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Hair Cortisol Concentration as A Biomarker of Parental Burnout

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Forthcoming in *Psychoneuroendocrinology*

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Abstract

Parental Burnout (PB) is a chronic stress-related disorder experienced in the parental role. Recent studies have shown that PB is a serious condition with severe consequences for parents (e.g., suicidal ideations) and children (e.g., parental neglect and violence). However, PB's biological correlates have not yet been examined. Numerous studies suggest that hair cortisol concentration (HCC) is a valid biomarker of a variety of chronic stress conditions. HCC has been shown to be related to job burnout, but no studies have looked at the association between HCC and *parental* burnout. Given that the two forms of burnout are only weakly related, it is important to fill this gap. In this study, we compared HCC of parents suffering from PB (N = 119) to that of control parents (N = 59). We also examined the correlation between PB scores and HCC levels, controlling for job burnout symptoms. The results showed that HCC was 213% higher in parents suffering from PB (mean level: 99.90 pg/mg) compared to controls (mean level: 46.83 pg/mg). Moreover, HCC was significantly related to PB (r = 0.27). These findings suggested that HCC can be considered as a biomarker of PB (though with caution, as 36.1% of the parents in PB had HCC values equal to or below the mean of the control parents) and reinforce the view that HCC is a biomarker of chronic stress conditions. The HCC levels observed in parents suffering from PB point to the importance of this condition as well as its potential harmful consequences for their health.

Keywords: burn-out; parenting; hair cortisol; biomarker

1. Introduction

While it has long been recognized that parenting is a stressful job, parenting stress has gained renewed attention since the discovery that it can lead parents to *burn out*, and that this condition affects 5 to 8% of parents (Roskam et al., 2017). Parental burnout (PB) is a stress-related disorder resulting from long-term exposure to parental stressors in the absence of enough resources to compensate (Mikolajczak and Roskam, 2018). Parents with PB feel run down by their role; they are no longer able to take pleasure in being with their children, and become less and less involved in the relationship with them (Roskam et al., 2018). The severity of PB's consequences for affected parents and their children (large effect sizes have been found for suicidal ideations, parental neglect and violence; Mikolajczak et al., 2019) attests to the fact that PB is a serious condition. Previous literature suggested that PB may affect also parents' health, leading to increased somatic complaints and decreased sleep quality (Mikolajczak et al., 2018; Sarrionandia-Pena, 2019). Nothing is known, however, about PB biological correlates.

Research in psychoneuroendocrinolgy has seen an increasing interest in the assessment of biological correlates of chronic stress. Since the early 2000s, there has been an exponential growth of studies employing hair cortisol concentrations (HCC) for this purpose (Greff et al., 2019; Stalder and Kirschbaum, 2012). HCC analysis is a non-invasive tool for the retrospective assessment of average cortisol levels over long periods. Assuming that hair grows at an approximate rate of 1cm per month, the collection of a 3-cm-long strand may provide an overview of cortisol concentration over the previous three months (Staufenbiel et al., 2013). HCC has thus been studied as a biomarker of chronic stress that may improve the understanding, diagnosis and treatment evaluation of many pathological conditions (Greff et al., 2019). In particular, Penz and colleagues (2018) have been the first to examine HCC alterations in job burnout, a chronic stress syndrome related to work. They found the presence of hypercorticolism in burned-out employees compared to healthy controls, suggesting a relation between HCC and burnout symptoms. However, the relation between HCC and PB has never been investigated.

Even though it can be hypothesized that PB leads to similar alterations to job burnout, this hypothesis needs to be formally tested, since previous studies have shown that PB is only weakly related to job burnout (Roskam et al., 2017), and that the two forms of burnout have partially distinct consequences (Mikolajczak et al., 2019, 2018). Yet, previous studies have already shown that the presence of risk factors that enhance stress levels in the field of parenting (e.g., intimate partner violence, low socio-economic status, adverse childhood experiences) are independently associated to increased HCC compared to controls (Boeckel et al., 2017; Bowers et al., 2018; Caparros-Gonzalez et al., 2017). Given that PB represents a condition of overwhelming stress related to parenting, the investigation of its association with HCC might reveal even larger effects.

To the best of our knowledge, only one study has investigated hair cortisol in the field of PB before. In this study, which focused on the effectiveness of PB treatment, HCC was assessed among outcomes as a biological indicator of chronic stress (Brianda et al., 2020). Results showed that the reduction of PB symptoms after the participation in a treatment was accompanied by a 52% decrease in HCC, suggesting that HCC may be related to PB. However, such hypothesis needs to be investigated in a more adequate design, specifically conceived to look at PB associations with HCC, including also control parents (i.e., parents who are not suffering from PB) in the sample. Thus, the current study aimed to investigate the association between HCC and PB. We first compared the HCC of parents consulting for PB to that of control parents, and then examined the association of PB with HCC, controlling for the amount of variance explained by job burnout.

