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# Household Chaos Relates to Cortisol Levels for Children in Head Start Preschool

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Household Chaos Relates to Cortisol Levels for Children in Head Start Preschool

A Dissertation Project

Presented to the Faculty of the

Department of Psychology

West Chester University

West Chester, Pennsylvania

In Partial Fulfillment of the Requirements for

the Degree of

Doctor of Psychology

By

Mary Ann Blumenthal, M.C.

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## Abstract

Poverty and related stressors have been demonstrated to negatively impact child development. Few studies to date have investigated the relationship between one such poverty related stressor, household chaos, and its impact on cortisol levels—a biomarker for stress—throughout the day. The present study investigated the relationship between household chaos and cortisol in a diverse sample of 288 children attending Head Start preschool. Household chaos was measured by a standardized parent report measure of chaos in the home. Salivary cortisol samples were obtained during four time points across the preschool day on two days at the beginning of the preschool year. Hierarchical linear modeling was used to examine within-persons relation between cortisol and time-of-day, and to examine household chaos as a potential moderator of this relationship. Children who came from homes characterized as high home chaos had a higher early morning cortisol level compared to children with low levels of home chaos, and also showed a steeper decrease in cortisol levels from early morning to midmorning. Children who resided in poverty had a higher morning cortisol level and a steeper decrease from early morning cortisol to midmorning cortisol time points compared to children who resided in households with family income-to-needs ratios above the poverty threshold. Additionally, children who came from households below the poverty threshold showed a greater increase in cortisol levels from midmorning to midafternoon. These results suggest that within a sample facing economic hardship, both poverty and household chaos are related to morning cortisol as well as changes in cortisol trajectories across the preschool day for young children, which underscores the need for policies and programs aimed at reducing poverty and poverty related stressors during the critical developmental period of early childhood.

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## **Chapter 1: Introduction**

Approximately 19% of children in the United States live in poverty (Koball & Jiang, 2018), which places them at risk for cognitive, social, and emotion difficulties (Bradley & Corwyn, 2002). Children living in poverty are more likely to experience chronic stress (Chen, et al., 2010) and associated dysregulation of physiological stress response systems including the hypothalamic pituitary adrenal (HPA) axis (Holochwost et al., 2020). Early childhood stress, as measured by the hormone cortisol, has been linked to cognitive and emotional difficulties (Blair et al., 2005). One potent form of stress for young children in poverty is household chaos, which is conceptualized as a lack of stability, noise, and frequent coming and going of people in the home (Matheny et al., 1995). Past research has linked home chaos with elevations in morning cortisol in children at a Head Start preschool (Brown et al., 2019; 2021). The current study investigated the relationship between household chaos and cortisol across the preschool day in children attending a Head Start program. Implications concern understanding risk associated with poverty circumstances and informing policy and early intervention planning for young children facing economic hardship.



## Chapter 2: Literature Review

### Poverty and Child Development

Poverty has a negative impact on childhood wellbeing, with effects that can persist into adulthood (Duncan et al., 2010). Children experiencing poverty live in families whose income falls below the federal government's threshold of an income necessary to meet basic needs, accounting for family size. For instance, the poverty level for a family of four in 2020 was \$26,200 (U.S. Department of Health and Human Services, 2020). Living in poverty, especially during early childhood, impacts a host of biological pathways that influence physical development and health outcomes. Children born into families living below the poverty line, for example, are more likely to be born prematurely, and to have low birth weight and length (Korenman et al., 1994). Another risk factor from experiencing poverty relates to inconsistent nutrition, with children living in poverty being about nine times more likely to experience food insecurity compared to their counterparts who do not face poverty (Brooks-Gunn & Duncan, 1997). In terms of overall health, research has documented that children living in poverty were four times more likely to be characterized as in fair to poor health (versus good health) compared to children above the poverty line (Brooks-Gunn & Duncan, 1997). Specific negative health outcomes include higher rates of childhood obesity (Min et al., 2018), diabetes (Ludwig et al., 2011), and high blood pressure (Lehman et al., 2009). These disadvantages related to physical development and health outcomes often co-occur with disadvantages in other areas of development. Due to systemic racism, children who are Black, Indigenous, and People of Color are disproportionately likely to live in poverty and may additionally experience specific forms of race-based stress and trauma, with correspondingly augmented risks to physical health functioning (Muscatell et al., 2022).

The impact of poverty negatively influences social, emotional, and cognitive development in children (Bradley & Corwyn, 2002). Parents of children living in poverty are more likely to experience depression, distress, and emotion dysregulation, which influences parent-child interactions and parenting practices, and in turn, children's social-cognitive development (Maholmes & King, 2012). For instance, receptive and expressive language skills in 2-year-old children living in poverty fell one standard deviation below the language skills evidenced by middle- or upper-income children at this age (Justice et al., 2019). Additionally, due to a combination of biopsychosocial risks including family, neighborhood, and school factors, children from high poverty neighborhoods may be almost a full school year behind in academic abilities (Wolf et al., 2017). In terms of mental health, youth growing up in poverty are more likely to be rated by parents and teachers as higher in terms of aggressive and delinquent behaviors (Bradley & Corwin, 2002) and are at a greater risk of developing a mental health disorder (Samaan, 2000). Overall, poverty can impact many facets of development for children, and is best understood from a systems approach that accounts for complex interactions among biological and environmental factors.

### **Bioecological Systems Theory**

Bronfenbrenner's bioecological systems theory provides a framework for understanding the impact of environmental risks on child development by considering the child as situated within multiple layers of the ecological system (Evans, 2006). There are four main components to consider: process, person, context, and time (Bronfenbrenner, 1999). Person, describes the characteristic of the individual, such as their traits, genetic predisposition, and temperament that interact with the environment. Process refers to the interactions between the individual person, other people, and aspects of the immediate

environment. Proximal processes occur when there is an interaction between the individual and another individual or component of the environment, such as the interaction between a child and a parent's parenting style (Wachs & Evans, 2010). These types of interactions, such as between a child's temperament and parenting style, have implications for developmental outcomes. For example, children with difficult temperaments may be more vulnerable to the negative impacts of negative parenting styles on cognitive and emotional outcomes (Slagt et al., 2016). Context is the social and environmental settings that interact with one another and influence proximal processes. The final component of the model, time, refers to the duration and continuity an individual is exposed to a risk or setting, as well as the historical time period. Each component plays a role and provides a lens to understand how poverty impacts childhood development.

Bronfenbrenner's model describes the direct and indirect effect of a child's contexts on their development. One influential context is the microsystem or immediate environment surrounding the child. Microsystem context greatly impacts development through the interaction between the child and aspects of the home environment, caregivers, school, peers, and neighborhood (Bronfenbrenner, 1999). Poverty impacts the quality of the home environment and parent-child interactions (Fiese & Winfer, 2010), as well as the quality of other microsystems, such as daycare and school (Burchinal et al., 2000). For instance, a young child living in poverty may attend a lower quality day care or preschool with a high teacher-to-child ratio in the classroom (Burchinal et al., 2000). The mesosystem describes interactions between microsystems, providing a framework for understanding how the experience of a low-income family living in an impoverished neighborhood may be different compared to a middle class family living in an impoverished neighborhood (Church et al., 2012).

The exosystem is a more distal environment for children, but indirectly influences their development through the social services available, parent's workplace, education policies, and the mass media (Wachs & Evans, 2010). A parent who has an unstable job and works long and inconsistent hours, for example, will likely face compromises in terms of the quality and quantity of interactions with their child (Wachs & Evans, 2010). The length of time and age of the child when they are exposed to poverty is important, such that longer exposure to poverty is linked with greater negative effects on wellbeing (Chen et al., 2010). The interactions between each element of the bioecological model impact development and an underlying mechanism to understand the impact of poverty can be seen in considering the biological response to stressors.

### **The HPA Axis**

The hypothalamic-pituitary-adrenal or HPA axis is one of the systems that regulates a number of daily functions, including the body's response to challenging or distressing conditions (Charmandari et al., 2005). During acute stressful situations, cortisol reacts and provides the body with energy to potentially adapt (Gunnar & Quevedo, 2007). First, corticotrophin releasing factor (CRF) is released and then stimulates the release of adrenocorticotrophic hormone (ACTH), which in turn, releases the glucocorticoid, cortisol. The result is rising cortisol levels that bind with glucocorticoid receptors which can help an individual respond to a stressful situation (Gunnar & Quevedo, 2007). Because cortisol is the key end product of the HPA axis, it can serve as a useful proxy for measuring the stress response in the body (Charmandari et al., 2005).

In addition to marshalling physiological response to stressors, cortisol acts as a regulator for the sleep-wake cycle and is involved in metabolism and learning, making cortisol

regulation an important aspect of healthy human development (Charmandari et al., 2005). Resting cortisol follows a diurnal pattern that is characterized by a morning peak shortly after waking up and a steep decline into midmorning, followed by a gradual decline across the remainder of the day (Shirtcliff et al., 2012). The initial morning peak of cortisol is referred to as the cortisol awakening response (CAR) and, during this time, cortisol levels increase about 38 to 75% thirty minutes after an individual awakens from sleep (Elder et al., 2014). The CAR is thought to be related to arousal and energy boosts (Elder et al., 2014), and the decline that follows this leads to a lowest level of cortisol that supports rest and is observed during nighttime sleep.

