Salivary Biomarkers of Parenting Stress in Mothers Under Community Criminal Justice Supervision

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Background: Community criminal justice supervised mothers are an underserved population who experience high rates of psychological distress and unique parenting challenges, but little is known about physiological stress system function in this population.

Objective: We tested the salivary biomarkers of the sympathetic nervous system (SNS) and hypothalamic–pituitary–adrenal (HPA) axis function as predictors of subjective maternal stress.

Method: We recruited 23 mothers (age: $M = 35.6$ years, $SD = 9.3$ years; 35% Hispanic, 22% Black, 22% White, 22% multiracial) who were court mandated to a residential treatment center. We measured salivary alpha-amylase (AA) and cortisol, which index SNS and HPA activity, respectively, before and after a naturalistic reminder of a stressful parenting experience. We assessed self-reported parenting stress using the Parenting Stress Index–Short Form (PSI-SF) subscales Parental Distress, Parent–Child Dysfunctional Interactions, and Difficult Child. We used regression to test AA and cortisol mean levels and reactivity as predictors of subscale scores.

Results: Mean, but not reactive, salivary stress biomarker levels were associated with parenting stress domains. Mean cortisol levels predicted scores on the Parent–Child Dysfunctional Interaction subscale (adj. $R^2 = .48$), whereas mean AA predicted Difficult Child subscale scores (adj. $R^2 = .28$).

Discussion: Our results demonstrate the potential predictive utility of AA and cortisol as salivary biomarkers of maternal stress in community-supervised mothers. Given that maternal stress is associated with criminal recidivism and child behavioral health in this population, these biomarkers could potentially inform interventions to improve dyadic health and social outcomes.

Key Words: alpha-amylase • cortisol • parenting stress • parole • probation • salivary biomarkers

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Criminal justice involved women are a large, hidden population with psychological health disparities. In the United States, 1.25 million women are under criminal justice supervision (Kaeble & Glaze, 2016). Approximately 85% of these women are supervised in the community on probation or parole (Kaeble & Bonczar, 2017). Criminal justice involved women, whether incarcerated or community supervised, have higher rates of psychological distress (Golder, Engstrom, Hall, Higgins, & Logan, 2015), mental illness, and substance dependence (Binswanger et al., 2010) than do women without this history. Women in this population are also more likely to report a personal history of trauma, with lifetime prevalence estimates as high as 92% in some studies (Lynch et al., 2017). Trauma exposure, psychological distress, and substance use are risk factors for women's initial and repeat criminal justice involvement (Brennan, Breitenbach, Dieterich, Salisbury, & van Voorhis, 2012).

Criminal justice involvement in women is also associated with intergenerational health disparities. An estimated 56%–72% of criminal justice involved women are mothers to minor children (Glaze & Maruschak, 2008). Maternal current or historical criminal justice involvement is associated with behavior problems in young children (Dallaire, Zeman, & Thrash, 2015) and with depression, academic difficulties, and arrest in adolescents (Hagan & Foster, 2012). Mothers under community supervision face extreme challenges meeting their children's most basic needs in the context of poverty and criminal justice supervision mandates not designed to support their parenting. Parenting stress may be higher during community supervision than during incarceration because women are actively parenting or attempting to reunify (McClure et al., 2015). Self-reported parenting stress predicts criminal recidivism in community-supervised women (Van Voorhis, Wright,

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Salisbury, & Bauman, 2010), even when women do not currently live with their children (Adams, Morash, Smith, & Cobbina, 2017).

In this population experiencing a unique set of acute and chronic stressors, physiological stress system function has not been fully examined. Altered function of the sympathetic nervous (SNS) and hypothalamic–pituitary–adrenal axis (HPA) systems, indexed via salivary cortisol and alpha-amylase (AA), respectively, has been observed in other chronically stressed mothers, such as mothers of children with developmental disabilities (Foody, James, & Leader, 2014) and mothers with a history of trauma exposure (Cordero et al., 2017). However, the reported nature and direction of differences associated with chronic parenting stress are inconsistent, with some studies reporting elevated AA (Foody et al., 2014) or cortisol (Howland, Pickler, McCain, Glaser, & Lewis, 2011) and others reporting lower basal stress hormone levels (Adam & Gunnar, 2001). Similarly, maternal trauma history has been associated with higher (Gonzalez, Jenkins, Steiner, & Fleming, 2009) and lower (Cordero et al., 2017) HPA axis activity and higher basal AA (Feldman, Vengrober, Eidelman-Rothman, & Zagoory-Sharon, 2013). Moreover, stress system function has been broadly associated with a range of psychological symptoms and dysfunctional parenting behaviors, such as harsh, hostile, or intrusive parenting (e.g., Martorell & Bugental, 2006).