2. Material and Methods

2.1 Participants and Procedure

The sample consisted of 123 parents voluntarily enrolled in group therapy for PB (henceforth "Burned-Out Parents") and 60 controls (henceforth "Control Parents"). A priori G*Power analyses suggested that a sample of 60 controls was sufficient to detect a medium effect size with a power of 90%.

The Burned-Out Parents were drawn from the abovementioned study looking at the effectiveness of group therapy for PB (Brianda et al., 2020). In the framework of that study, parents had been pre-screened to check for the following inclusion criteria: having at least one child still living at home, suffering from PB, and being motivated to engage in a group-intervention aimed at reducing PB symptoms (see Brianda et al., 2020, for a fuller description of the study sample). Among eligible participants (n = 151), only those who had hair at least 3cm long were invited to provide a strand of hair for the analysis of HCC, and those who accepted were included in the current study (n = 123). Burned-out parents completed self-reported measures online before the beginning of the therapy, and let the researcher take a strand of hair the day of the first session.

The control group consisted of parents willing to participate in a study on the "Estimation of hair cortisol levels of parents". The study was advertised on the Internet (on parents' public groups and parents' pages on the social networks), through flyers (at the main schools and youth clubs of our city), and by word of mouth among parents in our network. Inclusion criteria were to have at least one child still living at home and have hair at least 3cm long. Eligible parents completed the self-reported measures online, and agreed on a meeting with the researcher for the hair sampling.

All participants completed an informed consent form and were identified by anonymous codes to ensure the confidentiality of data. The study design was in accordance with the World Medical Association Declaration of Helsinki, and approved by the Institutional Review Board.

2.2 Measures

Parents provided the following sociodemographic data: sex, ethnicity, age, marital status, number of children, educational level, employment status, and household net monthly income (i.e., the sum of partners' net salaries for parents in couple, or their own salary for single parents). We also asked for information about health-related variables (BMI, medication intake, contraceptive use, smoking status), and hair-related variables (washes per week, natural color, hair dyeing). PB was measured using the *Parental Burnout Assessment - PBA* (Roskam et al., 2018), a 23-item questionnaire to assess

PB symptoms on a 7-point frequency scale from "*never*" (0) to "*every day*" (6) (α = 0.98). Job burnout was assessed among employed parents using the *Maslach Burnout Inventory-General Survey – MBI-GS* (Maslach et al., 1986), a 16-item questionnaire to assess job burnout symptoms on a 7-point scale, from "*never*" (0) to "*every day*" (6) (α = 0.89). HCC was assessed using a hair sample of approximately 150 hairs collected from the posterior vertex of the head of each participant. Cortisol contained in the 3cm most proximal to the scalp was analyzed using the Salivary ELISA Cortisol kit©, in order to assess cortisol accumulation over the three previous months, following the procedure described in Caparros-Gonzalez et al. (2017).

2.3 Statistical Analyses

Participants using oral cortisone (i.e., two parents from the Burned-Out group) were excluded from the sample. After checking for normality, we log-transformed HCC, PB, and job burnout scores. Two Burned-Out parents and one Control parent were excluded due to extreme values (>3SD from the group mean). The resulting sample consisted of 119 Burned-Out Parents and 59 Controls. In a first step, we ran preliminary analyses on sociodemographic data and PB scores. We used ANOVA tests to compare PB across groups based on the following sociodemographic characteristics: sex, age, marital status, number of children, educational level, employment status and household net monthly income.

In the second step, we focused on group differences between Burned-Out and Control parents. We started by comparing the two groups with respect to health-related and hair-related variables (using X^2 tests for categorical variables, and Mann-Whitney U tests for non-normally distributed continuous variables). We then examined group differences in HCC, PB, and job burnout levels using t-tests. We conducted analyses twice, with original and log-transformed scores, obtaining the same results; we present both for descriptive purposes.

