complete data and those missing data. Analyses were based on the sample of 78 families that had complete data.

DOI: 10.1002/icd

The children in the 78 families included 53% boys, 6% African Americans, 10% Asian Americans, 3% Native Americans, 70% European Americans and 11% children with other or multiple ethnic or racial backgrounds. Annual family income was roughly distributed across the continuum, with 15% of families earning less than \$20 000, 9% of families earning \$21 000–40 000, 24% earning \$41 000–60 000, 16% earning \$61 000–80 000, 10% earning \$81 000–100 000 and 26% of families earning over \$100 000. Eighteen per cent of the sample met the federal poverty cut-off based on an income-to-needs ratio. The modal level of mothers' educational attainment was some college or university graduate, and 76% of the families consisted of two-parent households.

Procedures

Procedures at both times involved mothers and children coming to the university for 2-h sessions. After explaining the study and procedures, mother consent and child assent were obtained. At the Time 2 session, mothers were instructed on how to collect saliva samples from their children at home on the two subsequent days after the laboratory visit. Children were administered a test of verbal ability and the effortful control tasks described below. Simultaneously, mothers completed questionnaires of demographics and family structure. Following the effortful control tasks, mothers joined their children for parent–child interactions. Time 1 measures of poverty, single parent status and parenting were used so that the predictors would temporally precede the outcomes, strengthening conclusions about direction of effects. At Time 2 only, mothers collected saliva samples from their children on the two mornings and evenings following their laboratory visit.

Measures

Poverty

Mothers reported on the total household income from all sources, and the 2002 Federal Health and Human Services income-to-needs ratio guidelines were used to determine whether a family fell beneath the poverty cut-off (1 = in poverty, 0 = not in poverty); 18% of the sample fell at or below the poverty cut-off.

Single parent status

Mothers reported their marital status and were assigned single parent status if they were never married, currently separated or divorced, and not living with a partner. On the basis of these criteria, 24% of the sample consisted of single parents.

Parenting

Parenting was assessed using three 5-min mother–child laboratory interaction tasks including a *restricted play*, where mothers were directed to not allow their child to touch desirable toys, an *unrestricted free play* and a challenging *Lego-building task*, where mothers were instructed to help their children build a Lego figure from a picture by providing only verbal assistance (Kerig & Lindahl, 2001). Parent behaviours were coded by trained undergraduates using an adapted version of The System for Coding Interactions and Family Functioning (Lindahl & Malik, 2000) and the Parenting Style Ratings Manual (Cowen & Cowen, 1992). All

DOI: 10.1002/icd

codes were rated on 5-point Likert scales, with 1 indicating the lowest level of a behaviour, and then summed across the three tasks for a possible range of 3–15.

Parenting behaviours of maternal warmth, scaffolding, limit setting and negative affect were rated. Maternal *warmth* (M = 11.73, SD = 2.34) captured verbal expressions of happiness, comfort, connection, verbal and nonverbal engagement towards the child. *Scaffolding* (M = 12.94, SD = 1.91) refers to parental intervention that is contingent to the child's need while also supporting child autonomy. *Limit Setting* (M = 11.25, SD = 1.43) included mothers' clarity, consistency and follow-through directed at her child's behaviour. *Negative Affect* (M = 3.2, SD = 0.56) assessed the negative tone expressed by the mother and included verbal and nonverbal expressions of irritation that were critical, rejecting or invalidating. Reliability was assessed by independent recoding of 30% of the cases. Single-measure ICCs were 0.85 for Warmth, 0.78 for Scaffolding, 0.69 for Limit Setting and 0.63 for Negative Affect. ICCs for Limit Setting and Negative Affect were low in part because of limited variability on these measures because these behaviours were observed at low rates. However, the per cent agreement across coders was good at 92% and 79%, respectively.

Verbal ability

Verbal ability, which is moderately correlated with effortful control (e.g. Krikorian & Bartok, 1998), was included as a covariate. It was assessed at Time 1 using the Peabody Picture Vocabulary Test—Revised (Dunn & Dunn, 1981) in which children are asked, for each of a series of items, to select from a set of four pictures the one best illustrating the meaning of an orally presented word.

Effortful control

Effortful control was assessed using five laboratory tasks. Effortful control scores were combined into a composite as described later.

Bear–dragon (Kochanska et al., 1996) requires the child to perform actions when a directive is given by a bear puppet, but not when given by a dragon puppet. Children's actions were scored as performing no movement, a wrong movement, a partial movement or a complete movement, with scores ranging from 0 to 3. Total scores were the sum of the scores on the five dragon trials. The average scores at Time 1 and Time 2 were 6.29 (SD = 6.38) and 10.46 (SD = 5.96), respectively.

Day–night (Gerstadt, Hong, & Diamond, 1994) requires the child to say 'day' when shown a picture of moon and stars and 'night' when shown a picture of the sun. Children's actions were scored 1 for correctly providing the nondominant response or 0 for providing the dominant response. Total scores were the proportion of correct responses. The average total scores at Time 1 and Time 2 were 0.53 (SD = 0.34) and 0.66 (SD = 0.32), respectively.

Grass–snow (Carlson & Moses, 2001) asked children to point to a green card when the experimenter says 'snow' and to a white card when the experimenter says 'grass'. Children earned one point for correctly pointing to the counter-intuitive card. Total scores were the proportion of correct responses. The average total scores at Time 1 and Time 2 were 0.36 (SD = 0.34) and 0.55 (SD = 0.36), respectively.