When an individual experiences a stressor, this stress response is superimposed on the normal trajectory of cortisol throughout the day, which serves the function of mobilizing additional physiological resources to respond (Shirtcliff et al., 2012). Yet when the HPA system is chronically overloaded by environmental stressors and challenges, dysregulation can occur, manifested as increased or decreased resting or baseline cortisol activity, as well as in response to challenges (Charmandari et al., 2005). Hypercortisolism refers to a pattern of increased and prolonged activation of the HPA system during homeostasis and in response to stressors (Gunnar, 2006), whereas hypocortisolism is characterized by a decreased HPA activation and lower levels of cortisol during homeostasis and weaker responses to stressors (Gunnar & Vasquez, 2001). HPA dysregulation can manifest in either of these ways, and the manifestation may depend on developmental timing as well as the duration and severity of stress.

The attenuation hypothesis posits that prolonged exposure to early and severe interpersonal stressors leads to chronic activation of the HPA system, which manifests first

as hypercortisolism and then, over time, as hypocortisolism (Sussman, 2006). This hypothesis underscores the complexities of the HPA system and regulation of the body in response to environmental challenges and stressors. High allostatic load refers to overall tax on physiological systems, of which HPA dysregulation represents just one aspect. Research has documented that the high allostatic load that follows repeated or chronic exposure to stress can negatively influence physical health as well as brain systems malleable to stress responses such as the hippocampus, prefrontal cortex, and amygdala (Danese & McEwen, 2011).

### **Poverty and HPA System**

Poverty can be conceptualized as a macrosystem that indirectly impacts child development through the impact it has on the HPA system. Poverty conditions tend to foster environments laden with various stressors, such as overcrowding, lack of adequate nutritious foods, less child supervision, and maternal depression (Maholmes & King, 2012). This accumulation of stressors induced by poverty can lead to an overload on the HPA system, and eventual dysregulation. A host of studies have demonstrated HPA dysregulation linked to childhood poverty. In a seminal study titled, “Can Poverty Get Under the Skin?” Lupien et al. (2001), for example, documented cortisol differences corresponding to socioeconomic status for children ages 6 to 10. Evans and colleagues have provided numerous studies linking poverty risks to aspects of allostatic load, including cortisol dysregulation, for children in elementary through high school (Evans, 2003; Evans et al., 2007; Evans & Kim, 2012). Blair and investigators from the Family Life Project have demonstrated effects of poverty on HPA functioning for a large sample of children studied longitudinally from infancy through age four (Blair et al., 2011; Blair et al., 2013). Also, a longitudinal study following cortisol levels of youth ages 9 to 18 in six-month intervals for two years found that lower income children

had greater cortisol outputs over the two-year period compared to higher income children (Chen et al., 2010).

Children living in poverty face a variety of chronic stressors that can impact HPA functioning. Even before a child is born, the negative effects of maternal stress are experienced via the prenatal environment (Lefmann & Combs-Orme, 2014). Parenting factors remain an important influence across the childhood years. A recent review suggested that both positive and negative parent behaviors can influence the HPA system (Holochwost et al., 2020). Maternal sensitivity, for example, has been linked to a child's baseline HPA functioning and to HPA reactivity to stress or challenge, as well as to how quickly cortisol returns to baseline following response to challenge (Laurent et al., 2016). For instance, research has demonstrated that the infants of mothers with greater sensitivity were more likely to return to baseline levels of cortisol just following a bath, which was considered a mild stressor (Albers et al., 2008). In terms of negative parenting behaviors, both maternal intrusiveness and negative affect towards the child have been associated with higher cortisol levels in early childhood (Dougherty et al., 2013; Laurent et al., 2016). Together, these findings suggest that parenting plays an integral role in the relation between poverty and the HPA system.

In addition to parenting, there are other aspects of poverty that may have a direct influence on child HPA functioning, such as domestic violence, environmental stressors in the home, and quality of daycare (Mills-Koonce et al., 2012). A study by Davies et al. (2007), for example, indicated that Kindergarten age children who were exposed to interparental conflict in the home were more likely to have lower cortisol reactivity in response to a simulated conflict between their mother and father, suggesting potential desensitization. In

terms of environmental stressors in the home environment, Blair et al. (2011) found that an index of household risk which describes safety, noise level, and number of rooms in the home was linked with higher cortisol levels for infants. Also, families living in poverty may only be able to access and utilize lower quality daycare options, which have been found to be linked with dysregulation of the HPA system (Geoffroy et al., 2006). Notably, BIPOC children are disproportionately likely to face poverty circumstances and may also face additional race-based stressors that contribute to a toll on HPA functioning (Brody et al., 2014).

The timing of poverty impacts the relationship between poverty and HPA functioning, such that experiencing poverty in early childhood is more likely to be related to dysregulation of the HPA system (Mills-Koonce & Towe-Goodman, 2012). Duration of exposure also matters, and adolescents who have lived in poverty for a greater portion of their lives have shown evidence of higher levels of HPA activation, as indicated by overnight urinary free cortisol (Evans & Kim, 2007). These findings highlight the importance of the ecological systems component of developmental time in understanding the impact poverty has on the HPA system.

The impact of poverty stressors on HPA functioning may play an important role in explaining the impact of poverty on not only physiological stress response functioning but also brain development and associated cognitive and emotional functioning. The hippocampus, prefrontal cortex, and amygdala are brain structures that are particularly vulnerable to the impact of stressors in early childhood, with implications for cognitive and emotional outcomes (Johnson et al., 2015). The hippocampus aids in learning and memory and is sensitive to stress hormones (McEwen et al., 2016). Studies comparing the size of the hippocampus in children from low SES versus high SES backgrounds have indicated that



children from low SES backgrounds tend to have a smaller hippocampus (Hanson et al., 2011). The prefrontal cortex is rich in cortisol receptors and is involved with planning, reasoning, and decision making; key components of executive functioning (Diamond, 2013). Structural differences in the prefrontal cortex have been observed based on SES (Lawson et al., 2013). Specifically, Lawson and colleagues (2013) found that the prefrontal cortex is thicker in children from higher SES homes, potentially supporting better executive functioning performance observed in this population. The amygdala, which supports emotional learning, motivation, and threat processing, also is highly sensitive to the impact of stress (Johnson et al., 2015). Children living in poverty are more likely to have less regulated amygdala activation during emotion processing tasks, which put children at risk for emotional dysregulation (Johnson et al., 2015). These findings underscore the biological changes that can transpire in development due to poverty exposure.

The time component of the bioecological model is salient in this consideration given that children go through critical periods of brain development, during which exposure to poverty may pose particular risks to brain structure and function (Johnson et al., 2015). Early childhood represents a critical period for the development of brain areas such as the prefrontal cortex and for the development of associated competencies such as those termed executive functioning. In a longitudinal Family Life Project investigation, which followed children from low income households, salivary cortisol levels at 7, 15, and 24 months of age were predictive of executive functioning at 36 months of age and academic achievement in prekindergarten (Berry et al., 2012). Further, the researchers found that children with higher levels of cortisol were more likely to have lower executive functioning in prekindergarten. In a longitudinal study of rural children living in poverty, chronic poverty was associated with greater

difficulties with executive functioning in early childhood (Raver et al., 2013). In early childhood, children coming from low SES homes were more likely to have lower selective attention compared to higher SES children (Lupien, et al., 2001). These findings highlight the role that the developing stress regulation system has on cognitive development and success in school as early as the prekindergarten years, which can set the stage for later achievement in school.

Some effects of early childhood poverty exposure may be lasting ones. Javanbakht et al. (2015), for example, found that lower SES at age 9 was associated with greater amygdala reactivity to fearful faces while higher SES was linked to higher amygdala reactivity to happy faces in adulthood. This suggests that poverty during childhood may lead to higher vigilance for threat cues in the environment that persists into adulthood. Due to the amygdala's involvement in processing emotion and the fear response, this structure is an important component in the development of anxiety disorders. For instance, both structural and functional differences in the amygdala have been found for youth and adults experiencing anxiety disorders (Martin et al., 2009). Overall, elevated cortisol levels in early childhood have negative implications for school success due to the impact of cortisol on cognitive and emotional functioning.

### **Environmental Chaos**

Chaotic environments are characterized by high levels of noise, crowding, instability, lack of routines, and lack of structure and predictability (Evans & Wachs, 2010). Chaos can occur in any of the bioecological spheres and can impact development direct or indirectly. For instance, instability of school personnel or teachers throughout a school year can engender chaos within the microsystem of the school environment (Evans & Wachs, 2010). Housing

policies or community planning can influence neighborhood-level chaos (Brooks-Gunn et al., 2010). War or political upheaval can cause chaotic circumstances, including for refugees (Lustig, 2010). On a broader scale, changes in cultural customs or societal institutions can engender chaotic circumstances (Lichter & Wetherington, 2010).

The home environment is a potent microsystem due to children spending the majority of their time in this setting. Household chaos refers to a lack of stability in the home, noise, lack of routine and structure, and frequent coming and going of people in the home (Matheny et al., 1995). Two major factors that are encompassed under home chaos are turbulence and disorder (Brooks-Gunn et al., 2010; Wachs & Evans, 2010). Turbulence describes lack of stability in settings, lack of stability in relationships, and unpredictable routines, while disorder refers to high levels of noise, crowding, clutter, and lacking structure (Brooks-Gunn et al., 2010). In homes with high levels of chaos there are typically less structure and fewer routines, such as not eating dinner together as a family and children lacking a consistent bedtime (Fiese & Winter, 2010). There also may be a lack in stability of who lives in the home and loud noise due to overcrowding (Wachs & Evans, 2010).

