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Title: Correlates of hair cortisol concentrations in disadvantaged young children

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Abstract

Children from highly disadvantaged families tend to experience worse health, educational, and job outcomes than less disadvantaged peers. However, the mechanisms underlying these relationships remain to be explicated. In particular, few studies have investigated the relationships between the psychosocial influences that children are exposed to early in life, and longer-term cortisol output. This study aims to contribute to the literature by exploring how disadvantaged young children's experiences of family adversity, and parenting and family functioning, are related to their long-term cortisol levels. A sample of 60 children (26 males, M age=4.25 years, SD=1.68) and their mothers (M age=34.18 years, SD=7.11) from a disadvantaged population took part in a single assessment. Mothers completed questionnaires on the family environment, parenting practices, and child behavior. Children provided a hair sample for cortisol assay, and anthropometric measures. A parsimonious multivariate regression model (including potential predictors identified by a selection algorithm) was used to investigate the correlates of hair cortisol concentration (HCC) in children. Higher levels of social exclusion, being male, and younger age were each associated with higher HCC. Maternal nurturing and emotion coaching were associated with lower HCC. Findings suggest that chronic stress may underlie relationships between adversity and its long-term effects, and that HCC offers a promising method for examining chronic stress in children and evaluating interventions by which it can be ameliorated.

Keywords: Disadvantage; Hair cortisol; Parenting; Children

1 Introduction

Disadvantage during childhood is widely accepted to negatively affect a range of health, educational, and vocational outcomes in adulthood (Lipina & Colombo, 2009; Shonkoff et al., 2012). Disadvantage during childhood is typically characterized through indices of income poverty; however, more broadly it is viewed as a multidimensional construct which, besides the economic dimension, also incorporates other domains of welfare such as health, education, and community participation (McLachlan, Gilfillan & Gordon, 2013). Compared to children from well-off families, children growing up in poverty are more likely to be exposed to physical and psychosocial stressors, including low-income, poor housing, family turmoil, neighborhood violence, and family break-up (Evans & English, 2002). Yet, little is known about the relative contributions of these factors to children's health, behavioral, and educational outcomes. The effects associated with disadvantage emerge early: exposure to poor environmental conditions during the critically formative early years of life significantly impacts children's social, emotional, neurobiological and cognitive functioning and development (Hackman et al., 2010; Shonkoff et al., 2012). There is evidence that cortisol, and the hypothalamic-pituitary-adrenal axis (HPAA) more broadly, may mediate associations between disadvantage and key outcomes (White et al., 2017). For example, salivary cortisol levels mediated associations between the income-to-needs ratio and cognitive ability in a low-income population in children (1 – 4 years old) and their families (Blair et al. 2011). Salivary cortisol is, however, a momentary measure of HPAA function, and the relationships between psychosocial influences on development and long-term cortisol output in early childhood remain to be explicated.

Utility of Hair Cortisol

Cortisol output has traditionally been assessed in saliva, urine, or serum samples. All these techniques are limited by the highly dynamic nature of cortisol. In particular, factors such as diurnal variation and reactivity to acute stress make it difficult to infer basal levels of cortisol activity from these unstable assessments. Studies are increasingly examining scalp hair, which allows measurement of total systemic cortisol levels over months, as a marker of chronic HPAA and stress (Stalder et al., 2017). Such measurements have shown relationships with the cumulative experience of stressful events in children (Simmons et al., 2016). Hair cortisol concentrations (HCC) have been argued to reflect total free cortisol, and this is supported by a study that found associations between 30 days of multiple salivary collections and the most proximal 1cm of hair growth (Short et al., 2016). Importantly, while one recent study found no relationship between brain morphology and HCC (Chen et al., 2016), another study reports that early life adversity (ELA) moderates the relationship between left hippocampal volume and diurnal salivary cortisol levels, such that a relationship was only present in children with ELA (Dahmen et al., In Press). This suggests that early environment may be a key factor in explaining relationships with HPAA function; however, few studies have been conducted, to date, on HCC and early environments.