Butterfly was developed for this study and is similar to a 'go/no go' task in which children are required to inhibit a prepotent response while ignoring or inhibiting responses to nontarget stimuli (Casey et al., 1997). Children were presented with 20 cards depicting a variety of animals with six of the cards depicting a butterfly. Children were instructed only to point or say 'butterfly' when a butterfly was depicted and do nothing when shown another animal. When presented

DOI: 10.1002/icd

with a butterfly, children's responses were rated as a full response (two points), partial/late response (one point) or no response (0 points). On other animal trials, a full response was scored 0, partial/late response was scored 1 and no response was scored 2. Total scores were the sum of scores on all 20 trials. The average total scores at Time 1 and Time 2 were 21.66 ($SD = 11.41$) and 27.30 ($SD = 12.85$), respectively. Twenty per cent of all effortful tasks were independently rescored. ICCs on all tasks were greater than or equal to 0.94.

Delay of gratification was also included as a component of effortful control. Delay of gratification was assessed using a gift delay task (Kochanska et al., 1996) in which the child was told that s/he would receive a present but that the experimenter wanted to wrap it. The child was instructed to face the opposite direction and not peek while the experimenter noisily wrapped the gift. Children's peeking behaviour (frequency, degree, latency to peek, latency to turn around) and difficulty with the delay were rated. Twenty per cent of the delay of gratification cases was independently recoded. The inter-rater reliabilities for number, latency, degree of peeks, latency to turn around and difficulty waiting were 0.71 on average.

Effortful control composite

Consistent with previous research, an overall effortful control score was computed as the mean-weighted sum of the five standardized effortful control task scores (Carlson & Moses, 2001). Scores were considered missing if >50% of the component scores were missing. Higher values on each task, as well as with the composite score, reflects greater levels of effortful control. Internal consistency of the effortful control measure was 0.72 and 0.66 at Times 1 and 2, respectively. Inter-rater reliability was assessed by duplicate coding of 30% of cases, and the ICC was 0.90.

Salivary cortisol sampling and collection

During the Time 2 session, mothers observed the collection of cortisol at the laboratory visit and then were given a home collection kit and instructions on how to collect the saliva samples at home. Mothers were instructed to collect their child's saliva 30 min after the child woke in the morning and 30 min prior to bedtime, for two consecutive days. To stimulate salivation, the children chewed Trident Original sugarless gum, which prior research has shown to not affect cortisol levels (Schwartz, Granger, Susman, Gunnar, & Laird, 1998). Salivettes were placed in the children's mouth. Once saturated, the Salivettes were placed in prelabelled plastic vials. Using cortisol diary cards, mothers reported on collection times, children's health conditions, food consumed, mediations taken and child behaviours at the time of each saliva collection. Mothers' reports generally indicated good compliance with collection protocol, and 98% of samples were collected within 40 min of either wake or bed time.

Cortisol assay

Until all families were assessed, the saliva samples were kept frozen and sent to Oregon Social Learning Center Salivary Cortisol Assay Laboratory (OSLC) for processing. Prior to the assay, samples were thawed and centrifuged at 3000 rpm for 15 min. To complete the assay, 25 μL of saliva from each sample was transferred into each of two wells, producing duplicate samples for each assay; samples were then averaged. Samples were assayed using the High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit provided by Salimetrics, Inc. (State College, PA, USA). All samples from the same subject for each set of saliva were included in the same

DOI: 10.1002/icd

assay batch to minimize inter-assay within-subject variability. Intra-assay reliabilities for the OSLC laboratory were obtained using the high and low cortisol controls provided by Salimetrics. The mean cortisol value (MCV) for the high concentration sample was 7.06%; MCV for the low concentration sample was 13.52%. For the high cortisol concentration, the MCV was 3.81%; for the medium concentration, it was 6.78%, and for the low concentration, it was 11.7%, all acceptable values.

The average morning cortisol level for the sample was 0.55 μg/dL ($SD = 0.34$), and the average evening cortisol level was 0.10 μg/dL ($SD = 0.20$). A measure of diurnal cortisol pattern was calculated as the difference between the average of the two morning samples and the average of the two evening samples (i.e. average morning – average evening). Larger values indicate a typical diurnal pattern that decreases throughout the day. The average difference across the day was 0.45 μg/dL ($SD = 0.25$). Guided by prior studies examining HPA axis activity in relation to low income and by meta-analyses regarding the relation of cortisol levels to chronic adversity (Miller, Chen, & Zhou, 2007), we sought to identify two forms of disruptions in HPA axis activity: blunted levels and elevated levels. A blunted pattern was defined by a diurnal cortisol pattern or difference that was 1.5 *SD* below the mean of this sample and morning values that were 1 *SD* below the mean of the sample. This group was characterized as having low morning and evening levels and a flat diurnal pattern (low AM/PM, $n = 7$). For these children, the average morning cortisol level was 0.14 μg/dL ($SD = 0.06$); the average evening level was 0.13 μg/dL ($SD = 0.07$) and the average difference across the day was 0.03 μg/dL ($SD = 0.06$).[1] An elevated pattern included children who demonstrated high cortisol levels across the day, with both morning and evening levels ≥1.5 *SD* above average (high AM/PM, $n = 4$). For these children, the average morning cortisol level was 1.35 μg/dL ($SD = 0.67$), and the average evening level was 0.76 μg/dL ($SD = 0.38$). All remaining children were included in the average diurnal pattern group. The values of these high and low groups would also be categorized as high and low in a recent study conducted by Bruce and colleagues (2009) in which they identified a high group on the basis of a morning value of >60 μg/dL and a low group as <0.30 μg/dL. Figure 1 depicts the average, low AM/PM and high AM/PM patterns. No children in this sample had increasing cortisol over the day.