### **Chaos and Child Development**

Chaotic household environments negatively influence child development both directly and indirectly. In terms of direct effects, high levels of noise and stimulation are inherently stressful to the developing organism (Evans, 2006). In terms of indirect effects, chaos may influence development via parenting practices (Fiese & Winter, 2010). Research has suggested that parents in chaotic homes are less likely to be responsive and involved with their children and are less likely to promote their children's exploration (Whitesell et al., 2015). Via both direct and indirect pathways, chaotic household environments overburden

physiological stress response systems, and disrupt children's development of self-regulation and self-efficacy (Ackerman & Brown, 2010).

Effects of household chaos on child development are apparent even with controls for parental SES (Vernon-Feagans et al., 2012). This finding suggests that household chaos predicts development over and above the effects of socioeconomic status. However, it is also the case that household chaos is more likely to occur in families facing economic hardship due to increased risk of experiencing social and physical stressors that comprise aspects of chaotic environments (Evans et al., 2010). For instance, families living in poverty are more likely to experience crowding and higher levels of noise in their homes. Families facing economic hardship also may experience frequent home and school relocations (Evans et al., 2010). The impact of chaos on cortisol may help to explain certain negative effects of poverty on child development.

### **Chaos and Cortisol for Children Facing Economic Hardship**

Evidence to date suggests that one of the pathways via which poverty influences child development is via its role in engendering chaotic household environments which are stressful for children and influence HPA functioning, as well as brain development and functioning. Yet studies on chaos and cortisol for young children are limited, and the nature of this relationship for children facing economic hardship is not entirely clear. Most young children in poverty show hypercortisolism, with elevated cortisol at baseline and in response to challenge, but a subset who have faced chronic stress or acute trauma show hypocortisolism. For example, Koss et al. (2016) found that children who were adopted from an institution or orphanage were more likely to exhibit signs of hypocortisolism, as shown by a blunted cortisol response to a stressful task, lower morning cortisol levels and a flatter slope during the day.

Koss et al. (2014) also found that toddlers recently adopted internationally in institutional care with less social care and more deprivation exhibited a flatter decline across the day compared to children who received higher social care. This is consistent with the attenuation hypothesis or the idea that early and chronic overactivation of the HPA system might eventually lead to desensitization (Roisman et al., 2009). What is not entirely clear is whether household chaos for young children in poverty is best characterized as a mild, repeated stressor that would be associated with high cortisol levels or as a chronic form of stress that would manifest as depressed cortisol even in early childhood.

Evidence to date is clear in terms of the detrimental effect of environmental chaos on HPA functioning but inconclusive in terms of the nature of this relationship for young children facing economic hardship. Some studies have found a positive relationship between chaos and cortisol, such that increased chaos is related to increased cortisol levels, at least at certain timepoints. Blair et al. (2013) have documented that aspects of cumulative poverty risk, including certain forms of home chaos, relate to a higher level of cortisol and a flatter trajectory of cortisol for children ages 7, 15, and 24 months, across an interval of ninety minutes beginning prior to an emotion-inducing task, and including two sampling periods after the task. These findings were replicated with children at 48 months of age (Blair et al., 2013). This is consistent with some of the evidence for children in middle childhood. Evans and colleagues (2007), for example, found that for 7<sup>th</sup> and 8<sup>th</sup> grade children, physical and psychosocial turmoil related to high allostatic load, including cortisol elevations as measured by overnight urinary cortisol. But when cortisol trajectories across the day are measured, the findings are particularly complicated. A longitudinal study of youth ranging in age from 9 to 18, found that family chaos was predictive of greater increases in cortisol output across the

day over a two-year period for children in the lower SES group (Chen et al., 2010). Yet in a different longitudinal study, Doom and colleagues found that the level of household chaos experienced by children from low-income families during the preschool years in Head Start predicted a more blunted cortisol slope across three samples throughout the day, around 8:00AM, 4:00PM and before bedtime between 7:30-9:30PM, in middle childhood. The findings of these two longitudinal studies are not necessarily inconsistent; blunted cortisol does not necessarily mean lower cortisol. Both studies suggest that poverty exposure can lead to change over time in the daily cortisol trajectory and leave questions unanswered about what different levels of chaotic living conditions might mean for the diurnal cortisol trajectory in young children.

To my knowledge, just one study has examined household chaos in relation to the trajectory of young children's cortisol across the preschool day. This study out of our lab examined a standard measure of household chaos along with other indicators of instability and poverty risk. A hierarchical linear regression with piecewise latent growth curve modeling showed that the standard, parent-report measure of chaos in terms of household noise and routines (Matheny et al., 1995) related to higher levels of morning cortisol whereas another indicator of family instability, changes in persons living in the home, related to less of a steep decline in cortisol from midmorning to noon (Brown et al., 2021). A potential interpretation considered was blunted cortisol change across the day for children who have faced a number of changes in where and with whom they live. This would be consistent with the attenuation hypothesis (Susman, 2006). This study, however, focused on issues of cumulative versus individual indicators of risk and did not probe the possibility that different levels of household chaos might be linked to different cortisol trajectories across the preschool day.

Understanding the impact of household chaos on children's cortisol in preschool context matters particularly, given the importance of this setting for their development of school readiness skills. The current study seeks to add to this by investigating chaos in the home using the standard parent-report measure of chaos in terms of household noise and routines and comparing high versus low household chaos groups. Notably, preschool context also influences cortisol levels, and the impact of this setting on HPA functioning for children facing economic hardship is not entirely clear either.

### **Children's Cortisol in Preschool Settings**

In contrast to the typical decreases in cortisol levels across the day, research has established that children in daycare and preschool settings tend to show increases in cortisol levels from midmorning through midafternoon (Vermeer & van IJzendoorn, 2006). This suggests that children in early childhood educational settings experience increased stress levels while away from home and caregivers, possibly due to the social challenges in a preschool setting. Increased cortisol when facing social challenges can serve an adaptive function, but there are questions about the impact of repeated elevations. Roisman et al. (2009), for example, found that children who experienced low levels of maternal sensitivity and spent more time in childcare during their first three years of life had lower cortisol awakening responses in adolescence, which suggests a potential tax of repeated exposure to the stress of childcare.

Literature is mixed regarding whether the quality of childcare impacts cortisol throughout the preschool day (Hartman et al., 2016; Roisman et al., 2009). Quality daycare settings are those that include process quality and structural quality. Process quality includes relationships and interactions with caregivers in preschool setting and quality of educational

play (Hartman et al., 2016). Structural quality involves factors such as teacher-child ratio, class and group sizes, and quality of education and training received by the teachers (Hartman et al., 2016). In a meta-analysis on stress and daycare for young children, there was a larger effect size for children in lower quality preschool settings, suggesting that cortisol increases at daycare might be more likely in lower quality preschool settings (Geoffroy et al., 2006). However, findings like those by Roisman et al. (2009) challenge the idea that quality has a meaningful impact on the overall pattern of cortisol response to childcare. Moreover, even studies that have focused on high quality preschools, a small rise in cortisol is observed in children at preschool, suggesting that the rise in cortisol may be adaptive to help meet challenges in an early educational setting (Watanabe et al., 2009). Interestingly, only a small number of studies to date have focused on Head Start preschool or other programs serving children facing economic hardship, and some extant evidence suggests that patterns of cortisol in preschool may be different for this subgroup of children.

### **Head Start**

Head Start programs provide high quality early childhood education and care to families facing economic hardship, who otherwise may not be able to access quality childcare. Head Start preschool is designed to promote school readiness for children from families facing economic hardship (Office of Head Start, 2020). Head Start programs aim to support children's growth by facilitating early learning and development, health monitoring, and fostering family wellbeing (Office of Head Start, 2020). Head Start has been found to be associated with higher cognitive abilities and academic achievement in children (Shager et al., 2013). Children in Head Start show additional gains in social-emotional development



(Aikens et al., 2013). This finding underscores the importance of early intervention for populations facing disproportionate risk.

### **Cortisol in Head Start Children**

It is important to investigate whether previous findings related to cortisol in early childhood generalize to children who attend Head Start, particularly given that this population faces high rates of poverty-related stressors. In a study comparing Head Start preschool children's cortisol levels at home, in half-day preschool, and full-day preschool, Lumian et al. (2016) found that children enrolled in greater preschool hours were more likely to show a flat or rising cortisol level during the day. Moreover, children's cortisol levels were more likely to be rising or have a flat trajectory on days they were in preschool. Another study with Head Start children documented a sharp decrease from initial morning cortisol levels to midmorning cortisol levels, followed by a gradual increase in cortisol from midmorning to afternoon (Brown et al., 2017). This finding is in line with previous research suggesting that preschool children exhibit increases in cortisol while in early childhood education settings (Vermeer & van IJzendoorn, 2006). Yet other research has suggested that the pattern of cortisol in preschool may differ for children at high risk due to poverty. For instance, Rappolt-Schlichtmann et al. (2009) found that children facing economic hardship who attended a high quality early childhood education center had decreasing cortisol levels across the day while in childcare. This finding highlights the need for further investigation to understand the trajectory of cortisol across the day for children facing economic hardship, and how poverty-related risks such as levels of household chaos might moderate this trajectory.

