



Link between children's hair cortisol and psychopathology or quality of life moderated by childhood adversity risk



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ABSTRACT

The hypothalamus-pituitary-adrenal axis (HPAA) and its end product, the glucocorticoid cortisol, has been shown to be associated with psychopathology. Determining cortisol concentrations in hair (HCC) allows the investigation of long-term HPAA-activity. There is a significant scarcity of studies investigating the link between HCC and psychopathology and quality of life in child and adolescent samples. In addition, as the HPAA constitutes a feedback system enabling adaption to environmental demands, it is important to consider the socio-environmental context that the children grow up in. We therefore investigated the associations between child HCC and psychopathology/quality of life and compared these links in two groups of five to 12-year-olds: children living with mothers who report experiences of early life maltreatment (ELM) (high-risk group) and children whose mothers did not report any ELM (low-risk group). We expected that, under conditions of a high-risk environment, elevated HPAA-functioning would be associated with low levels of psychopathology and high levels of quality of life in children. Under low-risk conditions, elevated HPAA-functioning would be associated with high levels of psychopathology and low levels of quality of life in children. For the complete sample of $N = 130$ children, three-months HCC did not significantly predict child psychopathology or quality of life. However, there was a significant moderating effect of group membership: In the high-risk group, high levels of HCC were significantly associated with high levels of self-reported quality of life. In the low-risk group, there was no association between HCC and self-reported quality of life. For child psychopathology, in the low-risk group, high levels of HCC were significantly associated with high levels of teacher reported behavior problems, whereas in the high-risk group, the association did not reach significance. Our results underline the importance of accounting for the social environment children grow up in when investigating the link between HCC and child psychopathology and quality of life.

1. Introduction

As a core stress response system, the Hypothalamic-pituitary-adrenal axis (HPAA) and its end product, the glucocorticoid hormone cortisol, activate and regulate further biological systems that prepare the individual for events that may threaten its wellbeing (McCrorry et al., 2010). Determining cortisol in hair allows a noninvasive investigation of cumulative HPAA-activity, which is less affected by intra-

and interindividual differences in cortisol secretion than other methods (Adam and Kumari, 2009; Staufenbiel et al., 2013).

1.1. Association between HCC, chronic stress and mental health in children and adolescents

So far, most previous research on cortisol concentrations in hair (HCC) has been focusing on adults, identifying HCC as a potential

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neurobiological marker of chronic stress with promising results (Gerber et al., 2017). In child and adolescent samples, there is still a significant scarcity of studies investigating HCC. In line with results in adult samples, preliminary evidence suggests child HCC to serve as a biological marker of stress in childhood, as elevated levels of child HCC have been related to chronic stress and stressful experiences (Groeneveld et al., 2013; Rippe et al., 2016; Simmons et al., 2016; Vanaelst et al., 2012; Vliegthart et al., 2016). Childhood stress, in turn, has been identified as a risk factor for impaired mental health and low quality of life (Thoits, 2011). However, there are only a few studies investigating the association between child HCC and child mental health or quality of life. Gerber et al. examined child HCC and parent reported health-related quality of life in a community sample of 6–8-year-olds, in which they found no significant association between child HCC and child quality of life (Gerber et al., 2017). Simmons et al. investigated child HCC and depressive symptoms in a community sample of 4–14-year-olds. In their sample of children reporting an overall low level of depressive symptomatology, there was no association between HCC and depressive symptoms. They did, however, find a significant relationship between HCC and reported number of traumatic events (Simmons et al., 2016). Ouellette et al. compared two groups of 3–7-year-old daughters of mothers reporting high versus low stress. For the entire sample, again there was no association between child HCC and behavioral problems in children (Ouellette et al., 2015). In contrast to this, examining a sample of 245 maltreated 3–16-year-old children and a comparison group, White et al. found that the association between maltreatment and symptomatology was dependent on the child's age. Significant associations between maltreatment and externalizing as well as internalizing symptoms were found from age 9.7 years onwards (White et al., 2017). All studies except Simmons et al. (2016) and White et al. (2017) used parent reports of child symptom level only. Consequently, inconsistent results may originate from moderating factors such as sample type (high vs. low childhood adversity risk) or methodological issues such as source of information (parent-, teacher- or self-report).

In summary, relevant data on the association between child HCC and psychopathology and quality of life has mostly been gathered in samples of children growing up under low-risk conditions and reporting low symptom levels of pathology. In these samples, no associations have been found (Gerber et al., 2017; Ouellette et al., 2015; Simmons et al., 2016), whereas in a high-risk sample of maltreated children and a comparison group, significant associations were reported from middle childhood onwards (White et al., 2017). There is a significant scarcity of evidence and further studies are needed to highlight potential moderating factors.

