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Intimate Partner Violence, Mental Health, and HPA Axis Functioning

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Abstract: Research results are mixed as to whether stress exerts its damaging effects via under- or over-production of diurnal cortisol. Facets of the stressor itself as well as the mental health sequelae that follow have been put forward as important considerations in determining levels of cortisol secretion. We hypothesized that the contradictory findings in the literature were the result of variable-oriented methods masking the presence of distinctive subgroups of individuals. Using person-oriented methods, we explored whether there were classes of women who exhibited unique profiles of cortisol secretion, stress, and mental health by assessing 182 community women, many of whom had experienced intimate partner violence. The best fitting model in a latent profile analysis had 5 groups, each with distinct profiles of intimate partner violence stress (pregnancy and postpartum), cortisol secretion [cortisol awakening response (CAR) and diurnal slope], and mental health (posttraumatic stress, depressive, and anxiety symptoms). These were a Physiologically Under-Responsive group, a Healthy group, a Problematic CAR group, a Highest Stress/Normal Diurnal Slope group, and a Moderate Psychopathology/Normal Diurnal Slope group. Except for the Healthy group, the specific patterns of stress, mental health symptoms, and cortisol secretion identified in the literature were not found. The profiles were validated using variables that, in prior research, had shown relationships with the variables used to constitute the profiles—three types of parenting (neglectful, sensitive, and harsh), antisocial behavior, and physical health. We concluded that there is heterogeneity in women's responses to stress. Current theories focused on the under- or over-production of diurnal cortisol in relation to stress and mental health symptoms are simplistic and fail to account for the significant subgroups of women who show unique biological and psychological responses.

Keywords: Intimate partner violence, cortisol, anxiety, depression, posttraumatic stress, life stress, trauma, HPA axis

Introduction

Research on the physiological manifestations of stress has focused mainly on cortisol secretion, the end product of the hypothalamic-pituitary-adrenocorticol (HPA) system, as it is one of the primary mechanisms that translates how chronic stress influences health. However, there are contradictory theories about how stress exerts its damaging effects. Some researchers argue that stress increases cortisol production, and the over-production of cortisol then leads to biological dysregulation (e.g., Heim & Nemeroff, 1999), while others believe that stress decreases cortisol production to the point that its deficiency can be problematic (Fries, Hesse, Hellhammer, & Hellhammer, 2005). Research supports both perspectives. A recent meta-analysis suggested that characteristics of the stressful events including, for example, timing and chronicity as well as the psychological sequelae that follow, affect whether individuals experience hypo- or hypercorticolism after stress exposure (Miller, Chen, & Zhou, 2007). Such findings have been taken to indicate the need for research that focuses on multiple characteristics of stressors as determinants of the in-

dividual's response to stress. However, taking another perspective, the findings also indicate the possibility that there are person-specific differences in stress responses. Using a person-oriented approach, and focusing on the stress of intimate partner violence (IPV), we tested whether there were subgroups of women with distinct profiles associated with their experiences of IPV stress, its psychological sequelae, and daily cortisol secretion.

IPV, unlike many other stressors (e.g., natural disasters), occurs frequently, with about 30% of women reporting lifetime experiences of IPV (Breiding et al., 2014). Importantly, IPV varies on two factors implicated in the amount of daily cortisol an individual produces in response to stress: the timing/chronicity of exposure to the stressor and the mental health sequelae that follow. Miller et al.'s (2007) meta-analysis found that chronic stress, not specific to IPV, was associated with high diurnal cortisol production. When the stressor ended, cortisol production was reduced, especially as time away from the stressor increased. As regards IPV, it manifests across individuals on a frequency continuum ranging from none to chronic stress (Martsolf, Draucker, Stephenson, Cook, & Heckman, 2012), and patterns of exposure may change over time. There is some research examining whether the timing/chronicity of IPV affects cortisol secretion. As far as timing goes, Inslicht et al. (2006) found that more recent abuse was associated with higher diurnal cortisol. As regards chronicity, Johnson, Delahanty, and Pinna (2008) found that chronic IPV was associated with lower cortisol awakening response. Although the indicators of cortisol secretion were different in the Inslicht et al. (2006) and Johnson et al. (2008) research, the findings suggest that timing as well as chronicity are important considerations when examining the influence of stress. However, no research has examined the relative effects of these two characteristics.