There are few studies that investigate the trajectory of cortisol levels throughout the preschool day in children attending Head Start. Previous studies have investigated cortisol

levels for preschool age children from low-income families, but few have exclusively used Head Start children as participants or compared Head Start children with other childcare settings. The Head Start population includes young children who are from low-income families and have access to a high quality preschool education, two factors that previous research have been found to impact the relationship between cortisol, poverty, and cognitive outcomes in children. Head Start programs aim to provide a high quality education to economically disadvantaged families, thus it is important to specifically investigate cortisol in children in Head Start because particular patterns of cortisol could facilitate or constrain the possibilities for promoting children's school readiness.

The present study aims to add to research on cortisol in Head Start preschool for children facing economic hardship. Investigating cortisol levels in Head Start preschool children is important due to the impact of the HPA system on cognitive, social, and emotional outcomes. Previous findings have suggested that cortisol influences executive functioning abilities, with implications for children's learning (Blair et al., 2011; Wagner et al., 2016). Understanding whether cortisol levels in Head Start children follow a pattern of increasing cortisol or decreasing cortisol trend throughout the day will provide insight into HPA system regulation for this population. This is important because it can inform early intervention strategies to target children's cognitive and emotional regulation in preschool, and specifically in Head Start preschool, which is our nation's key model for early childhood education for children facing economic hardship.

### **Environmental Chaos and Cortisol in Head Start**

Previous research looking at differences in cortisol levels based on environmental risk factors in children facing economic hardship have found mixed results. In one study,

preschool children from low-income households who had lower morning cortisol levels and higher cumulative risks showed a flatter diurnal cortisol slope during the day (Zalewski et al., 2012). Another study found that for children with lower levels of environmental risk, a greater number of hours in daycare at 7 and 36 months of age was linked with higher levels of cortisol at 48 months of age (Berry et al., 2014). Yet for children with higher levels of environmental risk, more hours in childcare was linked with lower cortisol levels at 48 months (Berry et al., 2014). This suggests that for children with higher levels of environmental risks, childcare may serve as a protective factor.

Few studies have specifically investigated household chaos in Head Start children. Bobbitt et al. (2016) found that higher household chaos was linked with decreased social emotional skills in Head Start children, suggesting that household chaos negatively impacts social emotional outcomes. However, this study did not investigate the role of cortisol in these findings. To my knowledge only two studies out of our lab have examined the relation between household chaos and cortisol in Head Start children. Both of these studies (Brown et al. 2019 and 2021) found that higher household chaos predicted higher morning cortisol levels in a sample of Head Start preschool children. The issue of whether children who come from homes with differing levels of home chaos are likely to have different trajectories of cortisol throughout the day when at preschool remains unclear.

### **Summary of Gaps in Research on Chaos and Cortisol for Young Children in Poverty**

Research has demonstrated meaningful links between poverty, cortisol, and child developmental outcomes, and has identified various moderating and mediating factors. It is known that greater cumulative environmental and psychosocial risks related to poverty, tend to be associated with dysfunction of the HPA system and negative outcomes related to

learning (Evans et al., 2007). The current research on chaos and cortisol levels has identified that there is a relationship between chaos and cortisol, such that higher chaotic environments tend to be associated with dysregulation of the HPA system (Evans and Wachs, 2010). However, it is not clear whether high levels of household chaos might be linked to high levels of cortisol (hypercortisolism) or low levels (hypocortisolism) for young children facing economic hardship, and, specifically, it is not clear what pattern of cortisol these children might show across a day of Head Start preschool. It is important to gain further insight into this because of the different implications of high and low cortisol for learning outcomes (Vedhara et al., 2000) and social-emotional functioning (Perry et al., 2019), and because of the potentially different interventions that might be implemented, depending on the type of cortisol dysregulation.

### **Present Study**

The present study aims are to add to the emergent literature on home chaos and cortisol levels by examining the trajectory of cortisol across the preschool day for children in Head Start and examining home chaos as a potential predictor of morning cortisol levels and moderator of the relation between cortisol and time of day. Few studies have examined the trajectory of cortisol throughout the day in preschool aged children, and none I know of have specifically examined this trajectory for children with high versus low levels of household chaos.

The present study utilized a within- and between-persons correlational design. The first within-persons component focused on the relation between time of day and cortisol level. Between-persons components focused on the relation between chaos and cortisol and on potential covariates of child birth-assigned sex, race/ethnicity, and family poverty status. The

first aim of the present study was to examine the trajectory of cortisol across the preschool day. Cortisol was measured at preschool arrival or early morning (9am), midmorning, noon, and midafternoon. The relation between time-of-day and cortisol level were examined. I hypothesized that, on average, cortisol would peak in the morning (*Hypothesis 1*), decrease sharply to midmorning (*Hypothesis 2*), and then increase slightly from midmorning through midafternoon (*Hypothesis 3*). Previous research investigating cortisol levels throughout the day in preschool and daycare settings have found that the trajectory of cortisol tends to increase from midmorning to midafternoon when children are in early childhood care settings away from their primary caregivers (Vermeer & van IJzendoorn, 2006), and multiple studies have documented this pattern for children in Head Start preschool (e.g., Brown et al., 2016; Brown et al., 2021).

The second aim was to examine the relationship between home chaos and morning cortisol. Home chaos was measured by a standard parent questionnaire (Matheny et al., 1995). Home chaos was transformed into a dichotomous indicator of risk, with scores falling 1 SD above the mean coded as “high chaos” or presence of risk for this variable. I hypothesized that home chaos would statistically predict cortisol levels in the morning (*Hypothesis 4*) and, specifically, that higher home chaos would relate to higher cortisol levels in the morning (*Hypothesis 5*).

The third aim examined the relationship between chaos and the trajectory of cortisol across the preschool day. I hypothesized that chaos would moderate the impact of time of day on cortisol (*Hypothesis 6*). A more specific exploratory hypothesis was that children who came from homes characterized as low chaos would show an increase in cortisol from midmorning to midafternoon while at preschool and that those who came from homes

characterized as high chaos home would show decreases in cortisol across this time period at preschool (*Hypothesis 7*). Understanding the impact of chaos on cortisol levels and the trajectory of cortisol levels could provide additional insight into processes that influence cognitive and social-emotional development for children in preschool and inform future interventions to increase school readiness for children at risk via poverty. A final set of hypotheses were offered related to the impact of poverty on cortisol. It was hypothesized that income would moderate the impact of time of day on cortisol (**Hypothesis 8**). Specifically, it was hypothesized that, within this economically disadvantaged sample, children experiencing higher levels of economic hardship (i.e., below the poverty threshold) would show decreases in cortisol across the period spanning midmorning to midafternoon during the preschool day (**Hypothesis 9**). Given evidence that both age and race/ethnicity influence cortisol levels (Gunnar et al., 2022), the present study includes controls for child age as well as BIPOC status, which serves in this study as a proxy for the impact of systemic racism.

## Chapter 3: Method

### Participants

Participants were 288 children and their primary caregivers who were enrolled in a broader study of poverty and child development from 2008-2012. The sample used in the present study was also utilized in a previously published study, Brown et al., (2021). As such, some of the descriptives and preliminary statistics were previously published as part of that paper. The children attended a Head Start preschool in Philadelphia, PA that was selected due to geographic proximity and the preschool's interest in research collaboration. All children who attended the Head Start preschool for a full day were eligible to participate. This excluded a subsample of children who attended special education programs in the afternoon. Children ranged in age from 3 to 5 years old and the average age was 4 years old. The mean age of the children was 4 years 1 month old ( $SD=6.71$  months). In terms of demographics, 52% of children were female, 55% were Black or African American, 15% were Latinx or Hispanic American, 10% Asian American, and 20% were White or European American. The mean family size was two adults (range =1-6,  $SD=0.83$ ) and three children (range=1-7,  $SD=1.2$ ). The primary caregivers were biological mothers, biological fathers, and biological grandmothers. About 30% of children represented the first generation in their family born in the United States. In terms of language, 68% were monolingual English language learners, and 32% were dual language learners, with Spanish being the most common language (15% of sample). The mean family annual income was \$12,638 (range = 0-50,000,  $SD=11,959$ ). The income-to-needs ratio for all children was calculated, with 80% of families classified as poor and 94% low-income.

## **Procedure**

The present study was approved by the appropriate institutional review boards (IRBs). Recruitment took place at the time of Head Start enrollment or at pickup and drop offs at the start of the year, at which points trained research assistants provided parents with information about the study and gave them the opportunity to sign informed consent. At the same times or via telephone follow up, parents were given opportunities to schedule interviews about their family circumstances. Trained research assistants conducted these 1hr interviews in person at the preschool or by telephone during September and October, and parents' received token compensation (a \$20 gift card) for their participation. Information about family demographics and household chaos was collected as part of these interviews.

Child cortisol was measured via salivary assay. Trained research assistants sampled children's saliva at four time points across the preschool day (9:00AM, 10:30AM, 12:00PM, and 1:30PM) on six days throughout the school year. Cortisol samples were taken on two days at the beginning of the school year in September, two days in the middle of the year in January, and two days at the end of the school year in June. Cortisol levels were lowest at the last time point collection in June, which likely reflects the children's increase in comfort level and acclimation to school and to the saliva collection procedure (Table 1). Children were randomly assigned to a schedule of cortisol assessment based on preschool class and those who were absent on the day of sampling, or whose parents reported potential interference from food or medication, were rescheduled for the same day of the week on the following week.