Childhood Disadvantage and Child Hair Cortisol

Several recent studies have examined relationships between socioeconomic status (SES) factors and child HCC. They consistently report a negative association between parental education and HCC (Rippe et al., 2016, Ursache, et al., 2017; Vaghri et al., 2013; Vliegenthart et al., 2016). However, findings for parental income differ, with some finding no association (Ursache, et al., 2017; Vaghri et al., 2013; Vliegenthart et al., 2016), and others a negative association (Rippe et al., 2017). Vliegenthart et al. (2016) also examined neighborhood (postcode) level SES factors, and found a negative association with HCC. No study to date has examined relationships between HCC and more specific indices of childhood SES, such as income poverty (i.e., family income below the poverty line) and social exclusion (i.e., experience of disadvantage in multiple domains), and particularly in a low-income population. A recent review of HCC as a measure of stress in children identified these issues (and others) as important next steps for research in this area (Bates, Salsberry & Ford, 2017).

Childhood Disadvantage and the Role of Family

A burgeoning literature has explored the role that family and parental functioning may play in moderating the adverse effects of growing up in disadvantaged environments on a range of health, behavioral, and educational outcomes. While a review of the relevant literature is beyond the scope of this paper, certain key studies are noteworthy. A longitudinal study of 16,916 children from the Millennium Cohort (from 3 and 7 years of age) modelled the simultaneous effects of neighborhood disadvantage, family poverty, and adverse life events on children's behavioral problems, while exploring the moderating role of parenting (Flouri et al., 2015). They found that all three risk factors predicted childhood problems, but that a positive parent-child relationship buffered risk effects. In related work, the current authors have demonstrated that disadvantage, specifically at the neighborhood level, influences brain development through adolescence, but that positive parenting, as Flouri et al. found, moderates this relationship (Whittle et al., 2017). To date, the influence of parenting and family functioning has not been examined in relation to child HCC.

This study aims to address some of the gaps in the literature by exploring how disadvantaged young children's experiences of family adversity, parenting, and family functioning, are related to long-term cortisol levels. We propose and estimate a multivariate regression model for HCC where potential predictors are selected using an algorithm to enhance the predictive accuracy and power of the statistical model. It was hypothesized that children exposed to higher levels of socioeconomic disadvantage will display higher levels of HCC. We also hypothesized a negative association between exposure to nurturing parenting/family environments and HCC, consistent with the role of positive parenting as a buffer to adversity in children.

2 Materials and Methods

2.1 Participants

A sample of 60 mother-child dyads from Melbourne, Australia, were recruited. Children (26 males, M age=4.25 years, SD=1.68) and their mothers (M age=34.18 years, SD=7.11) came from families involved in programs run by the Brotherhood of St Laurence (BSL; n=41), and their social networks (n=19). The BSL is a not-for-profit community organization that works to alleviate poverty in Australia, running programs that target highly disadvantaged communities exposed to multiple socioeconomic stressors. Exclusion criteria included a parent-reported history of developmental or intellectual disorder in the child, and the use of medications that influence cortisol levels. Data were collected during a home visit, which included completion of questionnaires and collection of hair samples. This research was approved by the research ethics committee of the University of Melbourne.

2.2. Measures

2.2.1 Hair cortisol

Hair was collected from an area approximately 1cm^2, as close to the scalp as possible, from the posterior vertex. The scalp end was marked on samples >3cm in length. Hair samples were sealed in aluminum foil and plastic zipped bags and stored in the dark until assayed. Assays were conducted by Stratech Scientific, where samples were cut down to 3cm lengths (from the scalp end) and processed as previously described (Simmons et al., 2016). Hair segments of 3cm represent approximately 3 months of hair growth (see Stalder et al., 2017). Quantification was conducted in duplicate using commercial ELISA kits (Salimetrics, USA) according to the manufacturer's instructions. The inter-assay coefficient of variation was 5.9%, and the intra-assay 5.4%.

2.2.2 Measures of early adversity

Family disadvantage was captured using a binary indicator that assesses whether family income was below the Henderson poverty line, a threshold calculated by the University of Melbourne which is widely used to quantify income-poverty in Australia. For the analysis, the poverty line for the June quarter of 2015 was used (Melbourne Institute, 2015). To control for differences in family size, family incomes were equivalized using the OECD modified equivalence scale that assigns a value of 1 to the first adult, 0.5 to other adults, and 0.3 to any individual below 15 years of age living in the household.

To capture non-economic dimensions of disadvantage, we also used a social exclusion measure (SEM) developed by the University of Melbourne in cooperation with the BSL (Scutella et al., 2009). Social exclusion has been defined as the "restriction of access to opportunities and [a] limitation of the capabilities required to capitalize on these [opportunities]" (Hayes, Gray, & Edwards, 2008, p. 6). This measure is regularly used to monitor trends in multidimensional disadvantage in Australia (BSL and Melbourne Institute, 2015) and has been used, among others, by the Australian Government Productivity Commission ─ a leading national governmental research body ─ to study socioeconomic disadvantage and microeconomic policy effects in Australia (McLachlan, Gilfillan & Gordon, 2013). The SEM is a multidimensional composite indicator of disadvantage which uses information on 21 zero-one indicators from seven different domains: material resources; employment; education and skills; health and disability; social; community; and, personal safety (see supplementary A1 for further details). Larger values of the composite measure indicate more disadvantage.