We are aware of only one study examining the physiological measures of stress in criminal justice involved mothers. McClure et al. (2015) recruited mothers inside prison and followed them for 6 months after release. Physiological stress, as indexed by hair cortisol, increased from the last 6 months of prison incarceration to the first 6 months postrelease. Cortisol and psychological parenting stress were positively associated in prison and after release, but surprisingly, living with the child after release was not significantly associated with either measure of stress. Maternal physiological stress was also associated with child behavioral health, with higher maternal postrelease cortisol predicting increased child internalizing behavioral problems and difficulty regulating emotions.

Understanding more about the associations between salivary stress biomarkers and psychological parenting stress could help to identify vulnerable mother–child dyads and inform tailored interventions to alleviate maternal stress, thus improving child health and decreasing recidivism in community-supervised women. Salivary biomarkers could also provide a reliable and cost-effective strategy for assessing the effect of chronic maternal stress on physiological stress system function and for tracking the efficacy of various intervention programs.

The aim of this study was to test salivary stress biomarkers of self-reported subjective parenting stress in a sample of community-supervised mothers. This aim was embedded in a larger mixed-methods study of the parenting experience in this population. We hypothesized that SNS and HPA axis function, indexed by salivary AA and cortisol levels, would be associated with psychological parenting stress. We also hypothesized that sympathetic and HPA reactivity, indexed by increases in AA and cortisol following a naturalistic parenting stress reminder, would be associated with psychological parenting stress. Given the exploratory nature of this study and the inconsistencies in the literature, we did not have directional hypotheses regarding the associations between salivary stress biomarkers and parenting stress.

METHOD

Participants

We recruited 23 women (age: M = 35.6 years, SD = 9.3 years, range = 22–52 years) who were mandated by the criminal courts to an urban residential treatment center. Each woman was currently under community criminal justice supervision by parole (n = 8), probation (n = 11), or a problem-solving court part (n = 4). Consistent with the population of women under criminal justice supervision in the city where this study took place, our sample was diverse; eight self-identified as Hispanic or Latina, five self-identified as Black or African American, five self-identified as White, and five self-identified as biracial or multiracial.

All participants were mothers to at least one minor child (number of children: M = 3.4, SD = 2.2, range = 1–8) and reported current in-person and/or telephone contact with at least one of their minor children. Most of the women (n = 19) were currently separated from all of their children. Four women currently lived with one of their children in the treatment center; three of these women also had children living with another caregiver. Twenty-two women reported child welfare involvement. Women without current contact with any of their children were excluded. By including separated and nonseparated mothers, we sought to reflect the complexity of parenting in women under community criminal justice supervision and situate our study within the existing literature on parenting stress in this population, which suggests that both groups experience similar levels of parenting stress.

Procedure

All study procedures occurred during a single 60–90-minute session. This session took place in the participant's room or a private office at the residential treatment center or in the principal investigator's office. Participants were fully informed regarding all study procedures. The consent form was read aloud by the researcher, and participants were asked to report the main purpose of the study and expectations for participation in order to continue. Following consent, the participants participated in a semistructured interview and provided saliva samples at three timepoints, including before and immediately after discussing a stressful parenting event. At the end of the session, participants were debriefed and compensated with a gift card to a local store ($20) and an age-appropriate children's

book. All study procedures were approved by the City University of New York Integrated Institutional Review Board.

Interview We conducted a semistructured interview to gather information on family structure, caregiving history for each of the women's children, child welfare history, and maternal criminal justice history (arrest, incarceration, community supervision), as well as how the women managed mothering under community supervision. The interview began with the following parenting stress reminder question: "Sometimes things happen with our children that are extremely upsetting, things like when a child is hurt or sick, when a mother has to leave her child and live somewhere else, or when a child is taken away from his or her mother. Has anything like this happened with the child you have the most contact with right now?" This question also served as a stressor and allowed us to examine changes in stress system activity in response to a reminder of parenting stress. Interviews were audio recorded with consent.