The second factor associated with daily cortisol output is the mental health sequelae that follow the stress (Miller et al., 2007). Post traumatic stress disorder (PTSD) and depression following stress are quite common (e.g., Shih, Schell, Hambarsoomian, Belzberg, & Marshall, 2010). IPV has been consistently associated with various psychological sequelae. The prevalence of depression among women experiencing IPV ranges from 35-75% (e.g., Nathanson, Shorey, Tirone, & Rhatigan, 2012; Petersen, Gazmararian, & Clark, 2001), and the prevalence of PTSD ranges from 45% to 84% (e.g., Jones, Hughes, & Unterstaller, 2001). Comorbidity between PTSD and depression is high (Nixon, Resick, & Nishith, 2004; Stein & Kennedy, 2001). Women exposed to IPV also have a higher risk for anxiety symptoms and diagnoses (e.g., Mitchell et al., 2006; Pico-Alfonso et al., 2006).

Two indices of diurnal cortisol secretion have been explored as correlates of mental health problems: (1) the cortisol awakening response (CAR), a steep increase 30 to 45 minutes after awakening and (2) the diurnal slope, the declining levels of cortisol from CAR throughout the rest of the day. Considerable research reports a flattened cortisol secretion profile for individuals with PTSD, characterized by reduced CAR and a less steep decline throughout the day (e.g., Neylan et al., 2005; Wessa, Rohleder, Kirschbaum, & Flor, 2006). And, yet, a recent meta-analysis found no effect of PTSD on cortisol (Klaassens, Giltay, Cuijpers, van Veen, & Zitman, 2012). Among depressed individuals, some studies report a flattened diurnal slope, while others report overall increased cortisol levels throughout the day (for review see Fries, Dettenborn, & Kirschbaum, 2009). Only dexamethasone-suppression test measures of cortisol have found different patterns of cortisol release related to psychopathology; individuals with PTSD had enhanced suppression of cortisol whereas those with major depressive disorder did not (Miller et al., 2007). Morris, Compas, and Garber's (2012) meta-analysis, that focused on PTSD and major depressive disorder, found similar results, but they cautioned that research must include PTSD that is comorbid with depression in order to understand fully which mental health problem is contributing to the level of cortisol output.

Specific to IPV exposure, findings of the associations among daily cortisol secretion, abuse, and subsequent mental health sequelae are also not consistent (e.g., Inslicht et al., 2006; Pinna, Johnson, & Delahanty, 2014). For example, in one study, women experiencing IPV with PTSD only or comorbid with depression had lower CAR compared to women experiencing IPV without PTSD as well as controls (Griffin, Resick, & Yehuda, 2005); whereas, in another study, women experiencing IPV had lower levels of CAR compared to controls, but there was no difference between IPV women with and without PTSD (Seedat, Stein, Kennedy, & Hauger, 2003). Furthermore, there is some research that finds, among women experiencing IPV, *no association* between basal or diurnal cortisol secretion and women with PTSD, major depressive disorder (MDD), and comorbid PTSD and MDD (Basu, Levendosky, & Lonstein, 2013) or *lower* baseline cortisol when women had PTSD or when PTSD was comorbid with depression (Griffin et al., 2005).

The two factors, noted above, that can affect cortisol secretion—timing/chronicity of exposure to the stressor and mental health sequelae–are not necessarily independent. In the IPV literature, a dose response effect for IPV and mental health has been found. More chronic IPV has been associated with more depression, anxiety, and PTSD (e.g., Bogat, Levendosky, DeJonghe, Davidson, & von Eye, 2004; Bogat, Levendosky, Theran, von Eye, & Davidson, 2003; Bonomi et al., 2006). Mental health status is also affected by recency of IPV as well as its termination. Research finds that more recent abuse is related to worse mental health outcomes for women (e.g., Bogat et al., 2003). When physical abuse ends, women's depression often abates (e.g., Bogat et al., 2004); but this is not always the case (see Anderson, Saunders, Yoshihama, Bybee, & Sullivan, 2003). Only one study to date has examined cortisol secretion as it relates to timing of IPV and mental health. Johnson et al. (2008) found that PTSD and IPV chronicity had opposite effects on cortisol secretion–PTSD was associated with higher CAR while IPV chronicity was associated with lower CAR. The analyses were variable-oriented, however, so there is no indication of whether certain patterns of mental health

and IPV relate to specific types of cortisol secretion.