## **Materials**



### ***Demographic Interview***

As part of the family circumstances interview, parents or caregivers completed a demographic interview for caregivers (Ackerman et al., 2004) which includes standard demographic information including about the child's family size, family income, birth-assigned sex, race/ethnicity, and age. Information about income was combined with information about family size and compared to federal poverty guidelines for the appropriate year to determine an income-to-needs ratio. A ratio of 1.0 represents the poverty line and 2.0 represents the threshold for economic disadvantage. This has been found to be a reliable measure of income and has shown a test-retest reliability of .80 in a sample of low-income families with young children (Newland et al., 2013). For the present study, Income was transformed into a dichotomous variable where 1=poor, and 0= low income or near low income.

Information about race/ethnicity was used to create a dichotomous variable with Black, Indigenous, or Person of Color or BIPOC status, which proxied for the impact of systemic racism, scored as a 1, and White or European Heritage scored as a 0.

### ***Household Chaos***

Parents or caregivers also completed a standard measure of household chaos, the Chaos, Hubbub, and Order Scale (CHAOS; Matheny et al., 1995). The measure contains 15 statements that the parent identifies as true or false for their home. An example of an item in the measure is "You can't hear yourself think in our home." Answers that indicate chaos in the home are scored as 1 and those that do not are scored as 0. The scores are summed in order to obtain an overall score. The ranges of scores are 0-15, with 0 indicating no chaos and 15

indicating the highest level of chaos. The CHAOS scale shows concurrent validity with observations by trained observers of the physical and social environment in the home (Matheny et al., 1995). This scale has acceptable test-retest reliability of .74 across an interval of 12 months and demonstrates good internal validity, with reported Cronbach's alpha=.79 (Matheny et al., 1995). In the present study scores range from 0-15, with a mean of 3.44 ( $SD = 2.56$ ) and Cronbach's alpha = .79 Household chaos was transformed into a dichotomous variable using a mean split, with above the mean coded as 1 and indicating high home chaos and below the mean was coded as 0 or low chaos.

### ***Cortisol***

Child salivary cortisol was collected on six preschool days across the preschool year. Samples were collected on two days in September, two days in December, and two days in June. Samples were collected at four time points throughout the day (9:00AM, 10:30AM, 12:00PM, and 1:30PM). Trained research assistants asked children to hold a swab under their tongue for about one minute to collect saliva. The swabs were checked by research assistants to ensure saturation and sampling was repeated if necessary. Saturated swabs were placed in conical tubes and stored at  $-20^{\circ}$  C to prevent sample degradation until they were assayed in duplicate for cortisol concentration using an ELISA kit (Salimetrics, LLC, State College, PA). The test uses  $25\mu l$  of saliva. It has a lower limit of sensitivity of  $.007mg/dl$ . The assay range is  $0.012-3\mu g/dl$ . The average of the duplicate assays was used, with a standard criterion of no more than 7% error in agreement (Schwartz et al., 1998). In accordance with standard procedure, we set an exclusion criterion of  $> 10.0$  for raw cortisol values.

### **Analytic Plan**

The analytic plan included two stages of analysis. First, descriptive statistics were provided for all variables of interest, including raw cortisol values. A log transformation of these raw cortisol values was applied and descriptive statistics for the log values examined. In accordance with the first three hypotheses, I expected that cortisol would peak in the morning (*Hypothesis 1*), decrease sharply to midmorning (*Hypothesis 2*), and then increase slightly from midmorning through preschool departure (*Hypothesis 3*).

Second, a hierarchical linear model (HLM) was used to examine the within-persons relation between cortisol and time-of-day, and to examine household chaos as a potential between-persons moderator of this relationship, along with appropriate demographic covariates. It was expected that home chaos would statistically predict cortisol levels in the morning (*Hypothesis 4*). In particular, higher home chaos was expected to relate to higher cortisol levels in the morning (*Hypothesis 5*). It was expected that chaos would moderate the impact of time of day on cortisol (*Hypothesis 6*). Specifically, an exploratory expectation was that children who came from homes characterized as low chaos would show an increase in cortisol from midmorning to midafternoon while at preschool and that those who came from homes characterized as high chaos home would show decreases in cortisol across this time period at preschool (*Hypothesis 7*). Poverty status was expected to moderate the impact of time of day on cortisol (*Hypothesis 8*). Specifically, it was expected that children living in poverty (compared with those in low-income households, defined as < 2X the threshold for poverty) would show decreases in cortisol across the midmorning to midafternoon portion of the day (*Hypothesis 9*).

## Chapter 4: Results

### Preliminary Analyses

Mean raw cortisol measured in micrograms per deciliter ( $N=6,908$  observations from 288 participants) was 0.18 ( $SD=0.34$ ) and log cortisol was  $-.87$  ( $SD=0.28$ ). Table 2 displays mean raw and log cortisol values at each time of day, overall and by high versus low chaos status (see also Figure 1). The log transformation was applied to correct for positive skew in cortisol values, which is in line with standard procedures (Blair et al., 2011). As such, log cortisol was used in subsequent analyses. The within-persons variance of log cortisol was 0.07 and the between persons variance of log cortisol was 0.01, which results in an interclass correlation coefficient of .13. This indicates that 13% of the total variability in log cortisol comes from children differing from each other in average levels of log cortisol. Pearson correlations among demographic and predictor variables of interest indicated no statistically significant relations at a zero-order level (Table 3). Notably, because cortisol observations were nested within persons, cortisol was not included in the zero-order correlational analysis but rather examined in core analyses using more sophisticated models that could account for within- and between-persons variation.

Piecewise latent growth curve modeling was used to model children's average trajectories of cortisol across the school day. Piecewise latent growth curve modeling is standard for accounting for the impact of time of day on cortisol (Gunnar & Adam, 2012). As indicated by the means displayed in Table 2, there was a sharp decrease in log cortisol from the initial morning cortisol sample to the midmorning sample. Second there was a more gradual increase in log cortisol from midmorning to early afternoon. Piecewise latent growth curve modeling was used to allow the shape of change within each of these phases to differ

based on change parameters estimated for each piece to capture the appropriate functional form of change. Linear change adequately captured the decreasing pattern from early to midmorning (Piece 1) and the increasing pattern from midmorning into early afternoon (Piece 2).

### **Core Analyses**

Hierarchical Linear Modeling was used for the primary analyses. Cortisol samples at the four time points across the day were nested within children. HLM meets the missing at random (MAR) assumption and employs case-wise deletion to handle missing data by using the full maximum likelihood for estimation of parameters. MAR is the probability that a missing cortisol score at a particular time point may be related to cortisol scores from a previous time point and to demographic predictors, but not to the missing cortisol scores at that particular time point.

Piecewise latent growth curve modeling was used to analyze the dependent variable of cortisol at midmorning, noon, and afternoon time points as a function of a linear functional form of time, as well as for poverty and household chaos. In the linear model, the  $i^{\text{th}}$  cortisol sample was nested within the  $j^{\text{th}}$  child. Based on the results of the preliminary analysis, cortisol's trajectory was modeled in two pieces: the first piece (Piece 1<sub>ij</sub>) is cortisol's trajectory from the first (9:00am) time point measurement to the second (10:30am) time point measurement. The second piece (Piece 2<sub>ij</sub>) is cortisol's trajectory across the second, third (12:00pm), and fourth (1:30pm) measurements. The complete level 1 equation was:

$$LOGCORT_{ij} = \beta_{0j} + \beta_{1j}*(PIECE1_{ij}) + \beta_{2j}*(PIECE2_{ij}) + r_{ij}$$

In this equation,  $\beta_{0j}$  represents the values of cortisol at the intercept, or 9 a.m. morning baseline,  $\beta_{1j}$  (Piece 1<sub>ij</sub>) corresponds to trajectory of cortisol from 9 a.m. to 10:30 a.m., and  $\beta_{2j}$  (Piece 2<sub>ij</sub>) is the trajectory of cortisol from 10:30 a.m. to 1:30 p.m. For each term in the Level-1 equation, there was a corresponding Level-2 equation. For  $\beta_{0j}$  the Level-2 equation was as follows:

$$\begin{aligned}\beta_{0j} &= \gamma_{00} + \gamma_{01}*(BIPOC_j) + \gamma_{02}*(AGE_j) + \gamma_{03}*(POOR_j) + \gamma_{04}*(CHAOS_j) + u_{0j} \\ \beta_{1j} &= \gamma_{10} + \gamma_{11}*(BIPOC_j) + \gamma_{12}*(AGE_j) + \gamma_{13}*(POOR_j) + \gamma_{14}*(CHAOS_j) \\ \beta_{2j} &= \gamma_{20} + \gamma_{21}*(BIPOC_j) + \gamma_{22}*(AGE_j) + \gamma_{23}*(POOR_j) + \gamma_{24}*(CHAOS_j)\end{aligned}$$

The Level-2 equations included Level-2 parameter estimates related with Pieces 1 and 2. Prior to analysis, the variable *age* was centered around the grand mean and Pieces 1 and 2 were centered around the group mean. Table 4 displays the estimates for the hierarchical linear model, with the cortisol samples nested within children. For the level-1 intercept ( $B_{0j}$ ), higher levels of household chaos ( $B=0.041149, p=0.003$ ) and BIPOC status ( $B=-0.051917, p=0.001$ ) statistically predicted higher cortisol at 9:00am. This was followed by a statistically significant decline in cortisol levels from 9:00 to 10:30am, which was indicated by the intercept for the first piece of the Level-1 slope ( $y_{10}$  of  $B_{1j}$ ,  $B=-0.135303, p<0.001$ ). Higher levels of household chaos ( $B=-.037487, p=0.022$ ) and BIPOC status ( $B=-.080598, p<0.001$ ) were associated with a steeper decline in cortisol during this time. Additionally, children living in poverty (as compared with those in low-income households) also had a statistically significant steeper decline in cortisol from 9:00am to 10:30am. ( $B=-.044265, p=0.031$ ). The second portion of cortisol's trajectory from 10:30am to 1:30pm was indicated by a non-significant increase in cortisol levels, which was accounted for by the second piece of the Level-1 slope ( $y_{20}$  of  $B_{2j}$ ,  $B=0.009136, p=.478$ ). Children who lived in poverty had a

statistically steeper slope of cortisol over the afternoon ( $B=0.026215$ ,  $p=0.014$ ). Household chaos and BIPOC status did not statistically change the direction of the cortisol trajectory across the afternoon.

