Journal of Neurobiology and Physiology

Wood et al., J Neurobiol Physiol 2021; 3(2):32-35.

Short Communication

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

Erin E. Wood[1], Michael M. Criss[2], Jennifer Byrd-Craven[1*]

[1]Department of Psychology, Oklahoma State University, Stillwater, OK, United States

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

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

Received date: May 29, 2021
Accepted date: July 12, 2021

Citation: Wood EE, Criss MM, Byrd-Craven J. The role of fathers on HPA-axis development and activity across the lifespan: A brief review. J Neurobiol Physiol 2021; 3(2):32-35.

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 attunement than mothers who reported low levels of relationship satisfaction. Marital satisfaction not only influences mother-infant attunement, but it can also influence infant resting cortisol levels. Findings in Hibel and colleagues [35] demonstrated that infants showed greater stress system coordination and recovery when their mothers had more cohesive martial relationships. Yet, for parents who are experiencing conflict, research conducted by Hibel 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 DelPriore 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

1. Geary DC. Evolution and proximate expression of human paternal investment. Psychological Bulletin. 2000 Jan; 126(1):55.
2. Marlowe F. Paternal investment and the human mating system. Behavioural Processes. 2000 Oct 5;51(1-3):45-61.
3. Trivers RL. Parental investment and sexual selection. Routledge; 2017 Jul 12;136-179.
4. Ahnert L. Parenting and alloparenting. Attachment and Bonding. A New Synthesis. 2005:229-44.
5. Hames R, Draper P. Women's work, child care, and helpers-at-the-nest in a hunter-gatherer society. Human Nature. 2004 Dec; 15(4):319-41.
6. Smaldino PE, Newson L, Schank JC, Richerson PJ. Simulating the evolution of the human family: Cooperative breeding increases in harsh environments. PLoS One. 2013 Nov 20;8(11):e80753.
7. Geary DC. Evolution of Paternal Investment. In: Buss DM (Ed.) The Handbook of Evolutionary Psychology. 2005; 483-505.
8. Hrdy SB. Cooperative breeding and the paradox of facultative fathering. Family, Ties, and Care. Family Transformation in a Plural Modernity. 2012:207-22.
9. Boyce WT, Ellis BJ. Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. Development and Psychopathology. 2005 Jun; 17(2):271-301.
10. Del Giudice M, Ellis BJ, Shirtcliff EA. The adaptive calibration model of stress responsivity. Neuroscience & Biobehavioral Reviews. 2011 Jun 1; 35(7):1562-92.
11. Ellis BJ, Bianchi J, Griskevicius V, Frankenhuis WE. Beyond risk and protective factors: An adaptation-based approach to resilience. Perspectives on Psychological Science. 2017 Jul; 12(4):561-87.
12. Kudielka BM, Kirschbaum C. Sex differences in HPA axis responses to stress: a review. Biological Psychology. 2005 Apr 1;69(1):113-32.
13. McEwen C, Flouri E. Fathers' parenting, adverse life events, and adolescents' emotional and eating disorder symptoms: The role of emotion regulation. European child & Adolescent Psychiatry. 2009 Apr; 18(4):206-16.
14. Thau L, Gandhi J, Sharma S. Physiology, cortisol. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan.

15. Tarullo AR, Gunnar MR. Child maltreatment and the developing HPA axis. Hormones and Behavior. 2006 Nov 1; 50(4):632-9.

16. Baum A, Garofalo JP, Yali AM. Socioeconomic status and chronic stress: does stress account for SES effects on health? Annals of the New York academy of Sciences. 1999 Dec; 896(1):131-44.

17. Pendry P, Adam EK. Associations between parents' marital functioning, maternal parenting quality, maternal emotion and child cortisol levels. International Journal of Behavioral Development. 2007 May; 31(3):218-31.

18. Sheikh HI, Joanisse MF, Mackrell SM, Kryski KR, Smith HJ, Singh SM, et al. Links between white matter microstructure and cortisol reactivity to stress in early childhood: Evidence for moderation by parenting. NeuroImage: Clinical. 2014 Jan 1; 6:77-85.

19. Schreiber LR, Grant JE, Odlaug BL. Emotion regulation and impulsivity in young adults. Journal of Psychiatric Research. 2012 May 1; 46(5):651-8.

20. Steptoe A, Feldman PJ. Neighborhood problems as sources of chronic stress: development of a measure of neighborhood problems, and associations with socioeconomic status and health. Annals of Behavioral Medicine. 2001 Aug; 23(3):177-85.

21. Zalewski M, Lengua LJ, Kiff CJ, Fisher PA. Understanding the relation of low income to HPA-axis functioning in preschool children: Cumulative family risk and parenting as pathways to disruptions in cortisol. Child Psychiatry & Human Development. 2012 Dec; 43(6):924-42.

22. Cabeza de Baca T, Barnett MA, Ellis BJ. The development of the child unpredictability schema: Regulation through maternal life history trade-offs. Evolutionary Behavioral Sciences. 2016 Jan; 10(1):43.

23. Flinn MV, Nepomnaschy PA, Muehlenbein MP, Ponzi D. Evolutionary functions of early social modulation of hypothalamic-pituitary-adrenal axis development in humans. Neuroscience & Biobehavioral Reviews. 2011 Jun 1; 35(7):1611-29.