Current Research

The relationship between stressful experiences and HPA axis dysregulation is complex. Characteristics of the stressor itself as well as the psychological consequences of the stress have been associated with hypo- or hyper-cortisol secretion. However, research on biobehavioral responses to stress, including IPV, suffers from numerous methodological problems, including (1) assessment of cortisol at one time point, (2) assessment of the stressor at one time point, and (3) failure to account for the multiple psychological problems that result from the stressor. Findings of two recent meta-analyses (Miller et al., 2007; Morris et al., 2012) suggest that a better understanding of the relationship between stress and HPA-axis dysregulation requires methods where multiple variables, from different systems, are examined simultaneously. This also comports with changes in our understanding of the relationship between physiological and emotional responses. There is much evidence that these responses are not linear, as once thought, but, in fact, are loosely coupled (e.g., Lewis, 2011). However, most research examining "biobehavioral" profiles has been conducted among children, rather than adults.

Investigating multiple causes for the production of cortisol under conditions of stress is a variable-oriented approach, getting us no closer to understanding person-specific differences in stress responses. The current research employed a person-oriented approach to determine whether there were subgroups of women who could be differentiated based on characteristics of the stress (IPV) experienced, their psychological response to it, and their daily pattern of cortisol production. We conducted latent profile analyses with variables assessing two time periods of stress (pregnancy and postpartum IPV), three mental health symptoms (depression, PTSD, and anxiety), and two measures of salivary cortisol (CAR and evening slope) in order to form groups built on data decomposition.

Based on the literature, we expected to find 4 groups of women: (1) a "healthy" group whose profile consisted of low stress, low levels of mental health problems, and typical cortisol secretion (elevated CAR and a sizeable decreasing diurnal slope) that corresponded to the relationships among these variables supported in the variable-oriented research, and (2) a resilient group with high levels of stress, low levels of mental health problems, and typical cortisol secretion. We predicted the resilient group based on the general resiliency research which finds that some adults do well even under conditions of high stress (Bonanno, 2004). The next two profiles we predicted were based on the possibility that under conditions of elevated stress, women's psychological manifestations of stress (i.e., mental health problems) would not necessarily correspond to the physiological manifestations of stress (i.e., diurnal cortisol secretion). Thus, there would also be (3) a physiologically under-responsive group with high/moderate levels of stress, high/moderate levels of mental health problems, and a blunted CAR and diurnal slope. These women would exhibit a phenotypic pattern of psychological distress but show no physiological signs of stress. And, finally, (4) a physiologically-activated group with high/moderate levels of stress, lower levels of mental health problems, and a dysregulated CAR and diurnal slope. These women would exhibit what we considered to be a "numbing" or "dissociative" profile—they exhibit low/no psychological distress but atypical physiological responses under conditions of tremendous stress. Although we hypothesized these would be the most likely profiles to emerge, we expected that other profiles might also be present.

We also explored the external validity of the profiles by determining whether they systematically differed on variables that were not used to create the groups but have been associated with mental health, stress, and/or cortisol secretion. Specifically, we expected the groups would vary on maternal physical health, parenting, and antisocial behavior. Physical health problems among abused women are widespread and include injuries, immune disorders, difficulty sleeping, and gastrointestinal problems (Eby, Campbell, Sullivan, & Davidson, 1995). Physical health problems are also associated with the mental health problems that we used to create the profiles [PTSD (e.g., McFarlane, 2010), depression (e.g., Gasse, Laursen, & Baune, 2014), and anxiety (e.g., Roest, Martens, de Jonge, & Denollet, 2010)] as well as HPA axis dyregulation (e.g., Charmandari, Tsigos, & Chrousos, 2005; Girod & Brotman, 2004). Women's experiences of IPV can also affect their parenting and the child's attachment security (Levendosky, Bogat, Huth-Bocks, Rosenblum, & von Eye, 2011; Levendosky, Leahy, Bogat, Davidson, & von Eye, 2006). Problems in parenting are associated with higher levels of IPV (e.g., Gustafsson, Cox, & Blair, 2012), mental health (especially depression, Hoffman, Crnic, & Baker, 2006; Lyons-Ruth, Wolfe, Lyubchik, & Steingard, 2002); and stress reactivity, Martorell & Bugental, 2006; Schechter et al., 2004). Finally, most IPV is bidirectional (Langhinrichsen-Rohling, Misra, Selwyn, & Rohling, 2012), indicating that both men and women have the potential to be aggressive and antisocial. In those samples where women are arrested for IPV perpetration, research finds that they are more likely to have antisocial personality disorder (ASPD) compared to control women (e.g., Stuart, Moore, Gordon, Ramsey, & Kahler, 2006), have the same rates of ASPD as men (e.g., Henning, Jones, & Holdford, 2003), or, when they have ASPD, are more likely to engage in physical violence than men (e.g., Dykstra, Schumacher, Mota, & Coffey, 2015).