2.2.3 Family environments and parenting practices

Family functioning was measured using the relationships component of the Family Environment Scale, which comprises three subscales that quantify the degree of cohesion, expressiveness, and conflict within the family (Moos & Moos, 1994). Maternal parenting style was assessed using the Parent Behavior Checklist (Fox, 1994), which includes three subscales that measure expectations about the child, discipline and responses to child's behaviors, and the extent of nurturing and support provided to the child; and, the Maternal Emotional Style Questionnaire (Lagace-Seguin & Coplan, 2005), which assesses the extent of emotion-coaching and emotion-dismissing in responses to children's feelings of sadness and anger. Higher scores indicate more positive parenting and better family functioning.

2.2.4 Other control variables

Data on child and family relevant characteristics were also collected for the study. These included child's height, weight, and Body Mass Index (kg/m^2); family information data including mother's age, ethnic group, educational level and employment status; family type (lone parent versus couple), number of siblings, and two indicator variables informing whether the principal carer is the biological mother and whether the child's biological father is a member of the household. Child behavior, as an indicator of child functioning, was measured using the parent report Strengths and Difficulties Questionnaire (Goodman, 1997). We used the one-sided version designed for parents of 4-10 year olds, which includes 25 items to identify emotional, conduct, hyperactivity/inattention, peer relationship problems and pro-social behavior.

2.3 Statistical analysis

Prior to analyses, all variables were examined for the identification and management of missing and extreme values. Data on weight and height were missing for 24 and 8 children, respectively. These values were imputed using data from the child growth standards published by the World Health Organisation (WHO, 2018), based upon corresponding height/weight norms constructed considering children's gender and age measured in days. Six families in the sample reported being on welfare at the time of the interview but did not provide an estimate of the welfare payments received by the family. Income for those families was imputed using data on the maximum level of welfare payments available to different family types published quarterly by the Melbourne Institute of Applied Economic and Social Research at the University of Melbourne (Melbourne Institute, 2015). HCC of two children were extreme outliers (Log HHC>1.9 pg/ml). Within sample information was used to impute the HCC levels of those children. Specifically, the imputed scores were derived using a linear regression model for HCC that included as covariates the child's age, gender, and BMI; mother's age and educational attainment; family type; and the variables capturing the extent of disadvantage at the family, and individual level. Exclusion of those children did not affect main results.

Multivariate linear regression models were used to investigate associations between HCC, adversity and family functioning while controlling for other potential covariates. A $\log_{10}$ transformation was applied to correct the non-normality of HCC. Statistical relationships with HCC were estimated using the *LARS-OLS* hybrid method proposed by Efron et al. (2004). This method encompasses two steps. In the first step, the selection of variables to include in the model is conducted using the least angle regression (LARS) model selection algorithm, which selects a parsimonious set of covariates for the efficient prediction of the endogenous variable. Selection of a parsimonious model is particularly important in contexts where the number of potential predictors is large relative to the sample size, as the use of complex models with a large number of parameters can lead to overfitting problems. The selection of predictors in the LARS algorithm is based on a sequential process where all regression coefficients are initially set equal to zero and predictors are sequentially added to the model depending on their absolute correlation with the residuals. Once the optimal set of predictors is identified, the second step comprises the estimation of their statistical relationship with HCC using multivariate ordinary least squares (OLS) regression. (See supplementary A2 for further details on data management and analyses).

3 Results

Table 1 presents the mean and standard deviation of all variables considered in the analysis and their correlation with HCC. We estimated a multivariate linear model which includes the measures of adversity, parenting and family environments, and the other controls described in Section 2.2. Application of the LARS selection algorithm to our data yielded a restricted model including the age and gender of the child; dummy variables for couple families, Asian mothers, children living with their biological father; income-poverty; the FES score for Expression, the PBC score for Nurturing, and the MESQ score for Emotion-coaching.