24. Gunnar MR, Quevedo KM. Early care experiences and HPA axis regulation in children: a mechanism for later trauma vulnerability. Progress in brain research. 2007 Jan 1; 167:137-49.

25. Atkinson L, Jamieson B, Khoury J, Ludmer J, Gonzalez A. Stress physiology in infancy and early childhood: cortisol flexibility, attunement and coordination. Journal of Neuroendocrinology. 2016 Aug; 28(8).

26. Feldman R. Parent–infant synchrony: Biological foundations and developmental outcomes. Current Directions in Psychological Science. 2007 Dec; 16(6):340-5.

27. Macfadyen A, Swallow V, Santacroce S, Lambert H. Involving fathers in research. Journal for Specialists in Pediatric Nursing. 2011 Jul;16(3):216-9.

28. Woltering S, Lishak V, Elliott B, Ferraro L, Granic I. Dyadic attunement and physiological synchrony during mother-child interactions: An exploratory study in children with and without externalizing behavior problems. Journal of Psychopathology and Behavioral Assessment. 2015 Dec; 37(4):624-33.

29. Byrd-Craven J, Clauss N. The psychobiology of family dynamics: Bidirectional relationships with adrenocortical attunement. InBiobehavioral Markers in Risk and Resilience Research 2019 (pp. 13-30).

30. Hendrix CL, Stowe ZN, Newport DJ, Brennan PA. Physiological attunement in mother–infant dyads at clinical high risk: The influence of maternal depression and positive parenting. Development and Psychopathology. 2018 May; 30(2):623-34.

31. Hibel LC, Granger DA, Blair C, Finegood ED, Family Life Project Key Investigators. Maternal-child adrenocortical attunement in early childhood: Continuity and change. Developmental Psychobiology. 2015 Jan; 57(1):83-95.

32. Bowlby J. Attachment and loss: retrospect and prospect. American Journal of Orthopsychiatry. 1982 Oct; 52(4):664.

33. Tarullo AR, John AM, Meyer JS. Chronic stress in the mother-infant dyad: Maternal hair cortisol, infant salivary cortisol and interactional synchrony. Infant Behavior and Development. 2017 May 1;47:92-102.

34. Clauss NJ, Byrd-Craven J, Kennison SM, Chua KJ. The roles of mothers' partner satisfaction and mother-infant communication duration in mother-infant adrenocortical attunement. Adaptive Human Behavior and Physiology. 2018 Mar;4(1):91-107.

35. Hibel LC, Trumbell JM, Valentino K, Buhler-Wassmann AC. Ecologically salient stressors and supports and the coordination of cortisol and salivary alpha-amylase in mothers and infants. Physiology & Behavior. 2018 Oct 15; 195:48-57.

36. Hibel LC, Mercado E. Marital conflict predicts mother-to-infant adrenocortical transmission. Child Development. 2019 Jan; 90(1):e80-95.

37. Lucas-Thompson RG. Associations of marital conflict with emotional and physiological stress: Evidence for different patterns of dysregulation. Journal of Research on Adolescence. 2012 Dec; 22(4):704-21.

38. Ibrahim MH, Somers JA, Luecken LJ, Fabricius WV, Cookston JT. Father–adolescent engagement in shared activities: Effects on cortisol stress response in young adulthood. Journal of Family Psychology. 2017 Jun; 31(4):485.

39. Denham SA. Dealing with feelings: How children negotiate the worlds of emotions and social relationships. Cognition, Brain, Behavior. 2007 Mar 1; 11(1):1.

40. Brand AE, Klimes-Dougan B. Emotion socialization in adolescence: The roles of mothers and fathers. New directions for child and adolescent development. 2010 Jun; 2010(128):85-100.

41. Lamb ME. How do fathers influence children's development? Let me count the ways. The role of the father in child development. 2010 Mar 10:1-26.

42. Lunkenheimer ES, Shields AM, Cortina KS. Parental emotion coaching and dismissing in family interaction. Social Development. 2007 May; 16(2):232-48.

43. Pellegrini AD. Perceptions and functions of play and real fighting in early adolescence. Child Development. 2003 Oct; 74(5):1522-33.

44. Booth A, Granger DA, Shirtcliff EA. Gender-and age-related differences in the association between social relationship quality and trait levels of salivary cortisol. Journal of Research on Adolescence. 2008 Jun; 18(2):239-60.

45. Morris AS, Criss MM, Silk JS, Houltberg BJ. The impact of parenting on emotion regulation during childhood and adolescence. Child Development Perspectives. 2017 Dec; 11(4):233-8.

46. Byrd-Craven J, Auer BJ, Granger DA, Massey AR. The father–daughter dance: The relationship between father–daughter relationship quality and daughters' stress response. Journal of Family Psychology. 2012 Feb; 26(1):87.

47. Wood EE, Garza R, Kennison SM, Byrd-Craven J. Parenting, Cortisol, and Risky Behaviors in Emerging Adulthood: Diverging Patterns for Males and Females. Adaptive Human Behavior and Physiology. 2021 Jun;7(2):114-32.

48. DelPriore DJ, Brener SA, Hill SE, Ellis BJ. Effects of Fathers on Adolescent Daughters' Frequency of Substance Use and Risky Sexual Behavior. Journal of Research on Adolescence. 2021 Mar; 31(1):153-69.