### **Post Hoc Analyses**

Because descriptive analyses indicated that cortisol levels diverged from time point 3 (12:00pm) to time point 4 (1:30pm) based on chaos level (see Table 1 and Figure 1), we also tested a model that included three pieces rather than two to capture the cortisol trajectory. Despite cortisol levels at 1:30pm differing between high and low chaos, the model based on three pieces provided results that were meaningfully the same as the model based on two pieces: there was no evidence that chaos statistically moderated the slope of cortisol trajectory for any portion of the time between midmorning and midafternoon.

## Chapter 5: Discussion

The present study investigated the relationship between household chaos and cortisol in children attending Head Start preschool, with goals of enhancing understanding of risk associated with poverty and informing policies and early intervention programs for children facing economic hardship. The first aim of this study was to examine the trajectory of cortisol throughout the preschool day. The second aim was to investigate the relationship between home chaos and morning cortisol levels. Finally, the third aim examined the relationship between household chaos and the trajectory of cortisol across the preschool day. Understanding the impact of poverty and related stressors such as household chaos can inform programming and interventions in early childhood education settings such as Head Start.

Household chaos was measured by the CHAOS scale, which is a standardized measure of home chaos that has been used in previous studies (Matheny et al., 1995). In the current study parent reports of home chaos ranged from 0-15, indicating that some families reported the lowest level of chaos, while others indicate the highest level of chaos. However, the mean chaos reported was 3.44 ( $SD=2.56$ ), which suggests that the majority of families indicated a level of chaos that fell well below the median. In Matheny et al. (1995) the mean CHAOS score was 3.37 ( $SD=2.64$ ), which is similar to the reported mean and standard deviation in the current sample. In Matheny and colleagues (1995) the average age was 16 months and the sample was primarily White or European Heritage, which differs from the present study. Although, demographics of the current sample and sample from Matheny and colleagues' (1995) study differ in terms of age and ethnicity, both samples reported similar levels of household chaos.



Overall children's cortisol levels were highest at the early morning time point or start of the preschool day (consistent with hypothesis 1) and this peak was followed by a steep decline to midmorning cortisol collection (consistent with hypothesis 2). Following this, there was a slight increase from midmorning to midafternoon, which was consistent with hypothesis 3. This is in line with previous studies of cortisol levels in children in preschool settings which have documented slight increases in cortisol from midmorning to midafternoon. The slight increase in cortisol during the preschool day is thought to reflect a child's experiences of greater social challenges encountered during the school day, compared to a typical day in a child's home setting (Vermeer & van IJzendoorn, 2006). Few studies have investigated cortisol levels in a Head Start preschool population. The current study therefore contributes to the literature by suggesting that children in Head Start preschool have a similar cortisol trajectory as children in preschools with children from households above the threshold for poverty or low-income status. Although children in Head Start programs typically come from households facing economic hardship and therefore experience poverty related stressors, the overall trajectory of cortisol appears to be similar to that of preschool children who do not experience these hardships. It is possible that the social challenges and stressors experienced by Head Start preschool children in the school setting influence cortisol's trajectory similarly to children who come from middle income homes, despite varying initial morning cortisol levels. In other words, although cortisol levels may differ throughout the day based on poverty related stressors, the overall trajectory and pattern during the preschool day remains roughly the same.

## **Household Chaos and Cortisol**

Results indicated differences in initial cortisol levels between children who came from homes characterized as high chaos versus low chaos, and this was consistent with hypotheses 4 and 5. Children whose parents indicated a higher level of home chaos had a higher early morning cortisol level compared to children with lower levels of home chaos. Chaotic living environments may lead to higher resting cortisol levels at the start of the day. Moreover, it is likely that chaos impacts a family's morning routine before children arrive at preschool. The disorganization and lack of routine that may be more common for families reporting higher home chaos may be reflected in higher cortisol levels upon arrival at preschool. Such levels could represent a combination of basal cortisol and the response to the challenge of morning chaos that might be imposed on the baseline.

Results also indicated a steeper decrease in cortisol levels from initial morning to midmorning cortisol collection for children experiencing higher levels of chaos. This may suggest that children who come from more disorganized and chaotic homes may experience some sense of relief at the physiological level as they settle into their routines during the preschool day. This is in line with previous findings suggesting that family routines and structure are associated with positive socioemotional development in young children (Spagnola & Fiese, 2007). Notably, the higher morning cortisol levels at the start of the preschool day also "allow for" the steeper decline in cortisol trajectory for children who come from homes with higher levels of home chaos, whereas there is less change across the morning possible for children from lower chaos homes who start the preschool day with lower cortisol levels.

In terms of the impact of home chaos on cortisol levels across further portions of the preschool day, descriptive statistics that did not account for covariates suggested that children who came from houses characterized as high home chaos had a slight increase in cortisol in the afternoon from 12:00pm to 1:30pm, whereas children from low home chaos had a slight decrease. One possible explanation for the slight increase in the afternoon could be that children coming from homes with high chaos might be experiencing anticipatory stress related to their return to the home environment. However, in the hierarchical linear model that accounted for not only time of day and chaos status but also covariates of child age, BIPOC status, and poverty status, there was no evidence of statistical differences in cortisol trajectories from midmorning to midafternoon between children from high and low chaos homes. In other words, even children who came from high chaos homes experienced an increase in cortisol during the afternoon hours in preschool. This was an unexpected finding, as some previous literature has suggested that for children experiencing higher levels of poverty related stressors, preschool may serve as a protective factor, and that these children might experience stress relief in preschool rather than cortisol elevations (Berry et al., 2014). Nonetheless, the pattern of the cortisol trajectory found in the present study is in line with previous findings of cortisol trajectories for children in preschool (Vermeer & van IJzendoorn, 2006), and some research (e.g., Roisman et al., 2009) has suggested that early childhood educational contexts place an overall tax on children's HPA functioning, regardless of poverty risks.

With this in mind, there are multiple possible explanations for the present results. One is that the level of stressors experienced by this sample of children who indicated high home chaos, may not be high enough to burden the HPA axis such that children would experience

relief across the midmorning to midafternoon portion of the preschool day. It is possible that a higher level of chaos or cumulative risk at home (Berry et al., 2014) would be associated with decreasing cortisol levels across the afternoon in preschool context. This would be one explanation for Berry and colleagues (2014) findings that for children facing high risk, a greater number of hours in childcare in early years was linked to lower cortisol at 48 months.

Another explanation for the present results, however, would be that children are experiencing an HPA axis toll related to preschool context, even as they may be gaining other benefits from their preschool experience. Indeed, the study by Berry's team did not measure cortisol within preschool context and therefore is not directly comparable to the present study. Berry and colleagues' (2014) findings could be explained by the fact that, notwithstanding a physiological tax imposed by preschool context, children facing high levels of cumulative risk at home (and therefore who already have high cortisol levels) acquire other benefits from early childhood care (such as emotion regulation strategies) that might benefit their ability to regulate stress over time. Further research will be important for clarifying the benefits versus taxes of early childhood educational context for different subgroups of children.

### **Poverty and Cortisol**

Due to the wealth of literature identifying the negative impacts poverty has on development, children who resided in poverty were compared to those residing in low-income households to identify the impacts of poverty versus lesser economic hardship on cortisol. Counter to expectations, poverty status did not show a statistical relation to morning cortisol levels. One possible explanation is that effects of poverty on morning cortisol could be mediated by household chaos; a possibility we did not statistically evaluate. Another possibility is that the restricted range for income limited relations for this variable. The

relations that would be expected within a heterogeneous income sample might not be apparent within a sample facing economic hardship. A further possibility that is related to both of the prior ones is that, within families facing economic hardship, the advantages of a marginal increase in income associated with a parent working may be offset by disadvantages in terms of the parent's ability to spend quality time with a child or provide or by the chaos associated with variable parental work schedules. Future studies might include heterogeneous income samples as well as test the extent to which chaotic home living conditions mediate effects of income poverty on child stress levels. Similar to the findings for household chaos, poverty status was associated with a steeper decrease from morning cortisol to midmorning cortisol time points, again, suggesting the preschool environment might provide some physiological relief. Poverty status relative to economic hardship did not relate to a difference in the direction of cortisol trajectory in the afternoon. However, children who came from homes categorized as in poverty showed a greater increase in cortisol levels from midmorning to midafternoon. This suggests that children living in poverty may experience greater physiological stress throughout the preschool afternoon compared to children who experience less severe economic hardship. This was counter to hypothesis 9, which was based largely on a prior study that found that children facing economic hardship who attended a high quality early childhood education center had decreasing cortisol levels across a portion of the day while in childcare (Rappolt-Schlichtmann et al., 2009). Yet whereas Rappolt-Schlichtmann and colleagues (2009) studied cortisol across 9:20 to 12:15pm, multiple studies that have studied cortisol across a time period similar to the present study have found increasing cortisol levels even for children facing economic hardship. The slightly different time period studied by Rappolt-Schlichtmann and colleagues (2009) could explain the difference in that team's

research findings. On the other hand, Rappolt-Schlichtmann and colleagues (2009) findings were generally consistent with those identified by Berry and colleagues (2014) in suggesting that children facing greater risk at home might experience less physiological tax from early childhood context, perhaps even finding relief. Future research should further investigate the trajectory of cortisol in preschool aged children living in poverty and investigate the role of income and other poverty related stressors, as well as child and center variables, on cortisol in center-based early childhood educational context.