The income poverty indicator constructed using the Henderson poverty line classified only 6 families as non-poor in the current sample. In consideration of the small number of non-poor families,[1] to examine the robustness of the results to changes in the threshold for income poverty we considered three alternative poverty indicators constructed using three income thresholds ranging between 95 and 70 per cent of the Henderson poverty line that then classified 8, 10, and 12 families as 'non-poor'. We applied the LARS algorithm to the set of potential covariates, replacing the original income poverty indicator with each of the three alternative poverty indicators (one at a time). The application of the LARS technique for each income poverty indicator yielded parsimonious models that selected all the variables selected by the original model; however, none of them included the income poverty measures. The SEM was not selected in the original parsimonious model but passed the LARS test and was selected as one of the best predictors when the alternative income poverty measures were considered (see Supplementary A2 for results of the LARS analyses). To further explore the association between family income and child HCC, we also considered the (continuous) measure of family equivalised income as a potential predictor of HCC, replacing the 0/1 (binary) income poverty indicator. The set of best predictors selected was the same as with the alternative income poverty indicators, where the SEM was the only measure of disadvantage included in the parsimonious model. In light of the LARS analyses, two parsimonious models were used to estimate relationships with HCC using multivariate OLS regression: one including the original income poverty indicator; and, a second adjusted model, including the SEM.

Table 2 shows the regression results of the two parsimonious models. Estimates with asterisks indicate significant predictors of HCC. Positive associations were found between HCC and mother's ethnicity (Asian), income-poverty (model 1 only), and SEM (model 2 only). As hypothesized, negative associations were found between HCC and child gender (female), child age, PBC (Nurturing) and MESQ (Emotion-coaching).

[Table 1 here]

[Table 2 here]

[1] We thank one of the reviewers for flagging this issue.

4 Discussion

Our results show that children's HCC levels were significantly associated with socioeconomic disadvantage, parenting measures, and child and family sociodemographic characteristics. HCC was, as hypothesized, significantly higher amongst those exposed to disadvantage. Amongst the measures of family disadvantage considered in the analysis, while income poverty demonstrated a relationship with HCC, this finding was not robust due to the small number of non-poor families taking part. When alternative definitions of income poverty were considered, the income poverty measures did not pass the LARS test and the only measure of disadvantage included in the parsimonious models was the social exclusion measure. Estimates from the adjusted model show that children from families with higher levels of social exclusion had higher HCC. Negative associations with HCC were also found in the analysis. Specifically, children being female and older, and mothers reporting greater nurturing and emotion-coaching parenting styles, were associated with lower HCC.

As noted, the income poverty indicator, when based on the Henderson poverty line, passed the LARS selection test in the first parsimonious model; however, this revealed only six non-poor families in the cohort, and thus brings into question the power to examine related effects, and the risk of type-I error. Our examination of the robustness of the relationship, by varying the poverty line threshold (70-95%), led to income poverty not being selected by the LARS algorithm, and therefore this result should be interpreted with extreme caution. The non-selection of the income poverty indicator from the set of best predictors could be caused by the reclassification of some income-poor children with high levels of HCC as non-poor when lower income standards are used to identify income-poor families. The re-classification of those families is hard to justify on economic and welfare grounds, as their incomes are below the threshold used to define poverty in Australia and therefore their socioeconomic well-being is likely to be lower than that of the typical non-poor family. This, in turn, undermines the validity of the income poverty indicator as measure of disadvantage, as well as its capacity to predict child HCC, in our sample. Equivalised family income, a continuous measure of economic (dis)advantage, was also examined, but did not pass the selection test, consistent with the null findings for income and HCC of Ursache et al. (2017) and Vaghri et al. (2013). In contrast, Rippe et al. (2016) did report an association (negative) between income and HCC in a cohort of 2,484 6-year old children, albeit in a predominantly middle-class cohort.

No previous study has investigated relationships between social exclusion and HCC. Social exclusion is primarily a multidimensional index of socioeconomic disadvantage designed to capture individuals' capacity to fully participate in society by quantifying their levels of deprivation in a range of dimensions such as health, employment, and education, in contrast to measures of income and income poverty, which primarily index economic resources (Hayes et al., 2008). Although they found no relationship between income and HCC, Ursache et al. (2017) and Vaghri et al. (2013) found that HCC was related to parental education, which, could arguably be considered a proxy of social exclusion. However, we did not find a relationship between maternal education and HCC, consistent with Liu et al. (2016), Rippe et al. (2016) and Vliegenthart et al. (2016). The positive relationship found between social exclusion and HCC suggests that in this primarily poor population (90% living below the poverty line), families' experiences of multiple deprivations and reduced capabilities to fully participate in society is associated with neurobiological differences in the long-term HPAA function of their children.