It is possible that the low morning values in these cases reflect a problem in the collection procedures, for example, that the samples were collected simultaneously with the evening values rather than in the morning as intended. However, this is unlikely for three reasons: (i) in every case, the average morning value is different

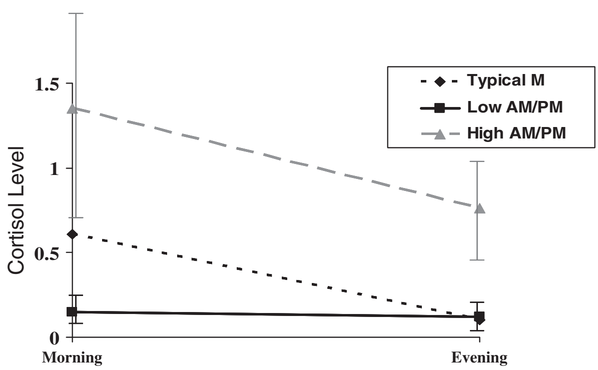

Figure 1. Low AM/PM, high AM/PM and typical diurnal cortisol patterns.

DOI: 10.1002/icd

than the average evening value (average difference = 0.08 μg/dL); (ii) in all but one case, the average morning value is higher than the average evening value; and (iii) there are differences in mother-rated diary card information across the morning and evening collections.

RESULTS

First, cortisol diary card variables were examined to identify potential covariates of cortisol levels. Health, medication, food ingestion, child behaviours and daily disruptions were examined in relation to cortisol variables. Eight children were reported to have an illness on the day of collection. However, excluding them from the sample did not alter the magnitude of the correlations of cortisol variables with other variables, and therefore, these participants' samples were retained. Four parents reported that their children use inhalers for their asthma, but none of them reported using their inhaler on the days of saliva collection. Twenty-nine children were reported to have eaten food before their saliva collection. However, excluding them from the sample did not alter the magnitude of the correlations of cortisol variables with other variables, and therefore, these participants' samples were retained. None of the remaining variables were consistently significantly related to cortisol variables. Wake time, bed time and latencies between these times and collection times were examined. Wake time and latency to morning collection were the only variables significantly associated with the cortisol variables. The majority of saliva samples were collect within 20 min of the ideal time, and all but one was collected within 40 min of the ideal time. Morning 1 and Morning 2 wake times were correlated 0.82, and both Morning 1 and Morning 2 latency to collection were equally correlated with cortisol variables. Therefore, Day 2 wake time and latency to collection were included in subsequent regression analyses as covariates. Neither evening collection times nor bed times were related to evening cortisol levels or diurnal patterns.

Hypothesis 1: Poverty, single parent and blunted diurnal pattern

First, correlations were examined to determine the hypothesized relations among poverty, single parent status and diurnal cortisol patterns (Table 1). Poverty status and single parent status were significantly related to a greater likelihood of demonstrating the low AM/PM pattern. Poverty and single parent status were not related to the high AM/PM cortisol pattern. Subsequent analyses did not examine the high AM/PM pattern (as it also did not relate to the other study variables tested below, parenting and effortful control).

As expected, there was significant overlap between poverty status and single parent status. In this sample, 55% of the single parents also lived in poverty (11/20), and 79% of the families in poverty were also single parent families (11/14). Thus, we conducted exploratory analyses to examine how the two variables were simultaneously related to cortisol to account for their overlap. To do this, we created two variables, one indicating single parents who were not poor and the other indicating families living in poverty regardless of marital status.

Logistic regressions were used to examine whether poverty or single parent status (not in poverty) predicted the low AM/PM cortisol pattern (Table 2). Poverty status, regardless of single parent status, was significantly related to a higher likelihood of demonstrating the low AM/PM cortisol pattern ($B = 1.59$, $SE = 0.81$, $p = 0.05$). Children living in poverty were 4.9 times more likely to demonstrate the low AM/PM cortisol pattern compared with children not in poverty. Single parent

DOI: 10.1002/icd

Table 1. Correlations among study variables

	Poverty[a]	Single parent	Warmth	Scaffolding	Limit setting	Negative affect	Low AM/PM cortisol	High AM/PM cortisol	Effortful control
Time 1 predictors									
Child age	0.05	0.09	0.14	0.08	0.08	0.07	0.02	−0.11	0.10
Child gender	−0.17	−0.05	−0.11	−0.06	−0.06	−0.13	−0.06	−0.17	−0.17
Poverty		0.57**	−0.10	−0.27**	−0.10	0.23*	0.21*	0.02	−0.20*
Single parent			−0.13	−0.31**	0.09	0.30**	0.23*	−0.15	−0.19*
Parenting behaviour									
Warmth				0.51**	0.10	−0.07	−0.19	0.11	0.04
Scaffolding					−0.08	−0.42**	−0.14	−0.06	0.23*
Limit Setting						0.17	−0.02	0.05	0.16
Negative Affect							0.23*	0.14	−0.17
Time 2 outcomes									
Low AM/PM cortisol								−0.08	−0.22*
High AM/PM cortisol									0.01
Effortful control									–

[a]For variables that are dichotomous, poverty, single parent status, low AM/PM and high AM/PM, a point-biserial correlation coefficient is presented.
*$p < .05$.
**$p < .01$.

Table 2. Logistic regression results for poverty and parenting predicting the low AM/PM cortisol pattern

	$\chi^2(df)$, p	B at entry	SE	Exp(B)	B final step	SE	Exp(B)
Step 1:	5.76(2), 0.06						
Wake time		0.00	0.00	1.00	0.00	0.00	1.00
Latency		39.83*	19.80	0.00	67.65	31.37	0.00
Step 2: poverty	3.65(1), 0.05	1.85*	0.94	6.34	3.00*	1.53	20.13
Step 3: parenting	12.08(4), 0.02.						
Warmth					−1.14*	0.53	0.32
Scaffolding					0.61	0.49	1.83
Limit Setting					−0.24	0.45	0.79
Negative Affect					2.99*	1.46	19.95

*$p < 0.05$.

status in the absence of poverty was unrelated to the low AM/PM cortisol pattern ($B = 0.94$, $SE = 1.22$, n.s.). Given the overlap in poverty status and single parent status, we examined the relation of children who were both living in poverty and single parent households to the low AM/PM cortisol pattern. Children living in poverty who were also in single parent households were significantly more likely to demonstrate the low AM/PM cortisol pattern ($B = 2.10$, $SE = 0.91$, $p = 0.03$), being 7.4 times more likely to demonstrate this pattern than other children. Given that single parent status alone, in the absence of poverty, was not related to the low AM/PM cortisol pattern, subsequent analyses examined whether parenting accounted for the relation of poverty to the low AM/PM cortisol pattern.