Saliva collection Participants provided saliva samples at three timepoints. At each timepoint, the participant placed an oral swab (Salimetrics, Inc.), under her tongue for 2 min, and then placed the swab into a sealed cryovial. The first sample was collected immediately after consent. The second sample was collected immediately after the participant responded to the parenting stress question during the interview. The second sample allowed us to capture peak AA, as this enzyme increases almost immediately (within 2–5 min) poststressor (Nater et al., 2005; Rohleder, Nater, Wolf, Ehlert, & Kirschbaum, 2004). As cortisol peaks approximately 20 min following the onset of a stressor (Kirschbaum & Hellhamer, 2000), the third sample was collected 20 min after the second sample. Salivary AA at each timepoint indexed sympathetic activity at that timepoint, whereas salivary cortisol at each timepoint indexed HPA axis activity approximately 20 min prior to that sample. The samples were stored in a −20°C freezer until assay.

Questionnaires Participants completed self-report measures of subjective stress. These measures included the Perceived Stress Scale (PSS), the Life Events Checklist for *DSM-5* (LEC-5), the PTSD Checklist for the *DSM-5* (PCL-5), and the Parenting Stress Index–Short Form (PSI-SF).

The PSS (Cohen, Kamarck, & Mermelstein, 1983) is a 10-item scale that measures the degree to which situations in a person's life over the past month are perceived as stressful. Item frequency is reported from 0 (*never*) to 4 (*very often*) and summed for a possible score between 0 and 40. Scores of 20 and higher are consistent with high perceived stress (Cohen & Williamson, 1988).

The LEC-5 (Weathers, Blake, et al., 2013) is a self-report screen for exposure to 16 stressful and potentially traumatic life events (e.g., severe accident, physical assault, sexual assault). For each event, the participant indicates, "Happened to me," "Witnessed it," "Learned about it," "Not sure," or "Doesn't apply." Due to the categorical responses, there are no summary scores for this measure.

The PCL-5 (Weathers, Litz, et al., 2013) is a 20-item self-report measure that assesses posttraumatic stress disorder (PTSD) symptom severity. For each symptom, the participant reports the extent to which she has been bothered by the symptom in the past month on a scale ranging from 0 (*not at all*) to 4 (*extremely*). The 20 items are summed for a total PTSD symptom severity score ranging from 0 to 80, and the suggested cutoff score for a provisional PTSD diagnosis is 33.

The PSI-SF (Abidin, 1990) is a 36-item scale that assesses parenting stress. The 36 items are divided into three empirically derived subscales: Parental Distress (α = .865), Parent–Child Dysfunctional Interaction subscale (α = .896), and Difficult Child (α = .901). Similar to the approach used in Tuerk and Loper's (2006) study of parenting stress in incarcerated women, participants were asked to consider the one minor child with whom they had the most contact at the time of data collection when answering these questions.

Data Preparation and Statistical Analyses

Saliva Biomarker Assays All assays were conducted by study personnel, and all samples were processed in duplicate. We conducted AA assays using Salimetrics kinetic reaction assay kits. The assay utilizes a chromagenic substrate, 2-chloro-*p*-nitrophenol linked to maltotriose. The amount of AA present in each sample is directly proportional to the increase in absorbance, measured spectrophotometrically by a standard plate reader at 405 nm. The intra-assay and interassay coefficients of variation for these kits are less than 7.5% and 6%, respectively.

We conducted cortisol assays using Salimetrics enzyme immunoassay kits. The kits utilize a microtiter plate coated with monoclonal anticortisol antibodies. Cortisol in samples and standards competes with cortisol conjugated with peroxidase for the antibody binding sites. The amount of cortisol enzyme detected is inversely proportional to the amount of cortisol present in the sample, measured spectrophotometrically by a standard plate reader at 450 nm. The intra-assay and interassay coefficients of variation for these kits are less than 7% and 10%, respectively.

Cortisol and AA values were positively skewed; therefore, we log transformed these variables to meet the assumption of normality. Cortisol and AA values that fell outside of the acceptable ranges suggested by the assay kit manufacturer were winsorized.

Analysis of Stress Reactivity As the sympathetic nervous system response peaks almost immediately following a stressor (Nater et al., 2005; Rohleder et al., 2004), we calculated AA percentage change from baseline to the sample immediately after description of a stressful parenting event. As the

HPA response is much slower, with a cortisol peak approximately 20 min poststressor (Kirschbaum & Hellhamer, 2000), we calculated cortisol percentage change from immediately after the parenting stress description to the sample collected 20 min postdescription.