Importantly, mothers' reports of higher nurturing and more emotion coaching of their children were both associated with lower HCC, suggesting the importance of these dimensions for buffering stress in children growing up disadvantaged environments, and specifically where exposed to social exclusion. To our knowledge, Ouellette et al. (2015) is the only previous study to investigate the influence of parenting using hair cortisol data, although they examined dyadic, mother-daughter relationships. They found that poor quality parenting moderates the strength of mother-child HCC covariation, but had no main effect on child HCC. Our results are consistent with our recent work with adolescents, where warm/positive parenting styles were found to provide a buffering effect to the negative effects of adversity on brain development and school outcome (Whittle et al., 2017). It was conjectured whether stress induced cortisol, which has demonstrated neurotoxicity (Lee et al., 2002), may underlie the relationships between adversity and altered brain development. This is consistent with a longitudinal study of low income children assessed from ages 2 to 4 years (N=201), in which exposure to greater levels of family instability and maternal unresponsiveness predicted elevated (and low)[2] basal salivary cortisol patterns, which were in turn associated with lower child cognitive functioning at age 4 (Suor et al., 2015). Further study is required to investigate these links via prospective longitudinal studies with measures of HPAA, brain development, and health/functioning outcomes.

HCC also declined with the age of the child, consistent with the age-gradient in early years reported in Karlén et al. (2013), and girls had lower HCC than boys, even after controlling for age, again consistent with other work with children (e.g., Simmons et al., 2016; Rippe et al., 2016).

Certain limitations must be considered in the interpretation of these results. First, the sample size was modest and results should be treated with caution, particularly because of the small number of families with incomes above the income poverty line. That the association between child hair cortisol and social exclusion only became significant in the absence of the income poverty measure (set at the Henderson poverty line) suggests a shared variance across variables, which needs to be examined in larger, more representative cohorts. Nonetheless, the consistent finding of elevated cortisol among children living below the income poverty line and children exposed to higher levels of social exclusion is indicative of the negative impact

[2] Lower cortisol in relation to adversity has been reported to occur as a longer-term result of early elevations in cortisol that lead to systemic down-regulation of the HPAA, i.e., the attenuation hypothesis (Gunnar & Vazquez, 2001).

of disadvantage on child stress. Second, parenting measures were self-reported and thus present inherent bias in reporting. Further, although the sample was ethnically diverse, numbers in each category were low, and thus the finding that having an Asian mother (n=6) was associated with higher HCC should be treated with caution. Note that the main conclusions regarding the relationship between HCC, disadvantage, and family environments were found to be robust whether relationships were analyzed controlling for that ethnic group or not. The limitations of the use of hair as a sample medium must also be considered: there are indications that extraneous factors, such as intense exercise, frequent hair washing, or hair treatments can affect HCC (Stalder et al., 2017), however while not specifically examined here, the ages of children in this study limits the likelihood of these factors playing a substantive role. Finally, interactions between variables were not explored, due to sample size. Future research is required to address these limitations, explore moderation and mediation, and replicate results.

5 Conclusions

This study demonstrates clear associations between young children's exposure to disadvantage, and specifically social exclusion, and elevated HCC. Further, nurturing and supportive parenting styles showed negative associations with HCC, associations that have not been shown previously. Relationships with income poverty need to be explored with larger, more varied SES, cohorts. The relationship between social exclusion, family environments, and children's outcomes may be partially mediated by children's exposure to chronic stress. The present study indicates that chronic stress may be a mechanism underlying the relationship between adversity and its long-term effects, particularly when adversity is defined in terms of families' exposure to multiple deprivations that undermine their capacity to participate in society. The further explication of factors influencing HCC suggests this may be a promising method for examining chronic stress in children and evaluating interventions by which it can be ameliorated.

Acknowledgements: We are grateful to the Brotherhood of St Laurence and participating families for all the support provided throughout the project.

Funding: This work was supported by the Melbourne Social Equity Institute and the Melbourne Neuroscience Institute at the University of Melbourne. Francisco Azpitarte acknowledges the support by the Australian Research Council Centre of Excellence for Children and Families over the Life Course (project number CE140100027). The Centre is administered by the Institute for Social Science Research at The University of Queensland, with nodes at The University of Western Australia, The University of Melbourne and The University of Sydney. The views expressed herein are those of the authors and are not necessarily those of the Australian Research Council. Francisco also acknowledges financial support from the Spanish State Research Agency and the European Regional Development Fund (ECO2016-76506-C4-2-R).