BIPOC status in children was used as a proxy for systemic racism, which has been demonstrated to place a burden on physiological stress response systems (Muscatell et al., 2022). In the present study, BIPOC children showed a higher morning cortisol level and a steeper decline in cortisol from morning to midmorning. There was no statistical evidence of a difference in the afternoon trajectory of cortisol for BIPOC children compared with their White peers. The present findings generally are in line with previous findings investigating differences on race and cortisol levels in children. Gunnar et al. (2022), for example, found that Black children had higher hair cortisol levels compared to White children, even after controlling for income. This underscores that systemic racism can impact BIPOC children physiologically and calls for the need to address structural inequalities facing children identified as Black, Indigenous, or People of Color.

### **Limitations**

There are various limitations that impacted the present study and are worth noting. It was intentional for the current study to examine household chaos and poverty in a sample of underserved children who attend Head Start. However, the focus on families facing economic hardship was associated with a restricted range for income and likely limited findings for the

impact of poverty. Whereas there are advantages to studying diversity within a sample facing poverty risk, future research also might study the variables of interest to this study in a heterogeneous income sample. Also, although the present sample included mostly BIPOC children, which is a strength given the paucity of research on these children and the risk to HPA functioning posed by systemic racism, the present sample was too small to disaggregate results based on race and ethnicity and future studies might recruit larger samples in order to examine potential differences in relations among poverty, chaos, and cortisol in preschool context for children from different racial and ethnic backgrounds. Also, particularly given the dynamic nature of the HPA axis, future studies might include a wider age range or study children longitudinally, including across the transition to kindergarten.

The present study suffers from typical limitations of correlational designs. The correlations demonstrated in the present study do not imply causation. Each child and family who experiences economic hardship may experience a range of related stressors that have varying levels of impact on the HPA axis. These stressors include aspects of household chaos as well as other variables not measured in the present study such as maternal mental health, parental substance use, and domestic violence (Coe et al., 2020; Lipscomb et al., 2022). Such additional covariates might help to explain relations demonstrated in the present study. Other types of future research may control for additional poverty-related stressors as well as add additional quantitative and qualitative measures related to families' experience of poverty and household chaos.

On a related note, household chaos was measured by using a single parent report measure of chaos (CHAOS; Matheny et al., 1995). Although the CHAOS measure is considered to be valid and reliable, it provides just one perspective on household chaos that

comes from a parent or caregiver. The parent or caregiver may be more likely to minimize household chaos and provide a more positive view of their home. This measure was chosen in the current study due to the feasibility of using a parent report measure and the sound psychometric properties of the measure. However, a more comprehensive picture of home chaos could be accomplished by completing home observations by a trained research assistant. Another method of assessing household chaos is to measure the noise level in the home by recording decibel levels (Andeweg et al., 2022). Future studies may want to include multiple measures of home chaos to obtain a more comprehensive and objective view of chaos in the home. Another aspect of chaos that could be considered is whether the chaos in the home is chronic or a new acute stressor. There may be different physiological responses for children who live in chronically chaotic homes versus homes that are chaotic for a briefer amount of time.

In addition to household chaos, understanding the role of classroom chaos on cortisol trajectories during the preschool day would provide more information on the overall role of environmental chaos on child development, especially given that quality of preschool programs has been found to impact cortisol (Hartman et al., 2016). Future studies may want to incorporate measures of classroom environment such as the Early Childhood Rating Scale (ECERS) in addition to household chaos (Harms et al., 2014).

Another limitation includes the collection time points of cortisol during the day. The trajectory of cortisol begins right after waking and extends throughout the day until it is at the lowest point just before bedtime. The current study utilized four time point collections during the preschool day. However, cortisol was not collected just after awakening, when it would be expected to be at its peak. This time point may have reflected significant differences among



children based on the level of household chaos. Future studies might examine the trajectory of cortisol throughout the day beginning first thing in the morning in order to obtain a fuller picture of cortisol before, during, and after the preschool day.

### **Implications**

The current findings have implications for scientific understanding of the manifestations of cortisol dysregulation for young children facing poverty-related stress, and on early childhood interventions. Cortisol influences brain areas involved in emotion regulation and executive functioning abilities, with an impact on children's overall school readiness (Blair et al., 2011; Wagner et al., 2016). As such, understanding whether children experiencing poverty-related household chaos are likely to manifest dysregulation of the HPA system as hypercortisolism or hypocortisolism matters for optimally designing early interventions for children placed at risk via poverty and household chaos. The implications of the current findings impact multiple stakeholders including parents, clinical practice, Head Start preschools, and policy makers.

In terms of parenting and the role parents play, providing education to parents on the importance on reducing chaos can positively impact child development. Parents can implement routines and structures to their home in an effort to reduce chaos. Due to the role poverty and related stressors such as food insecurity and housing issues play in home chaos, it would be vital to connect families with resources and social supports to assist in obtaining food and stable housing. In particular, poorer housing conditions have been linked to greater chaos in the home, suggesting that helping families to find more adequate housing options can help to decrease home chaos (Deater-Deckard et al., 2009).

The implications for clinical practice are through the therapeutic work of mental health providers who work with young children and the families. In particular, such therapists might provide psychoeducation to families on strategies to implement structure and routine in the home. Clinicians also may target the parent child relationship as means to reduce chaos through the home. One relevant therapy, Parent Child Interaction Therapy (PCIT) is an evidence-based treatment aimed at improving child mental health and behavioral outcomes through the parent child relationship (Thomas & Zimmer-Gembeck, 2007). PCIT involves promoting a child's secure attachment with their primary caregiver through the caregiver learning and applying skills to help the child feel calm and secure in their relationship with their parent or caregiver. Increasing the quality of the parent child relationship may be important for reducing home chaos, as indicated by previous findings on the interrelationship between parenting variables (lack of responsiveness, withdrawal, few positive reactions to children) and chaos in the home (Evans & Wachs, 2010). Another way clinicians can provide psychoeducation to families is on the impact that loud noises can have on child development. For instance, a constant background noise of loud music, constant arguing, or loud television sounds can increase home chaos. Families can be encouraged to have quiet time where loud noises are minimized and to be mindful of keeping loud noises from music and TV at a minimum when their young children are around. Due to home chaos influencing cortisol levels in young children, it would be helpful to include programming that addresses creating a more structured and peaceful family environment.

Head Start preschools provide a high quality education for children who are economically disadvantaged and may not have been able to access such care otherwise. The implications of differences in cortisol levels based on household chaos can inform selection

procedures as well as programming at the preschool. In terms of selection procedures, Head Start is unable to accept all eligible children and prioritizes children who face the highest level of risk based on several indicators related to poverty status. Including a brief screen of home chaos into the intake procedure might help identify children who are most in need of Head Start. Additionally, in terms of the preschool context, Head Start might use reduce the impact of home chaos is by creating a low chaos environment in the school. Ensuring that there is a predictable schedule, structure, routine, stability of staff, and low noise levels are ways preschools can maintain a low chaos environment. Providing professional development to teachers on methods to provide increased emotional support to children can support a lower chaos environment in school. In particular teachers having high levels of warmth, sensitive interactions to the child's emotions, and frequent child initiated activities has been associated with preschool children's decreases in cortisol from the morning into the afternoon during the preschool day (Hatfield et al., 2013).

Programming aimed at reducing stress at the physiological level such as mindfulness or yoga can be implemented first thing in the morning after children arrive and settle into the preschool day. Few studies have investigated the impact of yoga during the school day on cortisol levels. One study found that second graders who participated yoga for 10 weeks decreased in salivary cortisol levels from week 1 to week 10, however, there was no control to compare the experimental group's cortisol levels to (Butzer et al., 2015). Future studies should further explore whether children participating in age-appropriate yoga or mindfulness in the morning of their preschool day impacts cortisol levels for children who are experiencing poverty related stressors. Creative arts interventions also have been demonstrated to reduce

stress levels for preschool children facing economic hardship (Brown et al., 2016) and might be further explored.

At the policy level, household chaos disproportionately impacts economically disadvantaged households, and the present findings underscore the importance of policies that reduce poverty. Policies that work to provide affordable stable housing and higher minimum wages can support efforts to decrease household chaos. Many families who are facing economic hardship come from home with a single working parent, in many cases, a single working mother. For families where the working provider works shift work and has unpredictable hours, it can be difficult for a family to settle into a predictable and stable routine. Many low-income workers may need to pick up extra hours at their position or work overnight shifts, which can further increase chaos in home settings. The lack of affordable housing can lead to large families living in small apartments or homes, as well as multiple families sharing the same dwelling. This living situation perpetuates the likelihood of loud noises and frequent people coming and going in the home. Household chaos is the product of multiple layers and contexts within a child's life, calling the need to address chaos on a larger scale, such as through housing and employment policies.