Analysis of Biomarkers as Predictors of Subjective Maternal Stress We used regression analyses to test mean salivary AA and cortisol as predictors of self-reported parenting stress on the PSI and self-reported general perceived stress on the PSS. For these tests, if outliers were detected, we used robust regression analyses instead. Robust regression minimizes the influence of outliers on the model by weighting each data point according to its distance from the regression line.

Missing Data Of the 23 participants, three had insufficient saliva sample volume in one or more samples to measure cortisol and two had one or more values outside of the acceptable range, leaving 18 participants with valid data for cortisol reactivity analyses and 20 participants with valid data for mean cortisol analyses. For AA, two participants had insufficient sample volume in one or more samples and three participants had one or more AA values outside of the acceptable range, leaving 18 participants with valid AA data for reactivity analyses and 22 participants with valid data for mean AA analyses. One participant did not have values for the Difficult Child subscale of the PSI, and two participants did not complete the PSI; therefore, they were excluded from the relevant analyses.

RESULTS

Descriptive Data

Participant characteristics are summarized in Table 1. All women reported having experienced at least one traumatic event on the LEC-5 and most reported multiple events (number of traumatic events: $M = 6.6$, $SD = 2.7$). In addition to the listed events, participants also described additional unlisted traumatic events in the semistructured interview while discussing their lives as mothers, including violence enacted toward their children by others, homelessness, and having their children removed from them by child welfare authorities.

Self-report subjective stress measures are presented in Table 2. Despite the high numbers of traumatic life events, the sample mean for the PSS ($M = 17.9$, $SD = 4.5$) was not significantly higher than the normative mean for women

TABLE 1. Participant Characteristics ($N = 23$)

Age in years, *M* (*SD*), minimum–maximum	35.6 (9.3), 22–52
Race/ethnicity, *n* (%)	
Hispanic	8 (35)
Black or African American	5 (22)
White	5 (22)
Biracial or multiracial	5 (22)
Number of children, *M* (*SD*), minimum–maximum	3.4 (2.2), 1–8
Type of community criminal justice, *n* (%)	
Parole	8 (35)
Probation	11 (48)
Problem-solving courts	4 (17)
Number of trauma types, *M* (*SD*), minimum–maximum	6.6 (2.7), 2–10
Trauma type, *n* (%)	
Natural disaster	11 (48)
Fire/explosion	5 (22)
Transportation accident	15 (65)
Other serious accident	1 (4)
Exposure to toxic substances	1 (4)
Physical assault	21 (91)
Assault with a weapon	14 (61)
Sexual assault	15 (65)
Other unwanted sexual experience	17 (74)
Captivity	6 (26)
Life-threatening injury/illness	5 (22)
Severe human suffering	5 (22)
Witness violent death	2 (9)
Sudden, unexpected death of a loved one	16 (70)
Caused serious injury/death of another	4 (17)
Other very stressful event	14 (61)

TABLE 2. Self-Reported Subjective Stress Measures (*N* = 23)

Measure, possible scores	*M (SD)*, minimum–maximum
Perceived Stress Scale, 0–40	17.9 (4.5), 4–24
PTSD Checklist for *DSM-5*, 0–80	31.2 (20.7), 2–79
Reexperiencing	8.3 (6.4), 0–20
Avoidance & numbing	4.7 (2.6), 0–8
Negative alterations in cognitions and mood	10.0 (7.7), 1–28
Hyperarousal	8.2 (6.6), 0–23
Parenting Stress Index–Short Form	69.7 (22.1), 31–115
Parental distress	27.7 (8.3), 13–41
Parent–child dysfunctional interactions	19.9 (8.0), 9–36
Difficult child	23.2 (8.4), 13–32

Note. PTSD = posttraumatic stress disorder; DSM = *Diagnostic and Statistical Manual of Mental Disorders.*

(M = 16.14, SD = 7.56; Cohen & Janicki-Deverts, 2012), t (1053) = 1.11, p = .267, d = .22.

Scores on the PSS showed a medium strength association with the PSI-SF subscales of Parental Distress (r = .4, p = .059) and Parent–Child Dysfunctional Interactions (r = .35, p = .122), but not with the Difficult Child (r = .11, p = .647) subscale, although associations between PSS scores and parenting stress did not reach statistical significance.