Conflicts of interest: none.

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Table 1. Sample descriptive statistics

		Mean	St.dev.	Correlation with HCC
Log HCC (pg/mg)		0.46	0.40	1.00
Mother's age (years)		34.18	7.11	0.03
Child's age (months)		56.68	19.78	-0.31***
Child: Female (%)		57.00	50.00	-0.32**
Mother's ethnic group (%):	Oceanian	41.67	49.72	-0.06
	European	28.33	45.44	-0.08
	Middle-East	15.00	36.01	-0.16
	Asian	8.33	27.87	0.30**
	African	5.00	21.98	0.18
	American	1.67	12.91	0.00
Number of siblings		1.00	0.78	-0.12
Mother is biological mother: Yes (%)		97.00	18.00	0.10
Biological father at home: Yes (%)		72.00	45.00	0.21
Family type (%):	Couple	70.00	46.21	0.22*
	Lone parent	25.00	43.67	-0.23*
	Multifamily	3.33	18.10	0.05
	Other family type	1.67	12.91	-0.07
Mother's education (%):	Postgraduate	6.67	25.15	0.14
	Bachelor	30.00	46.21	-0.04
	Diploma	10.00	30.25	-0.06
	Certificate	20.00	40.34	0.04
	Year 12 or less	33.33	47.54	-0.03
Mother's employment (%):	Employed	35.00	48.10	-0.03
	Unemployed	38.33	49.03	-0.13
	Out of labour force	26.67	44.59	0.18
Disadvantage				
SEIFA index:	Disadvantage	918.40	122.43	0.07
	Advantage and disadvantage	920.22	143.7	0.08
	Economic resources	924.13	113.26	0.07
	Education and occupation	935.73	109.09	0.02
Income poor: Yes (%)		90.00	30.00	0.25*
Index of exclusion		1.78	0.95	0.17
SDQ:	Conduct problems	2.22	1.71	-0.13
	Hyperactivity	4.47	2.62	0.11
	Peer problems	1.91	1.53	0.09
	Emotional	2.22	1.85	0.03
	Pro-social behavior	7.43	1.78	-0.13
	Total score	17.65	6.01	0.02
Family environments and parenting				
FES:	Cohesion	6.84	1.78	-0.06
	Expression	5.34	1.99	0.13
	Conflict	5.47	2.17	-0.05
PBC:	Discipline	-41.11	7.28	-0.07
	Expectations	43.04	11.3	-0.14
	Nurturing	52.03	12.44	-0.17
MESQ:	Emotion dismissing	-3.54	0.64	-0.09
	Emotion coaching	-3.93	0.56	-0.19

Notes: Ethnic groups defined following the Australian Standard Classification of Cultural and Ethnic Groups (ASCCEG). SDQ=Strengths and Difficulties Questionnaire; FES =Family Environment Scale; PBC=Parent Behavioral Checklist; MESQ=Maternal Emotional Style Questionnaire. The original scores of the FES-conflict, MESQ-emotion dismissing, and MESQ-emotion coaching scales were multiplied by minus one so that larger values indicate more positive forms of parenting. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 2. Regression models predicting child cortisol

	Model 1			Model 2	
	Coeff.	p-val.		Coeff.	p-val.
Child: female‡	-0.66**	0.003	Child: female‡	-0.72**	0.002
Child: age (months)	-0.23*	0.044	Child: age (months)	-0.29*	0.013
Ethnic group: Asian	0.01*	0.023	Ethnic group: Asian	0.01*	0.017
Family: couple	0.01	0.209	Family: couple	0.005	0.363
Biological father at home	-0.05	0.921	Biological father at home	-0.04	0.929
FES: Expression	0.16	0.155	FES: Expression	0.20	0.087
PBC: Nurturing	-0.26*	0.020	PBC: Nurturing	-0.28*	0.014
MESQ: Emotion coaching	-0.24*	0.036	MESQ: Emotion coaching	-0.25*	0.028
Income poverty (HPL: Yes	0.96*	0.030	Social exclusion score	0.23*	0.043
Constant	-0.99+	0.052	Constant	0.04	0.854
R-squared	0.49		R-squared	0.48	

Notes: FES =Family Environment Scale; PBC=Parental Behavioral Checklist; MESQ=Maternal Emotional Style Questionnaire; HPL= Henderson Poverty Line. ‡ = - negative coefficient means males have higher HCC.
$^{+}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$