Longitudinal Patterns of Cortisol Regulation Differ in Maltreated and Nonmaltreated Children

Jenalee R. Doom, MA, Dante Cicchetti, PhD, Fred A. Rogosch, PhD

Objective: Child maltreatment is associated with dysregulation of stress-mediating systems and an increased risk of mental and physical health problems. Specifically, disruptions in hypothalamic–pituitary–adrenal (HPA) axis regulation have been reported in maltreated children. The current study investigates whether increased cortisol variability is responsible for inconsistent patterns in the literature. **Method:** This study modeled cortisol activity over 20 weeks in 187 maltreated and 154 nonmaltreated children (mean = 8.4 years, SD = 1.8 years) in order to capture week-to-week cortisol patterns. Maltreatment was assessed through coding of Department of Human Services records. Children attended an after-school program 1 day per week for 20 weeks, where saliva was collected at the same time each day and subsequently assayed for cortisol. **Results:** Multiple-group growth curves indicated that maltreated and nonmaltreated children differ in longitudinal cortisol patterns. Maltreated children showed higher variance in the initial cortisol levels and slope over time compared to nonmaltreated children, indicating greater between-person variability in the maltreated group. Maltreated children with higher cortisol at the first assessment showed cortisol suppression over time, indicating potential HPA blunting after chronic high cortisol levels. The severity, timing, and number of subtypes of maltreatment predicted individuals' cortisol variability, and both maltreatment status and greater cortisol variability predicted more behavior problems. **Conclusion:** Interventions for maltreated children may benefit from pre- and post-intervention HPA assessments to determine a component of treatment efficacy. As maltreatment dimensions predicted differential cortisol regulation, assessment of maltreatment experiences is necessary to understand alterations in behavior and HPA regulation post-intervention. J. Am. Acad. Child Adolesc. Psychiatry, 2014;53(11):1206–1215. **Key Words:** maltreatment, middle childhood, cortisol, behavior problems, structural equation modeling

Maltreatment during childhood is associated with disruptions in social, emotional, and cognitive development, and an increased risk of psychopathology and physical health problems throughout the lifespan.[1,2] Pathways to increased mental and physical health problems are thought to operate through cumulative deterioration of bodily systems caused by chronic stressors, such as the stress of abuse or neglect in childhood. The allostatic load model (ALM) postulates that the body is able to up- and down-regulate vital functions in response to acute stressors (e.g., mobilization of glucose to muscles, suppression of nonessential processes), but that these adaptations that promote survival in the short term are actually harmful if activated chronically.[3]

The hypothalamic–pituitary–adrenal (HPA) axis is of particular interest in the ALM, as it is a physiological system that mediates the impact of systemic and psychosocial stressors on biological and behavioral responses. The HPA axis has been targeted because of its importance in regulating the body's response to and recovery from stress, and there is growing evidence that this system may be dysregulated after chronic adversity.[4] Specifically, the stress of maltreatment in childhood has been linked to HPA dysregulation around the period of maltreatment as well as in adulthood.[5] In psychiatrically healthy adults, those who were maltreated as children tend to exhibit lower levels of cortisol in the evening,[6] blunted responsiveness to psychosocial challenge,[7] and stronger suppression to dexamethasone challenge.[6,8] However,

some studies report that adults maltreated as children have increased cortisol and adrenocorticotropic hormone (ACTH) responsiveness to challenge.[9] Furthermore, adult psychopathology is an important moderator of cortisol regulation that further complicates interpretation.[10,11]

The picture is less clear in maltreated children, with children showing elevated, lowered, and similar patterns of cortisol activity compared to nonmaltreated children.[5,12] Compared to nonmaltreated children, some physically abused children show low cortisol and a flattened diurnal slope.[13] Sexually abused girls have demonstrated a blunted ACTH response after a corticotropin-releasing factor (CRF) stimulation test compared to comparison individuals,[14] and both boys and girls who were maltreated have shown attenuated cortisol responses to stressors.[15,16] Researchers have found elevated cortisol levels in maltreated children with internalizing problems, even though adults who were maltreated as children often show hyposecretion of cortisol and increased ACTH responsiveness.[5] Few longitudinal studies of HPA regulation in maltreated individuals exist. However, 1 study reported that sexually abused girls with high cortisol levels in childhood showed attenuated cortisol in adolescence and exhibited low cortisol levels in adulthood.[17] This finding suggests a switch to hypocortisolism across time that could be the result of receptor down-regulation after a sustained ACTH drive in response to chronic stress.[18] One hypothesis is that dysregulation of the HPA axis occurs after repeated exposure to psychosocial stressors. Maltreated children may demonstrate difficulty in the following: responding appropriately to stressors, returning to baseline post-stressor, and maintaining a regular diurnal rhythm. Evidence supporting this hypothesis exists in the literature on foster children who also experience early adversity. Children in foster care have demonstrated an increasingly blunted diurnal cortisol slope compared to children in the community, suggesting an inability to regulate the HPA axis in response to accumulating stress.[19] In addition, children in foster care show higher variability in morning cortisol levels than children not living in foster care, which appears to be related to the type of maltreatment experienced, providing further evidence of cortisol dysregulation for children experiencing chronic stress.[20] The current study will examine whether similar cortisol variability occurs in maltreated children not living in foster care.

One challenge associated with investigating maltreatment is that children often experience multiple forms of abuse and neglect, including co-occurring stressors. Despite increased rates of a number of pathological conditions, some maltreated children are remarkably resilient, which may contribute to inconsistencies in the literature on the neurobiological correlates of maltreatment.[21,22] Factors such as the type and severity of maltreatment, developmental stages of occurrence, and recency of maltreatment are likely important determinants of HPA activity and may be responsible for inconsistencies. For example, children who have experienced both physical and sexual abuse have demonstrated high morning cortisol levels, and children who experienced multiple types of abuse are more likely to show elevated morning and afternoon cortisol.[13] Concurrent psychopathology and behavior problems may also be related to HPA regulation. School-aged children who experienced physical and/or sexual abuse before age 5 years showed attenuated diurnal cortisol slope but only with concurrent internalizing symptoms.[23] Specifically, severity of depressive symptoms may moderate the impact of maltreatment on cortisol levels, with severe depressive symptoms related to blunted cortisol reactivity and mild symptoms related to heighted cortisol reactivity.[24]

Although effects of child maltreatment on the diurnal rhythm and reactivity of the HPA axis have been reported, there are inconsistencies in the literature that may be due to increased within- and between-person variability in the maltreated group. To our knowledge, there are no studies that examine variability in cortisol levels in maltreated and nonmaltreated individuals measured consistently over time. To fill this gap, the current study models patterns of cortisol over 20 weekly assessments occurring in middle childhood. It was hypothesized that maltreated children would show greater variability in the initial cortisol level and the slope of cortisol levels over time than nonmaltreated children, indicating greater difficulty in regulating cortisol levels. The variance in cortisol levels was expected to be higher in the maltreated group, which would suggest greater variability between individuals in the maltreated group and may explain why consistent cortisol patterns are elusive. In response to research indicating down-regulation of cortisol levels with chronic stress, it was predicted that maltreated children would demonstrate a smaller slope for cortisol levels, especially for children with higher initial cortisol levels. As variability within the maltreated group