Next, we examined the association between PB and HCC through hierarchical multiple regression models, focusing on the entire sample (i.e., Burned-Out and Control parents together). In order to be able to remove the part of variance potentially attributable to job burnout, we performed this analysis on parents who also completed the measure of job burnout (i.e., 109 employed parents). We verified

that Burned-Out and Control parents were equally distributed in the employed subsample (55 Burned-Out vs. 54 Control parents), to ensure that the distribution of PB scores could not alter the results. Zero-order correlations, VIF values, tolerance statistics, and the Durbin-Watson test confirmed the absence of multicollinearity and the assumption of independent error. Based on the meta-analysis of Stalder and colleagues (2017) on basic determinants of hair cortisol, we introduced the following potential confounders in a first step: sex, age, BMI, oral contraceptive use, hair washes per week, and hair dyeing. Any sociodemographic variable that emerged as significantly different across the two subsamples was also controlled for and included in the first step of the model. Job burnout and PB were introduced in the second and third steps respectively.

3. Results

3.1 Preliminary analyses

The participants were mostly mothers (92.9%) and predominantly Caucasian (96.5%). The majority were aged between 35 and 44 (53.1%), and between 25 and 34 (21.5%). Most of them were part of a couple (87.0%) and had two or three children (72.2%). The majority had a bachelor's or master's degree (69.6%), were currently employed (79.9%), and had a household net monthly income between €2,500 and €5,500 ($2,800 and $6,160; 68.3%). ANOVA tests revealed significant differences in PB scores only with respect to the number of children and the working status of participants. Parents with more than three children and unemployed parents displayed the highest levels of PB (see Supplemental Table S1 for the full results of ANOVA tests).

3.2 Group comparisons of Burned-Out vs. Control parents

Except for employment status (which was controlled for in the analyses), the groups were statistically equivalent with respect to sociodemographic, health-related, and hair-related variables (sociodemographic data for each group are presented in Supplemental Table S2; health-related and hair-related variables are presented in Table 1). As regards stress-related variables (Table 1), Burned-Out Parents presented significantly higher PB scores (more than 6 times higher; Hedge's $g = 2.92$)

than controls, confirming the validity of this case-control study. As expected, the former also presented significantly higher HCC levels (more than 2 times higher; Hedge's $g = 0.58$). These results also held after controlling for potential confounders, including employment status.

Table 1

Group Comparisons on Health-Related, Hair-Related, and Stress-Related Variables

	Burned-Out Parents N = 119	Control Parents N = 59	*p-value*
Health-related variables			
BMI (*M, SD*)	24.91 (4.25)	23.93 (4.75)	0.08
Medication intake			
Antidepressants, %	16.8%	6.8%	0.07
Anxiolytics, %	8.4%	1.7%	0.08
Thyroid hormones, %	11.8%	15.3%	0.51
Mood stabilizers, %	3.4%	-	0.15
Antipsychotics, %	0.8%	-	0.48
Sleeping pills, %	2.5%	-	0.22
Oral contraceptive use, %	21.3%	29.6%	0.28
Smoking, %	19.2%	15.5%	0.57
Hair-related variables			
Washes per week (*M, SD*)	3.38 (1.79)	3.52 (1.71)	0.49
Natural color			0.19
Black, %	7.6%	3.4%	
Blond, %	6.3%	17.2%	
Light brown, %	26.6%	27.6%	
Dark brown, %	50.6%	43.1%	
White, %	1.3%	-	
Grey, %	7.6%	5.2%	
Hair dyeing, %	43.8%	51.7%	0.35
Stress-related variables			
HCC, pg/mg			<0.001
M (SD)	99.90 (109.25)	46.83 (30.28)	
Range	7.63 – 541.39	6.48 – 118.62	
HCC, log-transformed score			<0.001
M (SD)	4.17 (0.91)	3.62 (0.71)	
Range	2.03 – 6.29	1.87 – 4.78	
PBA			<0.001
M (SD)	85.76 (29.31)	13.00 (11.20)	
Range	18 – 135[a]	0 - 54	
PBA, log-transformed score			<0.001
M (SD)	4.37 (0.44)	2.16 (1.02)	
Range	2.89 – 4.91	0 – 3.99	
MBI			<0.001
M (SD)	35.95 (16.63)	26.75 (15.07)	
Range	7 – 81	5 – 75	
MBI, log-transformed score			<0.01
M (SD)	3.46 (0.53)	3.14 (0.57)	
Range	1.95 – 4.39	1.61 – 4.32	

Notes. HCC = hair cortisol concentration; PBA = Parental Burnout Assessment; MBI = Maslach Burnout Inventory (job burnout). [a] As this range shows, a few parents in the "Burned-Out group" had low PBA scores. We are however confident that these parents were in burnout because parents of the "Burned-Out Parents" group were all drawn from a previous study on the effectiveness of group therapy for PB (Brianda et al., 2020). In the framework of that study, we collected several indicators of participants' PB in addition to the Parental Burnout Assessment. First, there was a screening at the time of enrolment to check for PB symptoms, and to investigate the reasons why they wanted to participate in the treatment. We only kept parents whose responses and motivations showed an intense exhaustion in the parental role. Second, we asked participants to self-evaluate the severity of their PB on a 4-point scale (not in PB, minor PB, moderate PB, severe PB), and 100% of the participants

identified themselves as being in burnout. Finally, we also collected partner's perception of the participant's level of PB, which confirmed that these parents were displaying on average 80% of PB symptoms at least once a week.