### **Summary and Conclusion**

The present study demonstrates that household chaos impacts cortisol levels in economically disadvantaged children attending Head Start preschool. Children who experienced high levels of home chaos in their homes had higher morning cortisol at preschool and had a steeper decline in cortisol levels from morning to midmorning. These results suggest that household chaos contributes to taxing of the HPA axis. Additionally, children who were BIPOC also had higher morning cortisol levels at preschool and a steeper

decrease in cortisol from morning to midmorning. However, only poverty impacted the afternoon cortisol trajectory, such that children from poverty showed a greater increase in cortisol from midday to midafternoon compared to children who were low income, but not residing in poverty. This highlights the risk factors of poverty and systemic racism on child development. Frequent exposure to poverty related stressors that overload the HPA axis and impact cortisol output can have negative implications for child development. As such, it is important to provide early interventions to mitigate the effects of stressors like household chaos, as well as other poverty-risks such as food insecurity, housing instability, and parent emotional difficulties. Overall, the present study adds to the previous literature on the impact of poverty related stressors in early childhood and informs early interventions to help reduce the inequities experienced by children growing up in poverty.

**Table 1***Means and Standard Deviations for Cortisol Samples By Collection Time Point (N=288)*

	9:00 am Morning	10:30am Midmorning	12:00pm Noon	1:30pm Afternoon
Day 1				
Raw	0.29 (0.58)	0.19 (0.38)	0.18 (0.41)	0.21 (0.57)
Log	-0.72 (0.35)	-0.92 (0.32)	-0.87 (0.28)	-0.86 (0.30)
Day 2				
Raw	0.27 (0.64)	0.19(0.58)	0.18 (0.25)	0.18 (0.52)
Log	-0.74 (0.32)	-0.94 (0.31)	-0.85 (0.27)	-0.88 (0.26)
Day 3				
Raw	0.25 (0.23)	0.14 (0.20)	0.16 (0.14)	0.15 (0.11)
Log	-0.68 (0.26)	-0.94 (0.26)	-0.86 (0.24)	-0.88 (0.23)
Day 4				
Raw	0.28 (0.45)	0.13 (0.18)	0.15 (0.14)	0.15 (0.12)
Log	-0.68 (0.28)	-0.96 (0.22)	-0.90 (0.24)	-0.90 (0.22)
Day 5				
Raw	0.23 (0.19)	0.11 (0.09)	0.14 (0.11)	0.14 (0.08)
Log	-0.72 (0.25)	-1.04 (0.24)	-0.93 (0.25)	-0.92 (0.31)
Day 6				
Raw	0.23 (0.22)	0.13 (0.23)	0.14 (0.13)	0.15 (0.16)
Log	-0.72 (0.26)	-1.01 (0.29)	-0.94 (0.25)	-0.91 (0.22)

**Table 2.***Zero- Order Correlation for Demographic and Predictor Variables (N=288)*

Variable	1	2	3	4
1. Child Age	--	.008	-.078	.042
2. Child Race	--	--	-.024	.011
3. Poverty	--	--	--	.095
4. High Chaos	--	--	--	--

Note. Age is coded in months. Race is coded as 1=BIPOC. Poverty is coded as 1 = poverty. High Chaos is coded as 1 = CHAOS score above the mean.

**Table 3***Means and Standard Deviations for Cortisol Samples (N=288)*

Time Point	All		Low Chaos		High Chaos		<i>t</i> -value	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
9:00am	-.71	0.33	-.74	.28	-.67	.29	-4.699	<0.00***
10:30am	-.97	0.32	-.98	.28	-.96	.295	-2.135	.033*
12:00pm	-.89	0.27	-.90	.25	-.88	.26	-1.735	.083
1:30pm	-.89	0.28	-.91	.23	-.87	.26	-4.108	<0.00***

*Note.* Cortisol was in units of *ug/dl*. *t*-tests compared children in low chaos versus high chaos households.

\**p*<.05. \*\**p*<.01. \*\*\* *p*<.001



**Table 4**

*Hierarchical Linear Model of Cortisol as a Function of Time of Day, Household Chaos, Poverty, and BIPOC status N=6,908 Observations Nested within 288 participants).*

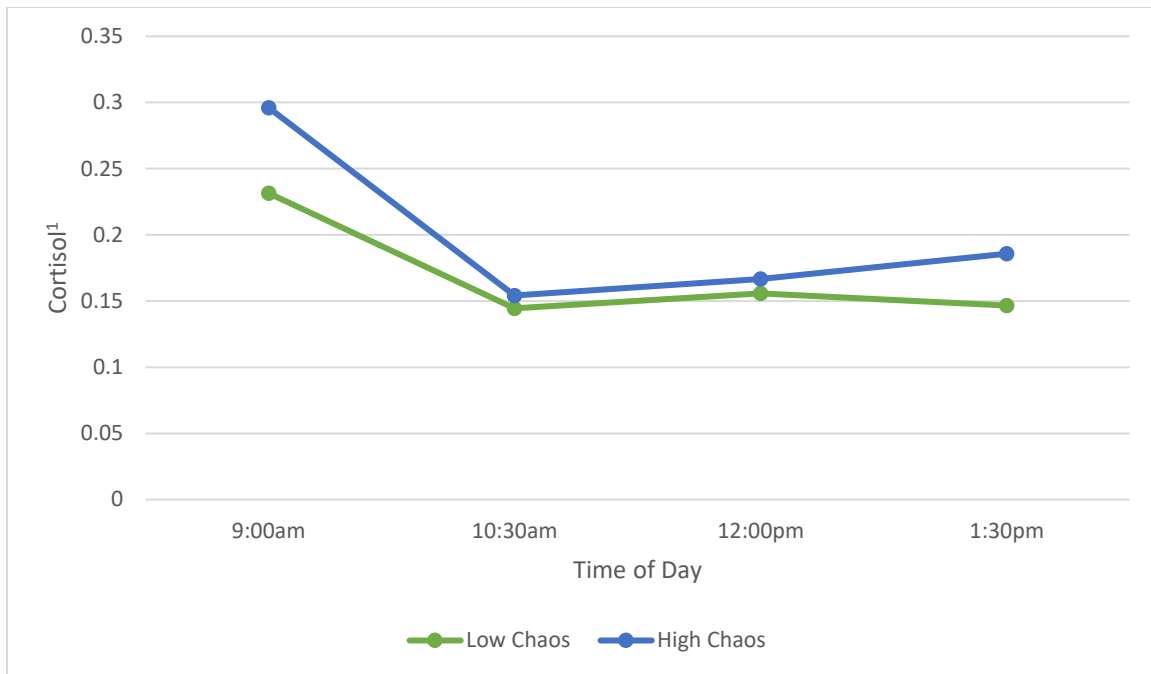
	<i>B</i>	<i>SE</i>	<i>t</i>	<i>df</i>	<i>p</i>
Fixed effects for level 1 intercept $\beta_0$					
Level 2 intercept, $\gamma_{00}$	-0.909	0.020	-44.729***	283	<0.001
Child race <sup>1</sup> , $\gamma_{01}$	0.052	0.016	3.207***	283	0.001
Child age, $\gamma_{02}$	0.001	0.001	1.038	283	0.300
Poverty status <sup>2</sup> , $\gamma_{03}$	-0.019	0.017	-1.095	283	0.274
Household Chaos <sup>3</sup> $\gamma_{04}$	0.041	0.014	3.036**	283	0.003
Fixed effects for level 1 slope: Piece 1, $\beta_1$					
Level 2 intercept, $\gamma_{10}$	-0.135	0.025	-5.493***	6604	<0.001
Child race <sup>1</sup> $\gamma_{11}$	-0.081	0.020	-4.116***	6604	<0.001
Child age, $\gamma_{12}$	0.000	0.001	0.164	6604	0.870
Poverty status <sup>2</sup> $\gamma_{13}$	-0.044	0.021	-2.156*	6604	0.031
Household Chaos <sup>3</sup> $\gamma_{14}$	-0.037	0.016	-2.284*	6604	0.022
Fixed effects for level 1 slope: Piece 2, $\beta_2$					
Level 2 intercept, $\gamma_{20}$	0.009	0.013	0.710	6604	0.478

Child race <sup>1</sup> $\gamma_{21}$	0.007	0.010	0.727	6604	0.467
Child age, $\gamma_{22}$	0.001	0.001	1.324	6604	0.186
Poverty status <sup>2</sup> $\gamma_{23}$	0.026	0.011	2.448**	6604	0.014
Household Chaos <sup>3</sup> $\gamma_{24}$	0.006	0.009	0.751	6604	0.453

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Note. <sup>1</sup>dichotomous, 1=minority), <sup>2</sup>(dichotomous, 1=poverty), <sup>3</sup> (dichotomous, 1=high), Cortisol was in units of logarithm of *ug/dl*. Piece 1 accounts for the average trajectory of cortisol from from the first to second morning measurement. Piece 2 accounts for the average trajectory of cortisol from second to fourth measurement in the afternoon.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$



**Figure 1.** *Cortisol Levels Across the Preschool Day between High and Low Home Chaos*

Note: <sup>1</sup>Cortisol values are raw. These descriptive statistics do not account for covariates.

High chaos is above the mean.

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