Method

Participants

Participants were 182 women from mid and southeast-lower Michigan who were assessed when their infants were one year of age. They were recruited from agencies that serve women (e.g., WIC, ob/gyn clinics), flyers posted in public settings (e.g., bulletin boards), and electronic bulletin boards. More than 900 women were screened for eligibility. We admitted women with heterogeneous experi-

ences of IPV—pregnancy only, postpartum only, pregnancy and postpartum, and no IPV. Women in these groups were matched on broad demographic categories of race/ethnicity, income, marital status, age, and educational status. Only women with moderate to severe IPV experiences (rated by the Severity of Violence Against Women Scales, see measures) were eligible for the IPV groups. Women also had to meet seven inclusion criteria in order to be in the study: (1) English-speaking, (2) 18 to 34 years old, (3) not pregnant, (4) not lactating or willing to not breast feed child for 2 hours prior to assessment, (5) *without* endocrine or other disorders associated with abnormal glucocorticoid release (Cushings, Addisons Disease, cancer, cancer therapy, Findling & Raff, 2006), (6) involved in a heterosexual romantic relationship for at least 6 weeks during the pregnancy; and (7) no premature delivery (i.e., $<$ 37 weeks; Buske-Kirschbaum et al., 1997).

Demographic information was determined through women's self report. The women's average age was 24.5 years (range: 18-34), and they had a median monthly income of \$900 (SD = \$961). More than half were not living with their partners (51%), 28% were living with their partners but were not married, and 21% were married. Most had completed high school or some post-high school education (80%). The racial composition of the sample was diverse: 43% were Caucasian, 33% African American, 15% multi-racial, and 9% Latina.

Measures for the Latent Profile Analysis

Intimate Partner Violence. We assessed women's experiences of IPV with the *Severity of Violence Against Women Scales* (Marshall, 1992), a 46-item scale which includes mild, moderate, and severe threats and violence. Each item is scored for frequency on a 4-point scale. Women completed the measure twice: once to recollect experiences of IPV during pregnancy and once for experiences of IPV during the first year after the child's birth (postpartum). "Event history" questions were used to aid our participants' recollection of these two time periods (Belli, 1998; Kessler & Wethington, 1991), a technique that increases the accuracy of IPV reports compared to a standard interview (Yoshihama, Gillespie, Hammock, Belli, & Tolman, 2005). Although, as stated above, the IPV criteria for study selection was moderate to severe violence, for the analyses, all of the IPV items were used to compute scores for pregnancy and postpartum IPV for all women.

The Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987), a 10-item questionnaire, assesses self-reported depressive symptoms in the past week. Each item has a 4-point Likert scale; the items were summed to create a depression score. Higher scores indicate greater symptom severity. Fifty-six percent of our participants scored in the "probable" depression range (>12, Cox et al., 1987).

The Modified PTSD Symptom Scale–Self Report (Falsetti, Resnick, Resick, & Kilpatrick, 1993) assessed posttraumatic stress disorder symptoms that could be secondary to any traumatic experience. This instrument measures the frequency of PTSD symptoms in the prior 2 weeks (e.g., 0 = not at all; 3 = 5 or more times per week/very much/almost always). A PTSD symptom score was calculated by summing all items. In a recent article, using a cutoff score of 29, the scale showed "a sensitivity rate of 89%, a specificity rate of 77%, and an overall classification rate of 80%" (p. 1, Ruglass, Papini, Trub, & Hien, 2014) for detecting PTSD.

The GAD-7 (Spitzer, Kroenke, Williams, & Löwe, 2006) consists of seven questions that query anxiety symptoms in the past two weeks. Each question has 4 response categories ranging from "not at all" to "nearly every day." Participants scoring "5" are considered to have mild anxiety, those scoring "10" have moderate anxiety, and those scoring "15 or higher" have severe anxiety. In general, a score of 10 or higher is consistent with a clinical diagnosis of Generalized Anxiety Disorder. The GAD-7 demonstrated high internal consistency and test-retest reliability (Spitzer et al., 2006) as well as good sensitivity and specificity for detecting generalized anxiety disorder (Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007).