Hypothesis 2: Poverty, blunted diurnal pattern and parenting

We examined the correlations of poverty and the low AM/PM diurnal cortisol pattern with the parenting variables to determine whether parenting could plausibly account for the effects of poverty on the blunted diurnal pattern (Table 1). Poverty status was related to lower maternal scaffolding and higher negative affect. In turn, some of the parenting variables were related to disrupted diurnal cortisol. Maternal negative affect was associated with a greater likelihood of demonstrating the low AM/PM cortisol pattern. The pattern of correlations suggested that parenting was a plausible mediator of the effects of poverty and single parent status on the blunted diurnal cortisol pattern.

Logistic regressions were used to examine whether parenting might account for the relation of poverty to the low AM/PM cortisol pattern. First, we entered cortisol waking time and collection latency covariates in the first step, poverty status in the second step and then entered the four parenting variables (maternal warmth, scaffolding, limit setting and negative affect) in the next step. Poverty continued to demonstrate a significant association with the low AM/PM cortisol pattern, as reported above. After accounting for the effect of poverty, maternal warmth and negative affect were significantly related to the low AM/PM cortisol pattern when all parenting variables were accounted simultaneously in the third step of the regression. Children experiencing higher maternal warmth were one-third as likely to demonstrate the low AM/PM cortisol pattern, and children experiencing higher maternal negative affect were 4.1 times more likely to demonstrate the low AM/PM cortisol pattern.

Hypothesis 3: Poverty, blunted diurnal pattern, effortful control

DOI: 10.1002/icd

Correlations between poverty, the low AM/PM diurnal pattern and the lower effortful control were significant (Table 1). This indicated that diurnal cortisol pattern could plausibly account for the relation between poverty and effortful control.

Multiple regression was used to test whether the low AM/PM cortisol pattern accounted for the relation between poverty and children's effortful control (Table 3). Children's age, gender, verbal ability and effortful control at Time 1 were included in the first step of the regression as covariates, along with wake time and cortisol collection time variables. Poverty status was entered in the second step of the regression and was significantly related to lower effortful control at Time 2. To characterize this effect, we examined the mean levels of effortful control from Time 1 to Time 2 for children in poverty and not in poverty. For children not in poverty, mean levels of effortful control increased (T1 M = 0.30, T2 M = 0.50), whereas for children in poverty, mean levels of effortful control decreased (T1 M = −1.34, T2 M = −2.45). Disrupted diurnal cortisol (low AM/PM cortisol pattern) was entered in the third step of the regression and was related significantly to lower effortful control at Time 2. When diurnal cortisol pattern was included in the regression, the effect of poverty decreased and became nonsignificant, suggesting that a disrupted diurnal cortisol pattern partly accounts for the effects of poverty on children's effortful control.

DISCUSSION

This study examined the relations of poverty, single parent status and parenting to preschoolers' diurnal cortisol patterns and effortful control. We identified two disrupted diurnal patterns, a blunted pattern in which children demonstrated both low AM and low PM levels and an elevated pattern, including children with high AM and high PM levels. After testing whether poverty was associated with disrupted cortisol patterns, we examined whether parenting accounted for cortisol disruptions beyond the effects of poverty and whether cortisol disruptions were related to the development of effortful control.

Poverty status and single parent status were correlated with the blunted diurnal pattern. Given prior findings suggesting an association between low income and elevated cortisol levels, it was surprising that the high AM/PM cortisol pattern was not related to any of the variables examined. This may have been a function of the low number of children demonstrating this pattern. However, the present study findings are consistent with the findings of other studies demonstrating relations of lower income with lower or blunted cortisol patterns rather than with

Table 3. Ordinary least-square regression results for poverty and low AM/PM cortisol pattern predicting effortful control

	ΔR^2	*B* at entry	*SE*	β at entry	*B* final step	*SE*	β final step
Step 1: covariates	0.29*						
Child age		0.12	0.23	0.06	0.13	0.22	0.07
Child gender		−1.73	1.26	−0.16	−2.08	1.25	−0.19
Verbal ability		0.11	0.04	0.36*	0.09	0.04	0.28*
T1 effortful control		0.28	0.11	0.30*	0.31	0.11	0.34*
Wake time		0.00	0.00	0.05	−0.00	0.00	−0.02
Collection latency		−3.78	28.63	−0.02	20.79	30.90	0.10
Step 2: poverty	0.01*	−1.55	0.79	−0.18*	−1.34	0.90	−0.08
Step 3: low AM/PM	0.04*				−5.13	2.60	−0.24*

*$p < 0.05$.

DOI: 10.1002/icd

elevated levels. An increasing number of studies have documented that chronic early adversity is associated with low morning cortisol levels that remain flat throughout the day (Fernald et al., 2008; Fisher & Stoolmiller, 2008; Gunnar & Vazquez, 2001). Although once thought of as a paradoxical suppression response to stress, the phenomenon of a down regulation of cortisol is being documented more often (Gunnar & Vazquez, 2001). However, not all studies find this, with some evidence of low income being related to elevated cortisol levels (Lupien et al., 2001). These conflicting findings could result from differences in the measures used, the degree of disadvantage captured in a sample or in the age group studied, and additional research is needed to clarify these findings.