3.3 HCC and PB associations controlling for job burnout

Zero-order correlations showed that *parental* and *job* burnout were significantly but only weakly related in the subsample of 109 employed parents ($r = .31$, $p = <.01$). Multiple regressions (Table 2) showed that whereas control and confounding variables, either taken alone or with the addition of job burnout, did not significantly predict HCC ($F_{1(9, 108)} = 1.56$, $p = .14$, $R^2 = .12$; $F_{2(10, 108)} = 1.40$, $p = .19$, $R^2 = .13$), the inclusion of PB led to a significant increase of variance explained ($F_{3(11, 108)} = 2.13$, $p = .03$, $R^2 = .19$). PB had a significant effect on HCC ($t = 2.89$, $p < .01$), even after controlling for job burnout.

Table 2
Hierarchical Multiple Regressions Predicting HCC from Job Burnout and PB

		HCC	
Predictor	ΔR^2	β	*p-value*
Step 1	.12		.14
Working status		-.08	.39
Sex		-.10	.33
Age			
25-34 years		-.13	.19
45-54 years		.01	.93
Over 54 years		-.08	.39
BMI		.24	.01
Oral contraceptive use		.07	.47
Hair washes per week		.08	.38
Hair dyeing		-.17	.10
Step 2	.00		.72
MBI		.04	.72
Step 3	.07		<.01
PBA		.29	<.01
Total R^2	.19		.03
N	109		

Notes. HCC = log-transformed hair cortisol concentration; PBA = log-transformed Parental Burnout Assessment scores; MBI = log-transformed Maslach Burnout Inventory scores.

4. Discussion

The results showed that parents suffering from PB displayed HCC levels twice as high as Control Parents, and revealed that PB and HCC are significantly related, even after controlling for job burnout. These findings contribute to both psychoneuroendocrinology and PB research.

First, they support the view of HCC as a biomarker of chronic stress (Russell et al., 2012). This does not mean, however, that HCC can be used to "verify" the presence (or absence) of chronic stress or parental burnout. Although HCC is, on average, 213% higher in Burned-Out Parents than Control

Parents, 36.1% of Burned-Out Parents showed HCC equal to or below the mean of the Control Parents, and the reasons for this remain to be clarified.

Concerning PB itself, our results provide a further argument to support the seriousness of this syndrome (Mikolajczak et al., 2019). Mean HCC levels observed in Burned-Out Parents (99.9 pg/mg) are not only twice as high as those observed in Control Parents, they are also comparable to – and even exceed – mean values observed in chronic pain patients (83.1 pg/mg; Greff et al., 2019), and in victims of partner violence (81.9 pg/mg; Boeckel et al., 2017). Moreover, the average HCC of Burned-Out Parents crossed the upper limit of normal cortisol levels (75.90 pg/mg), the threshold that distinguishes people with a medical hypercorticolism condition from healthy controls (Greff et al., 2019; Manenschijn et al., 2012). This shows that PB is not "just in the head of tired or lazy parents", nor is it a temporary state related to a sudden increase of parental demands. It is instead a serious and prolonged condition that may alter the hypothalamic–pituitary–adrenal axis and lead to increased cortisol levels, eventually representing a threat for parents' physical health. It should therefore not be underestimated, given the body of evidence pointing to the harmful effects of excessive cortisol secretion (Chiodini et al., 2019).

Another contribution of this study to the field of PB is that the higher HCC found in Burned-Out Parents may help explain PB's effect on parental violence (Mikolajczak et al., 2018), given that it has been shown that cortisol fuels anger, and that parents with higher cortisol reactivity report greater use of harsh parental practices (Martorell and Bugental, 2006).

The present study can clearly not expect to contribute to the field of job burnout, as its design was entirely conceived around PB. However, an interesting finding emerged that maybe deserves to be further explored in future studies: the lack of association between job burnout and HCC ($r = -.02$). A similar result emerged in the study of Penz and colleagues (2018), who found a significant effect of the classification between individuals with severe job burnout vs. no or moderate job burnout on HCC, but no significant linear effect of the job burnout measure on HCC. As stated by the authors, it may suggest the existence of a non-linear relation between job burnout and HCC. Given the mixed results

found in previous literature (Wang et al., 2019; Wekenborg et al., 2019), the job burnout field would certainly benefit from a further investigation of this issue.