Salivary Cortisol. Women independently collected salivary cortisol samples at home on two different days. On the first day, saliva was collected at awakening, 30 minutes post awakening, and 5 p.m. On the second day, saliva was collected at awakening and 30 minutes post awakening. Women recorded on a paper diary the time of each saliva collection. Women were instructed to place each sample in the freezer immediately after collection. Research assistants came to the house to collect the samples as soon as possible after all samples were taken. Samples were then frozen in the laboratory at -80 C. On the day of assaying, samples were thawed and centrifuged for 15 minutes at 1300 rpm.

Samples were assayed with a commercially available enzyme immunoassay (EIA) kit (Salimetrics, Carlsbad, CA). The assay is 510K cleared (US FDA) as a diagnostic measure of adrenal function; the range of detection is from 0.003 to 3.0 μg/dl. Two labs completed the assays, the Lonstein lab at Michigan State University and the Vasquez lab at University of Michigan Hospital. To obtain a measure of intra-assay variability, 10% of the samples were chosen randomly and assayed in duplicate. The intra- and inter-assay coefficients of variation were 15 and 17%, respectively.

Raw cortisol scores were analyzed for outliers (scores that could not exist given the inter- and intra-assay coefficients of variation). Scores that were 3 SDs above the mean were identified as outliers and truncated to reduce distributional problems while maintaining the relative order of scores. Cortisol values were log-transformed to address non-normality, per conventional practices. Two scores were calculated: the cortisol awakening response (CAR) slope and the evening slope. The CAR slope was calculated as (30 minutes post awakening cortisol) – (awakening cortisol); the average of the 2 consecutive days was used. CAR is more stable than other measures, better capturing trait-level cortisol secretion, and can be seen among 75% of healthy adults (Hucklebridge, Hussain, Evans, & Clow, 2005; Pruessner et al., 1997; Wust et al., 2000). The corre-

lation between raw scores for day 1 and day 2 was .74 for awake and .77 for 30-minute post-awake. The correlation between the raw scores was more stable than that for the log-transformed difference scores ($r = .22$). Although low, this is similar to that reported by other researchers (e.g., Edwards, Evans, Hucklebridge, & Clow, 2001). The evening slope was calculated as (30 minutes post-awakening cortisol) − (evening cortisol). This measure was only available for day 1. Importantly, research finds that CAR is independent from diurnal cortisol secretion (e.g., Edwards, Clow, Evans, & Hucklebridge, 2001).

Measures to Validate the Profiles

The Physical Health Questionnaire (Schat, Kelloway, & Desmarais, 2005) is a 14-item self-report questionnaire that measures somatic symptoms in four areas: gastrointestinal problems, headaches, sleep disturbances, and respiratory illness. Items were summed to create the physical health variable.

The Parenting Behavior Checklist (Fox, 1992) is a 100-item self-report questionnaire applicable for children ages 1-4. The nurturing and harsh subscales were analyzed.

Multidimensional Neglectful Behavior Scale (Kantor, Holt, & Straus, 2003) assesses 14 neglectful parenting behaviors via maternal self-report. It is applicable for children from age 0 to 4 years 11 months.

The Subtypes of Antisocial Behavior Questionnaire (Burt & Donnellan, 2009) measures three types of antisocial behavior: rule-breaking, social aggression, and physical aggression. It is a self-report measure with 32 items which are summed to provide an overall score.

Cumulative Risk. We created a cumulative risk score to control for demographic differences among the groups when we conducted a MANOVA to validate the groups. Each of 5 risk variables was dichotomized as either 1 = risk and 0 = no risk. The variables were income (below Medicaid poverty cut-off = 1), marital status (single = 1), age (< 22 years = 1), negative life events measured by the Life Experiences Survey (Sarason, Johnson, & Siegal, 1978) (highest 25% percentile = 1), and drug use measured by the Perinatal Risk Assessment Monitoring Survey (Gilbert, Shulman, Fischer, & Rogers, 1999) (any street drug use pre- or postnatal = 1). The cumulative risk score ranged from 0 to 5.

Procedures

Interested women who saw our flyer, telephoned the project office, provided informed consent to answer questions about their health and IPV status, and then were given a screening interview by trained research assistants to determine their eligibility. At the end of the interview, women who met criteria and were still interested in further participation were asked to provide contact information, including email and telephone numbers. Because there was the possibility that a woman might not wish her spouse to know about her participation, we collected specific information about preferences for telephone contact, including whether we should block caller ID, leave/not leave a message on her voicemail or answering machine, and/or only call during specific times of the day or evening. Based on eligibility and consent, women were scheduled for assessments when their children were about 1 year old. All assessments took place in project offices and were administered by trained graduate and/or undergraduate students. Women provided informed consent, and the questionnaires used in this research were administered. At the end of this assessment, women were financially compensated for their participation.

