The role of fathers on HPA-axis development and activity across the lifespan: A brief review

Erin E. Wood¹, Michael M. Criss², Jennifer Byrd-Craven¹*

¹Department of Psychology, Oklahoma State University, Stillwater, OK, United States
²Department of Human Development & Family Science, Oklahoma State University, Stillwater, OK, United States

*Author for correspondence: Email: jennifer.byrd.craven@okstate.edu

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Humans are within the rare 5% of mammal species that have paternal investment [1]. The quantity and quality of paternal investment is facultative on environmental and social context [1-3]. Because paternal investment is facultative in nature, father presence is not necessarily critical for survival [4-6]. However, the presence and involvement of the father can provide socio-competitive advantages, and indicate valuable information about the safety and predictability of the environment that can have many downstream effects on development and health [7,8]. The safety and predictability of the environment is particularly critical in early childhood during the calibration of the hypothalamic-pituitary-adrenal axis (HPA-axis) and can shape sensitivity to stressors as children age, as discussed below [9-13]. Because fathers are shown to provide unique context to environmental conditions that are important for shaping mental and physical health, more research is needed examining the role of fathers on child development outcomes to provide better accuracy in predicting developmental trajectories [7].

HPA Axis Development and the Fathers Role in Early Infancy

Early life experiences in social and physical environment can have many downstream effects on social, emotional, and biological development across the lifespan. The HPA axis is the neuroendocrine stress-regulatory system of the Central Nervous System that is responsible for important processes such as learning, memory, vigilance, and energy expenditure [12,14]. The development and sensitivity of the HPA axis in humans is largely contingent on early environmental conditions as the HPA axis adapts to the chronic and acute stressors present in the environment the individual lives [10,15]. For example, individuals raised in more secure, predictable environments are associated with a more sensitive pattern of HPA axis responding, but harsh environments are associated with HPA-axis down regulation that can be associated with health outcomes in later development [16-21]. These outcomes include delayed and decreased physical and brain development, increased propensity for developing PTSD, and increased susceptibility to chronic degenerative diseases [22-24].

One of the ways the sensitivity of the HPA-axis is calibrated to the environment is through infant-caregiver attunement [25-27]. Attunement is when the behavior or physiology of one member of a dyad matches that of the other member of the dyad [27,28]. For humans, attunement with caregivers is particularly important in infancy because at this developmental stage infants lack the ability to regulate their emotional and physiological states, but attunement with parents can provide opportunities for the infant to learn how to self-regulate and assist with the calibration of the HPA-axis system to the environment [26,29-31].

In regard to physiological attunement, as with other developmental investigations, the majority of research has focused on mother-infant attunement, presumably because mothers were perceived to be more critical to development [32], and we have only recently begun to appreciate fathers’ contributions to physiological regulation. Mother-infant cortisol attunement is important for the development of the HPA axis and its calibration to the environmental conditions as it influences mother sensitivity towards her infant [30]. Furthermore, mothers who experience chronic stress typically have lower levels of mother-infant attunement [25,33]. One of the ways fathers influence
infant HPA axis sensitivity is through the quality of the relationship they have with the infants’ mother. Research by Clauss and colleagues [34] found that mothers who reported higher levels of relationship satisfaction with fathers had greater mother-infant attachment than mothers who reported low levels of relationship satisfaction. Marital satisfaction not only influences mother-infant attachment, but it can also influence infant resting cortisol levels. Findings by Hibell and colleagues [35] demonstrated that infants showed greater stress system coordination and recovery when their mothers had more cohesive marital relationships. Yet, for parents who are experiencing conflict, research conducted by Hibell and Mercado [36] found that mothers’ ability to regulate cortisol response to conflict with partners significantly buffered infant response to stressor. Further, the effects of marital satisfaction and conflict can have long-term effects on biobehavioral development. For instance, Lucas-Thompson [37] reported that increases in mother-father conflict can lead to hypo-activity of adolescent HPA axis in response to acute stressors.

The Role of Fathers in Childhood Through Adulthood

One of the ways fathers can influence the activity and sensitivity of the HPA-axis to acute and chronic stressors is by spending time with their children [38]. By spending time with their offspring, not only do fathers provide indicators of the safety and predictability of the environment, but they also provide opportunities for children to learn to regulate their emotional and physiological responses to the environment [39]. During childhood and adolescence, interactions with fathers can occur in the context of play [40,41] which can afford unique opportunities for a child to learn how to regulate strong emotional and physiological states that accompany play [42,43]. For example, research by Ibrahim and colleagues [38] found that individuals who reported engaging in higher levels of shared activities with their fathers during adolescence had significantly lower cortisol response to social stressors in young adulthood. Conversely, Booth and colleagues [44] found that, in adolescence, experiencing low levels of paternal acceptance were related to high levels of cortisol response to acute stressors. These findings could provide support for arguments that reduced acceptance by their fathers is associated with lack of emotion regulation techniques and thus may reflect increased HPA-axis activation to acute stressors [13,45].

Additional experimental evidence found in Byrd-Craven and colleagues [46] demonstrated that females who reported negative relationships with their fathers displayed higher baseline cortisol and greater peaks in cortisol after discussing problems with a friend. In addition, Byrd-Craven and colleagues [46] found that high levels of father-daughter supportive and warm relationships were related to low baseline cortisol levels of cortisol though they did not display significant changes in cortisol in response to discussing problems with their friend. In contrast, research by Wood and colleagues [47] found that the link between father harsh parenting and risky behavior was stronger among youth who did not demonstrate HPA-axis activation to acute stress compared to other adolescents. Furthermore, research by Del Priore et al. [48] found that, in female sibling dyads, father social deviant behavior was significantly related to substance use among older (but not younger) sisters. These findings suggest that fathers may influence long-term biobehavioral health outcomes, but they can also shape behavioral outcomes as well. While the presence and involvement of fathers might indicate environmental safety and predictability, in some cases the presence of a father might actually indicate danger and unpredictability that creates an environment of chronic stress which might lead to HPA-axis downregulation and dysregulation and changes in behavior [10].

Conclusions and Future Directions

In sum, the present literature indicates that fathers have significant influences on HPA-axis development and activity across several developmental stages. Broadly, in infancy, research has shown that fathers influence the development and attunement of the HPA-axis system indirectly through the relationship that they have with the infants’ mother [34,36]. Then, starting in childhood and onto adulthood, fathers further influence the sensitivity of the HPA-axis system through the shared behaviors and activities they engage with their offspring [38,46,47]. While more research is being conducted on the role that fathers play on biobehavioral development, there is still much to explore in regard to the direct role fathers play on the development of the HPA-axis system.

References