One of the exploratory aims of this study was to tease apart the effects of poverty and single parent status and their associations with children's HPA axis. Children with mothers who were single parents but who were not living in poverty were not more likely to exhibit the low AM/PM diurnal pattern. Only children whose families were living in poverty and even more, whose mothers were single parents and living in poverty, demonstrated the blunted diurnal pattern. Although too small of a sample size to draw definitive conclusions, initial implications suggest that not all risk factors are equally influential to children's physiological stress response systems. Poverty is a marker for a host of other risk factors, such as residential instability, maternal mental health and legal problems and increased family conflict, all of which are potential mechanisms worth examining to explain how living in poverty affects children's HPA axis (Ackerman et al., 2004; Gilman et al., 2003; Linver et al., 2002).

After the effects of poverty and single parent status were clarified, parenting behaviours were examined. Specifically, the associations of parenting behaviours and children's diurnal cortisol patterns were examined to assess whether parenting behaviours accounted for the relations between poverty and children's diurnal cortisol patterns. Higher negative affect and lower maternal warmth were associated with the low AM/PM cortisol pattern. Interestingly, this pattern suggests that the affective rather than control (e.g. scaffolding and limit setting) components of parenting were related to cortisol disruption, which is consistent with other studies examining affective aspects of parenting. Another study that examined negative aspects of parenting, specifically emotional unavailability, found that emotional unavailability was associated with lower laboratory baseline levels of cortisol (Bugental et al., 2003). Future studies should replicate the finding that affective rather than control aspects of parenting are related to cortisol patterns in young children.

Another aim of this study was to test whether blunted diurnal HPA axis activity predicted effortful control. Poverty status predicted differences in mean changes of effortful control between Time 1 and Time 2, with children in poverty scoring lower in effortful control at the second time point. Above the effect of poverty, the blunted diurnal pattern was related to decreases in effortful control across 6 months. Similarly, Davis et al. (2002) found that higher scores on laboratory measures of attentional and inhibitory control were related to higher morning cortisol levels. In contrast, Turner-Cobb, Rixon, and Jessop (2008) found that greater effortful control predicted less of a reduction in cortisol levels across the day. However, in that study children were assessed 2 weeks after the start of their school year, which might have been a stressful time. This may not represent how children would respond during less stressful periods. In fact, 6 months after the school year had started, the relations between effortful control and diurnal cortisol were nonsignificant. More research is needed to clarify the relation between effortful control and the HPA axis.

DOI: 10.1002/icd

Limitations

One of the limitations of this study is the small number of children demonstrating disrupted diurnal cortisol patterns, which likely resulted from the use of a community sample. The use of a high-risk sample would have likely yielded more children having atypical diurnal patterns. Nonetheless, the proportions of children demonstrating these disrupted patterns are consistent with findings in other samples (Bruce, Fisher, Pears, & Levine, 2009). The study was also limited in its ability to draw conclusions about direction of effects between cortisol patterns and effortful control as cortisol was not assessed at the first time point.

Another limitation was the small number of families living poverty. The sample was intentionally designed to sample families across the full range of income to provide a robust test of the effects of income. However, this resulted in a relatively small number of families in poverty, and these findings should be replicated using a larger sample. The significant association that emerged with poverty, negative parenting, maternal warmth and cortisol in this study suggests that follow-up studies are warranted.

Finally, poverty and single parent status likely co-occur with other known risk factors associated with disrupted cortisol. This includes maternal depression and child maltreatment, both of which have been associated with disrupted patterns (Ashman et al., 2002; Cicchetti & Rogosch, 2001; Dougherty, Klein, Olino, Dyson & Rose, 2009). Future studies should examine the different contributions that each of these risk factors makes in predicting disrupted cortisol patterns.

CONCLUSIONS

The results of this study suggest that poverty may have deleterious effects on preschoolers' HPA axis system, suggestive of allostatic load. In addition, low maternal warmth and high negativity may be important pathways for how poverty and single parent status alter preschooler's HPA axis. More studies are needed that examine how gradients in nonextreme forms of parental care impact neurobiology (Hane, Henderson, Reeb-Sutherland, & Fox, 2010). Research thus far has focused more on abusive or extreme forms of environmental deprivation. In addition, this study demonstrated that disrupted diurnal cortisol was related to lower effortful control beyond the effects of poverty. This finding is important but concerning because it hints at the possibility of a cascade effect in which poverty has deleterious effects on one neurobiological system, which can produce additional harmful effects on other self-regulatory systems. As more children are growing up in poverty each year in the US (DeNavas-Walt et al., 2010), it is imperative that we understand the mechanisms responsible for how poverty has consequential and lasting impacts on children's HPA axis, which confers risk for young children's mental health (McEwen, 1998). Identifying potent mechanisms will permit the development of the most effective intervention efforts.

ACKNOWLEDGEMENTS

Support for this research was provided by an award from the University of Washington Center for Mind, Brain and Learning through a gift from the Talaris Research Institute and the Apex Foundation, the family foundation of Bruce and Jolene McCaw. The authors wish to thank the families who participated in this study.

Note

1. A few years after collection of the cortisol data included in this study, new research demonstrated that the validity of cortisol results could be compromised by low volume rates associated with use of various collection devices, including the Salivette, a cotton collection device (Harmon et al., 2007). Interestingly, another article published around the same time offered suggestions for how to increase spit volume if using cotton devices (Granger et al., 2007). One suggestion to increase volume was to have children increase saliva production by chewing gum. Children in this study were asked to chew gum to increase their saliva production. In addition, although information on saliva volume was not recorded in this study, cortisol data were only recorded for those children whose saliva sample volumes were adequate. Thus, we are confident that low saliva volumes cannot fully account for the findings of low cortisol levels in this study.