Women were also asked whether they were interested in participating in an additional component of the research—the collection of diurnal salivary cortisol at their homes. They were asked a series of questions, using a decision tree model, which allowed the research team to assess for the woman's safety in completing the collection. If safety was not a concern, and if the women consented to provide these samples, they were given a "kit" consisting of test tubes and instruction sheets that described what time to take the samples, how to fill the test tubes, what activities or foods were prohibited before the collection, and the importance of keeping the samples frozen. A time that a research assistant could drive to the woman's home to retrieve the samples was arranged. Upon completion of the diurnal salivary cortisol samples, the woman was provided additional financial compensation.

Results

Missing Data

Less than 5% of all data points were missing. Sixteen percent of women were missing at least one cortisol score, and missing values were primarily due to women forgetting to complete the home saliva samples, completing the home samples outside of the sampling timeframe (e.g., taking both morning samples 60 minutes after awakening), or not providing enough saliva for assaying. To explore potential systematic missingness, we evaluated the differences between women with complete data and those with missing cortisol scores using T-tests. ANOVAs showed a random pattern of missingness, as means for income, exposure to violence pre- and postnatally, depression, anxiety, and PTSD symptoms were not significantly different between these two groups. Missing-at-random data allowed use of full information maximum likelihood (FIML) as the estimation method in all analyses, which maximizes power by fitting the models to all of the non-missing values for each participant (Widaman, 2006).

Descriptive Statistics

Some variables showed the expected pattern of associations. For example, IPV during pregnancy and the first year postpartum were significantly associated with each other ($r = .70$), and were both associated with higher levels

Table 1. Latent Profile Models Fit Indices.

	N	AIC	BIC	Adj BIC	Entropy
2 Latent Profiles	LP1 = 132 LP2 = 50	6855.58	6926.07	6856.39	.89
3 Latent Profiles	LP1 = 105 LP2 = 18 LP3 = 59	6719.72	6815.84	6720.82	.89
4 Latent Profiles	LP1 = 57 LP2 = 103 LP3 = 3 LP4 = 19	6618.66	6740.41	6620.06	.91
5 Latent Profiles	LP1 = 51 LP2 = 85 LP3 = 11 LP4 = 3 LP5 = 32	6554.83	6702.21	6556.52	.90
6 Latent Profiles	LP1 = 51 LP2 = 85 LP3 = 1 LP4 = 11 LP5 = 32 LP5 = 2	6544.61	6717.63	6546.60	.92

of depression, anxiety, and PTSD (r = .31 to .49). However, mental health variables were not correlated with cortisol levels during morning or afternoon, or with indices of change in cortisol levels throughout the day (i.e., the cortisol awakening response slope or the evening slope). The lack of linear relationships between the diurnal cortisol rhythm and risk or psychopathology outcomes provided further evidence that the person-oriented approaches we proposed may be better suited to explore subgroups of IPV exposed women with particular profiles of stress, mental health, and neurobiological functioning.

Latent Profile Analysis

Latent Profile Analysis (LPA; Lazarsfeld & Henry, 1968) empirically defines subgroups or profiles of individuals based on their degree of similarity on a number of continuous indicators (Lanza, Flaherty, & Collins, 2003). Models with different numbers of predetermined profiles are estimated and the best solution can be selected based on model fit, using indicators of external validity or generalizability (i.e., BIC and AIC), as well as indicators of maximal distinction between the groups (i.e., entropy; Kline, 2005). LPA was conducted using scores on pregnancy IPV, postpartum IPV, depression, anxiety, PTSD symptoms, the cortisol awakening response (CAR) slope (awakening to 30 minutes post awakening), and the morning to evening cortisol slope (30 minutes post awakening to 5 p.m.).

Models with one to six latent profiles were estimated using MPLUS 6 (Muthén & Muthén, 2010). Fit indices (See Table 1) suggest that AIC and BIC improved as the number of profiles increased, with a significant improvement on both indices from the 2-profile to the 5-profile model. AIC improved only moderately from the 5-profile to 6-profile model, while BIC showed moderate fit worsening for the 6-profile model. The scree plot showed that AIC and BIC level-off or increase after the 5-profile solution, suggesting that additional decreases in AIC (associated with increasing the number of classes to 6) are negligible. Entropy was high and very similar for all models, ranging from .90 to .92. Thus, the model with 5 latent profiles was selected as the best fitting model. See Figure 1.