Despite its strengths, this study is not without limitations. First, its cross-sectional design makes it impossible to determine the direction of causation. However, the substantial decrease in HCC observed after group therapy for PB (Brianda et al., 2020) does suggest a causal association. Second, the underrepresentation of the fathers in the current sample may undermine the generalizability of our findings to fathers. However, given the consistent evidence of gender differences in hair cortisol, with men usually displaying higher HCC compared to women (Stalder et al., 2017), the possibility cannot be excluded that the effects found in the present study would have been even greater if we had more fathers in the sample. Third, as a result of the self-selection of participants, our sample does not include parents with the most extreme PB levels, i.e., parents hospitalized for PB. In line with the abovementioned hypothesis of non-linear relations between HCC and burnout (Penz et al., 2018), it is possible that at extremely high levels of PB cortisol collapses, leading to hypocorticolism in the most serious cases (Miller et al., 2007; Rohleder, 2018). Lastly, larger samples would be needed to have enough statistical power to enter even more control variables in the model. Future studies should for instance consider the impact of variables that we have not been able to assess, and that may affect hair cortisol expression in the specific context of parenting (e.g., children's age, or the eventual lack of sleep resulting from having a newborn child).

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Supplementary material

Table S1
PB Means and Standard Deviations with Respect to Sociodemographic Characteristics

	PBA *M (SD)*	*p-value*	PBA, log-transformed *M (SD)*	*p-value*
Sex		0.29		0.95
Females	62.55 (43.04)		3.64 (1.28)	
Males	49.00 (29.78)		3.66 (0.78)	
Age		0.12		0.23
25-34 years	47.95 (40.99)		3.36 (1.21)	
35-44 years	67.31 (40.51)		3.82 (1.17)	
45-54 years	63.50 (45.00)		3.57 (1.44)	
Over 54 years	55.00 (50.77)		3.26 (1.71)	
Marital status		0.30		0.33
In a couple	60.37 (42.03)		3.60 (1.27)	
Single parents	70.17 (44.45)		3.64 (1.25)	
Number of children		0.01		0.06
One	40.17 (38.73)		3.16 (1.14)	
Two or three	64.97 (41.56)		3.70 (1.29)	
More than three	71.30 (44.53)		3.94 (0.97)	
Education		0.62		0.79
College or high school	59.12 (45.76)		3.54 (1.28)	
University	63.55 (41.96)		3.68 (1.26)	
Tertiary education	55.22 (41.63)		3.54 (1.20)	
Employment status		<0.001		<0.01
Full-time	50.82 (41.74)		3.44 (1.15)	
Part-time	60.72 (44.27)		3.52 (1.41)	
Unemployed	84.63 (29.31)		4.28 (0.81)	
Net monthly income		0.71		0.36
Less than €2500	69.00 (36.08)		4.05 (0.70)	
€2500 to €5500	65.34 (40.87)		3.78 (1.13)	
Over €5500	74.33 (35.04)		4.15 (0.67)	

Table S2
Group Comparisons on Sociodemographic Data

	Burned-Out Parents N = 119	Control Parents N = 59	*p-value*
Sociodemographics			
Females, %	93.3%	93.2%	0.99
White Caucasians, %	94.9%	100%	0.22
Age			0.07
25-34 years, %	16.8%	31.0%	
35-44 years, %	59.7%	39.7%	
45-54 years, %	21.0%	25.9%	
Over 54 years, %	2.5%	3.4%	
Number of children			0.06
One, %	11.8%	25.4%	
Two or three, %	75.6%	66.1%	
More than three, %	12.6%	8.5%	
In a couple, %	85.7%	89.8%	0.44
Education			0.37
College or high school, %	14.3%	15.3%	
University, %	73.1%	64.4%	
Tertiary education, %	12.6%	20.3%	
Working status			<0.001
Full-time, %	30.3%	54.2%	
Part-time, %	42.0%	42.4%	
Unemployed, %	27.7%	3.4%	
Jobless, %	5.9%	-	
Retired, %	2.5%	-	
On sick leave or invalidity, %	11.8%	-	
On unpaid leave, %	0.8%	-	
On parental leave, %	4.2%	1.7%	
House-wives/husbands, %	2.5%	1.7%	
Net monthly income			0.28
Less than €2500, %	18.8%	4.8%	
€2500 to €5500, %	66.3%	81.0%	
Over €5500, %	15.0%	14.3%	