Average PTSD symptom severity measured using the PCL (M = 31.2, SD = 20.7) was not above the suggested cutoff for a provisional PTSD diagnosis, which is 33. However, 10 scores were above the cutoff and 8 also met the other *DSM-5* criteria for a provisional PTSD diagnosis.

Mean AA and cortisol levels at each timepoint are presented in Table 3. Values for AA (M = 49.9, SD = 48.1) and cortisol (M = 0.18, SD = 0.16) were comparable with basal levels in normative samples of female smokers (AA: M = 59.9, SD = 50.9; cortisol: M = 0.23, SD = 0.14) (Granger et al., 2007).

Sympathetic and HPA Axis Activity

We conducted nonparametric paired-samples signed-rank tests to test differences among the three timepoints (T1, T2, and T3) for each analyte. Alpha-amylase and cortisol did not systematically differ across timepoints (see Table 3). Given the absence of observed sympathetic or HPA axis reactivity, we did not proceed with analyses testing the relation between reactivity and parenting stress. Additionally, given the absence of systematic differences across timepoints, and that we observed flat AA and cortisol profiles, which are consistent with normative activity over a brief (~1 hour) interval (Adam & Gunnar, 2001; Nater et al., 2006), we instead focused on the overall levels of salivary stress biomarkers. We used the mean values of AA and cortisol across the three timepoints to get the most accurate measures of biomarker levels during the study procedures.

HPA Axis Function and Self-Reported Parenting Stress

We used regression to test mean cortisol as a predictor of self-reported stress on the PSI (see Table 4). We visually inspected scatterplots, and if we detected outliers (i.e., individual data points with high leverage that were disproportionately influencing the slope of the regression line), we instead used robust regression. Mean cortisol predicted Parent–Child Dysfunctional Interactions, F(1, 16) = 16.64, p = .001, adj. R^2 = .48. However, mean cortisol did not predict the Parental Distress subscale, F(1, 16) = 1.56, p = .230, adj. R^2 = .03, or the Difficult Child subscale, F(1, 15) = 0.02, p = .896, adj. R^2 = −.07.

SNS Function and Self-Reported Parenting Stress

We used regression to test mean AA as a predictor of self-reported parenting stress (see Table 4). In a robust regression analysis, mean AA predicted scores on the Difficult Child subscale, F(1, 17) = 7.24, p = .015, adj. R^2 = .28. Mean AA did not predict the Parental Distress subscale, F(1, 18) = .03, p = .868, adj. R^2 = −.05, or the Parent–Child Dysfunctional Interaction subscale, F(1, 18) = 0.00, p = .981, adj. R^2 = −.06.

Stress System Function and General Perceived Stress

We used regression to test mean salivary cortisol and AA, separately, as predictors of general perceived stress as reported on the PSS. Mean cortisol and AA did not predict PSS scores (AA: F(1, 20) = 0.52, p = .477, adj. R^2 = −.023; cortisol: F(1,18) = 1.30, p = .270, adj. R^2 = .015).

DISCUSSION

We tested mean levels of salivary stress biomarkers and stress reactivity and their associations with subjective parenting stress in a sample of mothers under community criminal justice supervision. It is the first study, to our knowledge, to explore physiological parenting stress in mothers on probation or under supervision by a treatment court, two populations who experience serious acute and chronic stressors. Consistent with the literature on stress system function in other populations contending with extraordinary parenting challenges (Birditt, Kim, Zarit, Fingerman, & Loving, 2016), mean levels of salivary cortisol and AA were associated with self-reported parenting stress. Interestingly, these two biomarkers were associated with different subscales of the PSI, suggesting that SNS

TABLE 3. Salivary Stress Biomarkers Across the Study Time Points

Biomarker, *M* (*SD*)	Time 1	Time 2	Time 3	*M* (*SD*) Levels
Alpha amylase (U/ml)	50.3 (58.0)	43.2 (37.7)	57.4 (64.3)	49.9 (48.1)
Cortisol (μg/dl)	0.22 (0.25)	0.15 (0.12)	0.17 (0.13)	0.18 (0.16)

Note. There were no significant differences among the three points for either analyte.