REFERENCES

Ackerman, B. P., Brown, E. D., & Izard, C. E. (2004). The relations between contextual risk, earned income and the school adjustment of children from economically disadvantaged families. *Developmental Psychology*, *40*, 204–216. DOI: 10.1037/0012-1649.40.2.204

Alink, L. R. A., vanIjzendoorn, M. H., Bakersmans-Kranenburg, M. J., Mesman, J., Juffer, F., & Koot, H. M. (2008). Cortisol and externalizing behavior in children and adolescents: Mixed meta-analytic evidence for the inverse relation of basal cortisol and cortisol reactivity with externalizing behavior. *Developmental Psychobiology*, *50*, 427–450. DOI: 10.1002/dev.203000

Ashman, S. B., Dawson, G., Panagiotides, H., Yamada, E., & Wilkinson, C. W. (2002). Stress hormone levels of children of depressed mothers. *Developmental Psychopathology*, *14*, 333–349. DOI: 10.1017/S0954579402002080

Badanes, L. S., Watamura, S. E., & Hankin, B. L. (2011). Hypocortisolism as a potential marker of allostatic load in children: Associations with family risk and internalizing disorders. *Development and Psychopathology*, *23*, 881–896.

Blair, C. (2010). Stress and the development of self-regulation in context. *Child Development Perspectives*, *4*(3), 181–188.

Blair, C., Granger, D., & Razza, R. P. (2005). Cortisol reactivity is positively related to executive function in preschool children attending Head Start. *Child Development*, *76*, 554–567.

Blair, C., Raver, C. C., Granger, D., Mills-Koonce, R., Hibel, L., & The family life project key investigators. (2011). Allostatis and allostatic load in the context of poverty in early childhood. *Development and Psychopathology*, *23*, 845–857. DOI: 10.1017/S0954579411000344

Bornstein, M. H., & Bradley, R. H. (2003). *Socioeconomic status, parenting, and child development*. Mahwah, NJ: Lawrence Erlbaum Associates.

Boyce, W. T., & Ellis, B. J. (2005). Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology*, *17*, 271–301. DOI: 10.10170S0954579405050145

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The Future of Children*, *7*(2), 55–71. DOI: 10.2307/1602387

Bruce J., Fisher P. A., Pears K. C., & Levine, S. (2009). Morning cortisol levels in preschool-aged foster children: Differential effects of maltreatment type. *Developmental Psychobiology*, *51*(1), 14–23. DOI: 10.1002/dev.20333

Bugental, D. B., Martorell, G. A., & Barraza, V. (2003). The hormonal costs of subtle forms of infant maltreatment. *Hormones and Behavior*, *43*, 237–244. DOI: 10.1016/S0018-506X(02)00008-9

Carlson, S. M., & Moses, L. J. (2001) Individual differences in inhibitory control and children's theory of mind. *Child Development*, *72*(4), 1032–1053. DOI: 10.1111/1467-8624.00333

Casey, B. J., Trainor, R. J., Orendi, J. L., Schubert, A. B., Nystrom, L. E., Giedd, J. N., et al. (1997). A developmental functional MRI study of prefrontal activation during performance on a go-no-go task. *Journal of Cognitive Neuroscience*, *9*, 835–847.

Cicchetti, D., & Rogosch, F. A. (2001). The impact of child maltreatment and psychopathology upon neuroendocrine functioning. *Development and Psychopathology*, *13*, 783–804.

Cowen, P. A., & Cowen, C. P. (1992). *Parenting style ratings: School children and their families project*. Berkeley: University of California.

Davis, E. P., Bruce, J., & Gunnar, M. R. (2002). The anterior attention network: Associations with temperament and neuroendocrine activity in 6-year-old children. *Developmental Psychobiology*, *40*, 43–56. DOI: 10.1002/dev.10012

DeNavas-Walt, C., Proctor, B. D., Smith, J. C. (2010). Income, poverty and health insurance coverage in the United States: 2009. *Current population reports, U.S. Census Bureau, P60–238*. Washington DC: U.S. Government Printing Office.

Diamond, A., & Taylor, C. (1996). Development of an aspect of executive control: Development of the abilities to remember what I said and to "Do as I say, not as I do". *Developmental Psychobiology*, *29*, 315–334. DOI: 10.1002/(SICI)1098-2302(199605)29:4<315::AID-DEV2>3.0.CO;2-T

Donzella, B., Gunnar, M. R., Krueger, W. K., & Alwin, J. (2000). Cortisol and vagal tone responses to competitive challenge in preschoolers: Associations with temperament. *Developmental Psychobiology*, *37*, 209–220. DOI: 10.1002/1098-2302(2000)37:4<209::AID-DEV1>3.0.CO;2-S

Dougherty, L. R., Klein, D. N., Olino, T. M., Dyson, M., & Rose, S. (2009). Increased waking salivary cortisol and depression risk in preschoolers: The role of maternal history of melancholic depression and early child temperament. *Journal of Child Psychology and Psychiatry*, *50*, 1495–1503. DOI: 10.1111/j.1469-7610.2009.02116.x

Dufar, M. J., Howell, N. C., Downey, D. B., Ainsworth, J. W., & Laprapy, A. J. (2010). Sex differences in parenting behaviors in single-mother and single-father households. *Journal of Marriage and Family*, *72*(5), 1092–1106. DOI: 10.1111/j.1741-3737.2010.00752.x

Duncan, G. J., Brooks-Gunn, J., & Klebanov, P. K. (1994). Economic deprivation and early-childhood development. *Child Development*, *65*, 296–318.