The profiles are discussed in relationship to each other. For the mental health variables, where scale norms are available, they are discussed vis-à-vis clinical cut offs. For the anxiety scale that is 10 or higher, for the PTSD scale that is 29 or higher, and for the depression scale that is 12 or higher.

Two of the 4 hypothesized profiles were found in the 5 group LPA. Latent Profile 1 (LP1 n = 51) included women with relatively low levels of pregnancy and postpartum IPV (second lowest among the groups); borderline clinical levels of anxiety, non-clinical levels of PTSD, clinical levels of depressive symptoms as well as flat CAR and diurnal slope (See Table 2). These women were similar, but not identical to, the hypothesized Physiologically Under-Responsive group, and they will be referred to as such. This latent profile of women did not have high/moderate levels of IPV as did the predicted group. Compared to the other groups, women in LP2 (n = 85), the hypothesized "healthy" group, were characterized by the lowest levels of pregnancy and postpartum IPV, the lowest levels of depressive, anxiety, and PTSD symptoms (all well below the clinical cutoffs), and a "normative" pattern of diurnal cortisol secretion.

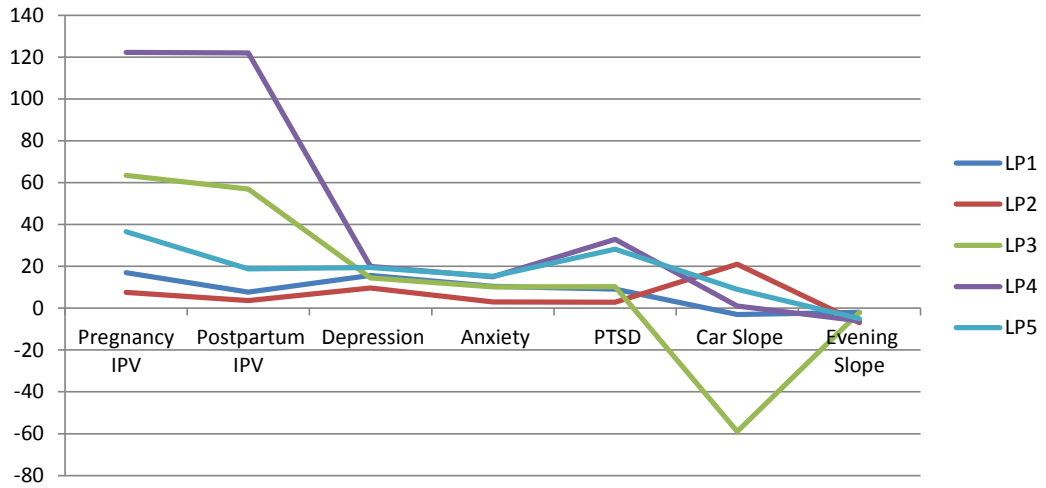

Figure 1. Five profiles of women based on means of IPV, mental health, and diurnal cortisol. Cortisol slopes are multiplied by 10 to facilitate graphic representation. 1 = Physiologically Under-Responsive Group; 2 = Healthy Group; 3 = Problematic CAR Group; 4 = Highest Stress/Normal Diurnal Slope Group; and 5 = Moderate Psychopathology/Normal Diurnal Slope Group.

The remaining three groups were not predicted by us based on the variable-oriented literature. The women in LP3 ($n = 11$) had the second highest levels of IPV during both pregnancy and postpartum, clinical levels of depression, borderline clinical levels of anxiety, and nonclinical levels of PTSD symptoms. They also had a *decrease* in CAR, and a flattened diurnal slope. We labeled this profile the "Problematic CAR" Group. Three-subjects (LP4) were distinguishable from other women and identified in the models with 4, 5, and 6 profiles, potentially due to their extremely high levels of violence exposure during pregnancy and postpartum as well as clinical levels of all mental health symptoms. Their CAR was flat, but their evening slope was most similar to the Healthy Group. We labeled this profile the "Highest Stress/Normal Diurnal Slope" Group. The last group (LP5) of women experienced the second highest levels of IPV during pregnancy and postpartum and mental health symptoms very similar to LP4 (depression and anxiety met clinical cutoffs, PTSD nearly met the cutoff (28.16 vs. 29). However, interestingly, the cortisol diurnal pattern was similar to that of the "healthy" LP2 group. This profile was labeled the "Moderate Psychopathology/Normal Diurnal Slope" Group.