TABLE 4. Salivary Stress Biomarkers as Predictors of Self-Reported Psychological Parenting Stress

	PSI-SF PD	PSI-SF PCDI	PSI-SF DC
Mean alpha amylase	−.05	−.06	.28*
Mean cortisol	.03	.48**	−.07

Note. PSI-SF = Parenting Stress Index–Short Form; PD = Parental Distress; PCDI = Parent–Child Dysfunctional Interactions; DC = Difficult Child.
R^2 values: *$p < .05$. **$p < .01$.

and HPA axis function are differentially associated with particular domains of parenting stress. These results contribute to the broader literature highlighting the distinct roles of the sympathetic and HPA systems and speak to the unique associations of AA and cortisol with maternal stress domains in community-supervised mothers.

Mean cortisol predicted higher parenting stress within the domain of dysfunctional parent–child interactions. High stress in this domain encompasses greater maternal dissatisfaction regarding the quality of dyadic interactions (e.g., a lack of perceived reciprocity) and has been linked with reduced maternal perception of her ability to control her child's behavior (Abidin, 1990). Dysfunction at the level of the mother–child dyad also predicts a variety of negative child outcomes, including internalizing symptoms (Costa, Weems, Pellerin, & Dalton, 2006) and aggression (Whiteside-Mansell et al., 2007). This result is consistent with the literature emphasizing the predominance of the HPA in response to threats of a social or relational nature. In particular, Laurent, Powers, and Granger (2013) reported an association between cortisol and negative affect following a social conflict. Similarly, Kiel and Buss (2013) reported an association between intrusive parenting and maternal embarrassment regarding their child's inhibited temperament among mothers with HPA hyperactivation. Finally, in studies using daily diary methods, negative interactions with offspring have been associated with changes in daily cortisol (e.g., Birditt et al., 2016). Stress related to negative interactions with children may be more acute in community supervised women given high rates of child welfare involvement and the resulting critical need to demonstrate maternal fitness. In women who are separated from their children, many interactions also occur in the presence of others, further amplifying stress. Interventions focused on empowering mothers to approach these interactions with their children more effectively, especially in the presence of others, might help to attenuate stress in this domain.

Conversely, mean AA was associated with the Difficult Child subscale, which assesses how difficult the mother perceives her child's behavior or temperament. Parental stress in this domain is associated with children's behavioral and self-regulatory problems (Costa et al., 2006). Although we did not assess child outcomes in this study, this finding is consistent with literature documenting a high burden of behavioral problems in the children of criminal justice involved women (Dallaire et al., 2015), including those under community supervision (Phillips, Venema, & Roque, 2010). This result also supports the predominance of the SNS versus HPA activity in response to imminent threats or challenges. In daily life, dealing with difficult child behavior is a challenge to which mothers must respond quickly to curtail future undesired behavior.

Importantly, both sympathetic and HPA hyperactivity can negatively affect maternal health and independently predict risk for suboptimal parenting practices. Whereas heightened stress system activity may be adaptive in the short-term, for example, by enabling mothers to respond to problematic behavior or avert potentially dangerous situations with their children, chronic activation of the stress systems can become maladaptive. For example, persistent sympathetic activity to child-related stimuli is associated with greater risk for harsh discipline (Joosen, Mesman, Bakermans-Kranenburg, & van Ijzendoorn, 2013). Likewise, higher maternal cortisol levels are associated with negative-intrusive parenting behaviors, and maternal cortisol reactivity to difficult child behavior is associated with harsh parenting practices (e.g., Martorell & Bugental, 2006). Although the mean levels of AA and cortisol in our sample were not elevated above the values reported in normative samples, our results suggest that even within these ranges, higher levels predict greater maternal stress. Targeting these biomarkers might therefore be an important component of parenting interventions.

At the group level, we did not observe sympathetic or HPA reactivity to our naturalistic parenting stress reminder. Given the literature on stress reactivity following trauma, this result was unexpected; although blunted HPA reactivity is often observed in trauma-exposed populations (Cordero et al., 2017), most of the literature suggests persistent sympathetic hyperactivation. However, a few studies have also reported blunted autonomic reactivity in response to stressful stimuli, potentially related to trauma-related dissociation, particularly in survivors of sexual abuse (Ginty, Masters, Nelson, Kaye, & Conklin, 2017). Although we do not discount the possibility of this dissociative subtype in our sample, given the high prevalence of severe sexual abuse, it is important to note that we did not observe a systematic decline in AA in response to our stress or or any behavioral evidence of stress-related immobilization.