Dunn, L. M., & Dunn, L. M. (1981). *Peabody picture vocabulary test—revised* (2nd ed.). Circle Pines, MN: American Guidance Service.

Ehrensaft, M. K., Cohen, P., Chen, H., & Berenson, K. (2007). Developmental transitions in youth behavioral opposition and maternal beliefs in social ecological context. *Journal of Child and Family Studies*, *16*, 577–588. DOI: 10.1007/s10826-006-9108-z

Eisenberg, N., Gershoff, E. T., Fabes, R. A., Shepard, S. A., Cumberland, A. J., Losoya, S. H., et al. (2001). Mother's emotional expressivity and children's behavior problems and social competence: Mediation through children's regulation. *Developmental Psychology*, *37*, 475–490.

Eisenberg, N., Valiente, C., Fabes, R. A., Smith, C. L., Reiser, M., Shepard, S. A., et al. (2003). The relations of effortful control and ego control to children's resiliency and social functioning. *Developmental Psychology*, *39*, 761–776.

Evans, G. W., & English, K. (2002). The environment of poverty: Multiple stressor exposure, psychophysiological stress, and socioemotional adjustment. *Child Development*, *73*, 1238–1248.

Evans, G. W., & Kim, P. (2007). Childhood poverty and health: Cumulative risk exposure and stress dysregulation. *Psychological Science*, *18*, 953–957. DOI: 10.1111/j.1467-9280.2007.02008.x

Fernald, L. C., Burke, H. M., & Gunnar, M. R. (2008). Salivary cortisol levels in children of low-income women with high depressive symptomatology. *Development and Psychopathology*, *20*, 423–436. DOI: 10.1017/S0954579408000205

Fisher, D. B., Serbin, L. A., Stack, D. M., Ruttle, P. L., Ledingham, J. E., & Schwartzman, A. E. (2007). Intergenerational predictors of diurnal cortisol secretion in early childhood. *Infant and Child Development*, *16*, 151–170. DOI: 10.1002/icd.474

Fisher, P. A., & Stoolmiller, M. (2008). Intervention effects on foster parent stress: Associations with child cortisol levels. *Development and Psychopathology*, *20*, 1003–1021. DOI: 10.1017/S0954579408000473

Fisher, P. A., Van Ryzin, M. J., & Gunnar, M. R. (2011). Mitigating HPA axis dysregulation associated with placement changes in foster care. *Psychoneuroendocrinology*, *36*(4), 531–539. DOI: 10.1016/j.psyneuen.2010.08.007

Francis, D. D., Caldji, C., Champagne, F., Plotsky, P. M., & Meaney, M. J. (1999). The role of corticotropin-releasing factor-norepinephrine systems in mediating the effects of early experience on the development of behavioral and endocrine responses to stress. *Biological Psychiatry*, *46*, 1153–1166.

Gardner, F., Connell, A., Tretacosta, C. J., Shaw, D. S., Dishion, T. J., & Wilson, M. N. (2009). Moderators of outcome in a brief family-centered intervention for preventing early problem behavior. *Journal of Consulting and Clinical Psychology*, *77*(3), 543–553. DOI: 10.1037/a0015622

Gerstadt, C. L., Hong, Y. J., & Diamond, A. (1994). The relationship between cognition and action: Performance of children 3.5–7 years old on a Stroop-like day–night test. *Cognition*, *53*, 129–153. DOI: 10.1016/0010-0277(94)90068-X

Gilman, S. E., Kawachi, I., Fitzmaurice, G. M., & Buka, L. (2003). Socio-economic status, family disruption and residential stability in childhood: Relation to onset, recurrence and remission of major depression. *Psychological Medicine*, *33*, 1341–1355. DOI: 10.1017/S0033291703008377

Granger, D. A., Kivlighan, K. T., Fortunato, C., Harmon, A. G., Hibel, L. C., Schwartz, E. B., et al. (2007). Integration of salivary biomarkers into developmental and behaviorally-oriented research: Problems and solutions for collecting specimens. *Physiology & Behavior*, *92*, 583–590. DOI: 10.1016/j.physbeh.2007.05.004

Gunnar, M., & Quevedo, K. (2007). The neurobiology of stress and development. *Annual Review of Psychology*, *58*, 145–173. DOI: 10.1146/annurev.psych.58.110405.085605

Gunnar, M. R. (1994). Psychoendocrine studies of temperament and stress in early childhood: Expanding current models. In J. E. Bates, & T. D. Wachs (Eds.). *Temperament: Individual differences at the interface of biology and behavior* (pp. 175–198). Washington, DC: APA. DOI: 10.1037/10149-006

Gunnar, M., & Vazquez, D. M. (2001). Low cortisol and a flattening of expected daytime rhythm: Potential indices of risk in human development. *Developmental Psychopathology*, *13*, 515–538. DOI: 10.1017/S0954579401003066

Hane, A. A., Henderson, H. A., Reeb-Sutherland, B. C., & Fox, N. A. (2010). Ordinary variations in human caregiving in infancy and biobehavioral development in early childhood: A follow-up study. *Developmental Psychobiology*, *52*, 558–567.

Harmon, A. G., Hibel, L., Rumyantseva, O., & Granger, D. A. (2007). Measuring salivary cortisol in studies of child development: Watch out—what goes in may not come out of saliva collection devices. *Developmental Psychobiology*, *49*, 495–500.