1.2. Association between HCC and mental health depending on childhood adversity

Typically, the HPAA constitutes a feedback system enabling adaptation to environmental demands (Nicolson, 2008). Evidence obtained by studies examining child cortisol levels in saliva has indeed suggested an important role of the social environment children grow up in (Gunnar and Quevedo, 2007). Altered cortisol levels have been found in children whose mothers show less optimal interactional quality, have been diagnosed with mental disorders or report experiences of childhood maltreatment themselves (see e.g. Hunter et al., 2011 for a review). Preliminary evidence also suggests that the social environment impacts on child HCC, as some studies report it to be influenced by maternal parenting stress, maternal depressive symptoms (Palmer et al., 2013) and traumatic events such as child abuse (Simmons et al., 2016; White et al., 2017). Consequently, ignoring the socio-environmental context children are required to adapt to marks a highly relevant shortcoming in HPAA-research (Miller et al., 2007).

According to the attenuation hypothesis, a system exposed to continuous threat calibrates and adapts through protective inhibition. Depending on the chronicity and severity of environmental demands,

HPAA-functioning seems to follow the form of an inverted u-curve (Raison and Miller, 2003; Staufenbiel et al., 2013; van den Bos et al., 2017). The initial up-regulation of HPAA-activity in response to stress has been described to shift to down-regulation if the stressor persists (Miller et al., 2007). This inhibition or “hypo-responsiveness” of the HPAA in response to chronic and overwhelming stressors has been defined by lower basal levels, flatter diurnal patterns and blunted stress responses (Koss et al., 2016). Following this way of reasoning, in a highly stressful environment placing many demands on homeostasis, high levels of cortisol output might indicate that the stress system has not been subject to exhaustion yet. Consequently, under conditions of chronic stress, activation of the HPAA would be associated with higher levels of mental health and quality of life. Furthermore, the link between HPAA-functioning and psychopathology or quality of life could be especially pronounced under conditions of a high stress environment (Gerber et al., 2017). Functioning of the stress regulation systems might play a more prominent role under conditions requiring higher levels of adaption (Jaffee et al., 2015). On the other hand, children who are growing up in low-risk environments and whose HPAA-functioning is characterized by up-regulation may be experiencing higher levels of stress. Therefore, in a generally safe and protected environment, higher levels of HPAA-activity would be associated with lower levels of mental health and quality of life. The release of cortisol would be considered as having detrimental effects on child development (Lupien et al., 2009).

Consequently, environmental context might serve as a moderating factor influencing the strength and direction of the association between long-term HPAA output and psychopathology or quality of life. However, there is a significant scarcity of studies comparing the association between child HCC and mental health or quality of life in children living in high versus low socio-environmental risk conditions.

1.3. Maternal early life maltreatment and offspring childhood adversity

Exposure to early life maltreatment (ELM) has been associated with a broad range of detrimental psychosocial outcomes in adolescence and adulthood (Putnam, 2006). Mothers who have experienced ELM have been shown to be at a higher risk for suffering from mental disorders (Norman et al., 2012; Putnam, 2006), from revictimization (Arriola et al., 2005) and show disturbed mother-child interaction (Dixon et al., 2005; Fuchs et al., 2015; Smith et al., 2014). In addition, adverse childhood experiences have been shown to be passed on to the next generation (“cycle of abuse”; Begle et al., 2010; Bert et al., 2009; Smith et al., 2014). Consequently, children of mothers with ELM are at a higher risk to experience childhood adversity and are considered a high-risk sample.

1.4. The current study

In order to contribute to scientific knowledge on links between child HCC and child psychopathology and quality of life, we chose to integrate the risk status of the social environment children need to adapt to. To the best of our knowledge, this is the first study examining the association between child HCC and psychopathology and quality of life in a case control design of mothers with/without ELM. Furthermore, in contrast to earlier studies using parent ratings of child adjustment only, we incorporated multiple informant ratings.

We investigated the following hypothesis: There is an association between child HCC and child psychopathology or quality of life. The nature of the association is dependent on the social context children grow up in: Under conditions of a high-risk environment (mothers with ELM), elevated HPAA-functioning would be associated with low levels of psychopathology and high levels of quality of life in children. Under low-risk conditions, elevated HPAA-functioning would be associated with high levels of psychopathology and low levels of quality of life in children.

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