A more parsimonious explanation for the lack of reactivity is that our mild, nonantagonistic stressor was insufficient to elicit a stress response. Given the sensitive nature of this research, we were motivated to design a stressor that would not be overwhelmingly distressing. Additionally, due to the open-ended nature of our parenting stress reminder prompt, participant responses varied in length, complexity, and relevance to the essence of our question. In some cases, women's accounts also included optimistic expressions about the future or acknowledgement of positive aspects of the stressful situation, potentially attenuating the stress response. Additionally, our participants might have been accustomed to talking about

these experiences as a result of their residence at the treatment center, where they are often asked to engage in such discussions of difficult life experiences. Future studies examining reactivity to parenting-related stressors in this population may need to utilize stressors that better mirror the daily challenges of mothering within the context of community criminal justice supervision.

Despite reporting considerable life adversity, our participants endorsed only moderate levels of perceived stress on the PSS, which were comparable to the mean values reported in normative samples. These results are consistent with previous studies that reported no differences in self-reported perceived stress between high and low socioeconomic status populations (Prescott, Godtfredsen, Osler, Schnohr, & Barefoot, 2007) and suggest that traumatized, chronically stressed women might have altered perceptions of external stressors as an adaptive mechanism for coping with unusually difficult life circumstances. Additionally, the women in our sample primarily interacted with other similarly disadvantaged women at the treatment center, which might have normalized experiences of severe trauma. Thus, the PSS might not adequately capture experiences of stress and its effects within chronically stressed and economically disadvantaged populations.

Limitations

One important limitation is our relatively small sample size, which limited the ability to assess the association between current custody status and parenting stress. Whereas mean AA and cortisol remain significantly associated with the Difficult Child and Parent–Child Dysfunctional Interactions subscales, respectively, when we exclude the four participants who lived with their children, future studies should be powered to include custody status in the analysis. The small sample size was compounded by instances of missing saliva data, given our relatively high rate of inadequate sample volume (~20%). Sample size also disproportionately affected statistical power for our analyses regarding reactivity, given that these analyses required that participants had valid data for at least two timepoints. Rates of inadequate sample volume could have been related to participant characteristics and treatment center residence. For example, smoking, which reduces salivary flow rate, is common in our population of interest, and most (82%) of our participants were habitual smokers. Participants also had relatively limited access to water in this treatment setting, which may have contributed to mild dehydration and xerostymia.

Second, although the samples were predominantly collected in the late morning and early afternoon, we were unable to rigorously control for collection time as the sample consisted of mothers whose supervision in the community was contingent on adherence to court-ordered mandates beyond their control (e.g., visits with parole/probation officers, drug testing, court appointments), thus limiting the times that they were available for study sessions. In addition, due to the treatment center's regulations, participants had limited access to phones and email, occasionally preventing them from successfully meeting with our research team at expected times. Similarly, whereas most studies required participants to refrain from eating, smoking, or drinking prior to study sessions to ensure accurate measurement of analytes, we could not reasonably impose these requirements on this population as they were already restricted in times that they were allowed to partake in these activities. Finally, given limited access to this population, it was not feasible to impose inclusion criteria related to age, medical conditions, and medication use, which are known to influence stress system activity and could have influenced levels of AA or cortisol. Future work with larger sample sizes could provide opportunities to control for the effects of these variables.

In addition to the challenges of obtaining saliva data, we were unable to obtain valid parenting stress data from two participants due to limited contact with their children at the time of data collection. Many of the items on the PSI presuppose a more traditional parent–child caregiving relationship, thus decreasing their applicability for currently noncustodial parents. Frequent maternal–child separations present a challenge for work in this area, and future studies might attempt to recruit more mothers who are currently living with their children. Alternatively, developing indices of parenting stress with this population in mind would allow researchers to examine mothering in the context of limited parent–child contact. As parenting stress in this population is associated with worse maternal (Adams et al., 2017; Van Voorhis et al., 2010) and child (McClure et al., 2015) outcomes regardless of custodial status, continued focus on both custodial and noncustodial mothers is warranted.

CONCLUSIONS

Our results point to the potential utility of two salivary stress biomarkers as predictors of various domains of parenting stress in mothers under community criminal justice supervision. Importantly, these associations can be detected at rest, sparing the burden to participants of experimentally induced stress. These results, if replicated with larger samples, could inform parenting interventions and provide a reliable and cost-effective strategy for measuring intervention efficacy. Ultimately, interventions that reduce maternal stress could bolster the maternal–child relationships and alleviate intergenerational health risks and maternal recidivism.

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