Hertsgaard, L., Gunnar M., Erickson, M. F., & Nachmias, M. (1995). Adrenocortical responses to the strange situation in infants with disorganized/disoriented attachment relationships. *Child Development*, *66*, 1100–1106. DOI: 10.2307/1131801

Jackson, A. P., Preston, K. S. J., & Franke, T. M. (2010). Single parenting and child behavior problems in kindergarten. *Race and Social Problems*, *2*(1), 50–58. DOI: 10.1007/s12552-010-9026-y

Kerig, P. K., & Lindahl, K. M. (2001). *Family observational coding systems: Resources for systemic research*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Krikorian, R., & Bartok, J. (1998). Developmental data for the Porteus Maze Test. *Child Neuropsychologist*, *12*, 305–310. DOI: 10.1076/clin.12.3.305.1984

King, S. L., & Hegadoren, K. M. (2002). Stress hormones: How do they measure up? *Biological Research for Nursing*, *4*(2), 92–103. DOI: 10.1016/j.apnr.2006.02.001

Kochanska, G., Murray, K., Jacques, T. Y., Koenig, A. L., & Vandegeest, K. A. (1996). Inhibitory control in young children and its role in emerging internalization. *Child Development*, *67*, 490–507. DOI: 10.2307/1131828

Lemery-Chaifant, K., Doelger, L., & Goldsmith, H. H. (2010). Genetic relations between effortful and attentional control and symptoms of psychopathology in middle childhood. *Infant and Child Development*, *17*(4), 365–385. DOI: 10.1002/icd.581

Lengua, L. J. (2003). Associations among emotionality, self-regulation, adjustment problems and positive adjustment in middle childhood. *Journal of Applied Developmental Psychology*, *24*, 595–618. DOI: 10.1016/j.appdev.2003.08.002

Lengua, L. J. (2012). Poverty, the development of effortful control, and children's academic, social and emotional adjustment. In V. Maholmes & R. King (Eds.), *The Oxford handbook of poverty and child development*. New York, NY: Oxford University Press.

Lengua, L. J., Bush, N., Long, A. C., Trancik, A. M., & Kovacs, E. A. (2008). Effortful control as a moderator of the relation between contextual risk and growth in adjustment problems. *Development & Psychopathology*, *20*, 509–528. DOI: 10.1017/S0954579408000254
Leventhal, T., & Brooks-Gunn, J. (2011). Changes in neighborhood poverty from 1990 to 2000 and youth's problem behaviors. *Developmental Psychology*, *47*(6), 1680–1698. DOI: 10.1037/a0025314
Lindahl, K. M., & Malik, N. M. (2000). System for coding interactions and family functioning (SCIFF): A coding system for family problem discussions.
Linver, M. R., Brooks-Gunn, J., & Kohen, D. E. (2002). Family processes as pathways from income to young children's development. *Developmental Psychology*, *38*, 719–734. DOI: 10.1037/0012-1649.38.5.719
Lupien, S. J., King, S., Meany, M. J., & Bruce, M. S. (2000). Child's stress hormone levels correlate with mother's socioeconomic status and depressive state. *Biological Psychiatry*, *48*(10), 976–980.
Lupien, S. J., King, S., Meaney, M. J., & McEwan, B. S. (2001). Can poverty get under your skin? Basal cortisol levels and cognitive function in children from low and high socioeconomic status. *Development and Psychopathology*, *13*, 653–676. DOI: 10.1017/S0954579401003133
Lupien, S. J., Gillin, C. J., & Hauger, R. L. (1999). Working memory is more sensitive than declarative memory to the acute effects of corticosteroids: A dose–response study in humans. *Behavioral Neuroscience*, *113*, 420–430. DOI: 10.1037/0735-7044.113.3.420
MacKenzie, E. P., Fite, P. J., & Bates, J. E. (2004). Predicting outcome in behavioral parent training: Expected and unexpected results. *Child and Family Behavior Therapy*, *26*, 37–53. DOI: 10.1300/J019v26n02_03
McEwen, B. S. (1998). Seminars in medicine of the Beth Israel Deaconess Medical Center: Protective and damaging effects of stress mediators. *The New England Journal of Medicine*, *338*, 171–179. DOI: 10.1056/NEJM199801153380307
Middlemiss, W. (2003). Brief report: Poverty, stress, and support: Patterns of parenting behavior among lower income black and lower income white mothers. *Infant and Child Development*, *12*, 293–300. DOI: 10.1002/icd.307
Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and hypothalamic–pituitary–adrenocortical axis in humans. *Psychological Bulletin*, *133* (1), 25–45. DOI: 10.1037/0033-2909.133.1.25
Posner, M. I., & Rothbart, M. K. (2000). Developing mechanisms of self-regulation. *Development and Psychopathology*, *12*, 427–441. DOI: 10.1017/S0954579400003096
Rothbart, M. K., & Rueda, M. R. (2005). The development of effortful control. In U. Mayr, E. Awh, & S. Keele (Eds.), *Developing individuality in the human brain: A tribute to Michael I. Posner* (pp. 167–188). Washington, DC: American Psychological Association.
Rothbart, M. K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: Linking temperament, brain networks and genes. *Child Development Perspectives*, *1*(1), 2–7. DOI: 10.1111/j.1750-8606.2007.00002.x
Scaramella, L. V., Neppl, T. K., Ontai, L. L., & Conger, R. D. (2008). Consequences of socioeconomic risk across three generations: Parenting behavior and child externalizing problems. *Journal of Family Psychology*, *22*, 725–733.
Spangler, G., & Grossman, K. E. (1993). Biobehavioral organization in securely and insecurely attached infants. *Child Development*, *64*, 1439–1450. DOI: 10.2307/1131544
Schwartz, E. B., Granger, D. A., Susman, E. J., Gunnar, M. R., & Laird, B. (1998). Assessing salivary cortisol studies of child development. *Child Development*, *69*, 1503–1513.
Turner-Cobb, J. M., Rixon, L., Jessop, D. S. (2008). A prospective study of diurnal cortisol responses to the social experience of school transition in four-year-old children: Anticipation, exposure, adaptation. *Developmental Psychobiology*, *50*, 377–389. DOI: 10.1002/dev.20298