Using MANOVA, with the cumulative risk score as a control variable, we validated 4 of the 5 profiles (Group 4 was too small to include in the analysis) by examining whether they differed on three types of parenting (sensitive, harsh, and neglectful), physical health, and antisocial behavior. There was a main effect for neglectful parenting, antisocial behavior, and physical health ($F = 5.10$, $p < .001$, $\rho\eta^2 = .13$). Group 2 had less neglectful parenting than Group 5 ($\bar{X} = 20.19$ and $\bar{X} = 21.87$; respectively). Group 2 had less antisocial behavior than Groups 1 and 5 ($\bar{X} = 45.77$, $\bar{X} = 53.60$, and $\bar{X} = 62.97$; respectively), and Group 1 had less than Group 5. For physical health, Group 2 had better health than Groups 1, 3, and 5 ($\bar{X} = 36.65$,$\bar{X} = 45.68$, $\bar{X} = 58.42$, and $\bar{X} = 54.07$; respectively), and Groups 1 and 3 ($\bar{X} = 43.77$) had better physical health than Group 5.

Discussion

In our sample, there were 5 distinct profiles of women who differed in their IPV experiences, mental health symptoms, and cortisol secretion patterns. Thus, as expected, there are person-specific differences in women's physiological and psychological responses to stress. Although research has focused on understanding specific stress-related factors that might discern why some individuals hypo- or hypersecrete cortisol, our findings suggest that searching for those factors and studying them in isolation may prove futile.

The Healthy Group (LP2) is the only group of women who conformed to the "typical" or "standard" patterns found by previous variable-oriented research. All the other patterns were diverse from each other, suggesting that individual differences are important and may vary considerably, and in unexpected ways, from the "normal" patterns. There were groups with high, moderate, and low levels of pregnancy and postpartum IPV as well as mental health symptoms that did and did not meet clinical cutoffs. There were groups with the patterns of cortisol secretion documented with normative populations (high CAR with a gradual lessening throughout the day) as well as those with dysregulated cortisol secretion (no elevation in CAR, a substantial decrease in CAR, and a flattened diurnal pattern).

Importantly, there were no specific patterns of psychological features of the women associated with the cortisol patterns. This runs counter to prior research. For example, Johnson et al. (2008) found higher CAR associated with PTSD, and IPV chronicity was associated with lower CAR. In our study, the groups with the highest levels of PTSD had flat CARs and typical diurnal slopes (Highest Stress/Normal Diurnal Slope—LP4 and Moderate Psychopathology/Normal Diurnal Slope—LP5).

Regarding IPV, we also did not find that timing and/or

Table 2. Latent Profile Estimated Means (and Standard Errors) for IPV, Depression, PTSD, Anxiety, and Cortisol.

	LP1 ($n = 51$)	LP2 ($n = 85$)	LP3 ($n = 11$)	LP4 ($n = 3$)	LP5 ($n = 32$)
Pregnancy IPV	16.97 (3.62)	7.59 (1.85)	63.41 (7.00)	122.22 (4.98)	36.48 (6.73)
Postpartum IPV	7.70 (1.68)	3.57 (.74)	56.86 (4.91)	122 (7.12)	18.84 (3.71)
Depression	15.63 (.61)	9.68 (.45)	14.51 (.68)	19.98 (2.87)	19.40 (.76)
Anxiety	10.44 (1.10)	3.02 (.45)	10.10 (1.19)	14.94 (3.51)	15.19 (.77)
PTSD	9.06 (1.75)	2.88 (.50)	10.29 (1.96)	32.83 (6.44)	28.16 (1.87)
CAR Slope	-0.03 (.15)	0.21 (.12)	-0.59 (.46)	0.01 (.36)	0.09 (.18)
Evening Slope	-0.02 (.01)	-0.07 (.01)	-0.02 (.03)	-0.06 (.04)	-0.05 (.02)

chronicity was associated with a consistent pattern of physiological responses. High levels of IPV stress at both pregnancy and postpartum (i.e., chronic) were not always associated with the same physiological response. Two groups failed to show the normative CAR slope: women with the highest levels of pregnancy and postpartum IPV and clinical levels of all mental health symptoms (Problematic CAR Group—LP3), and women with relatively low levels of IPV and clinical levels of depression, borderline clinical levels of anxiety, and non-clinical levels of PTSD (Physiologically Under-Responsive Group—LP1). These 2 groups also displayed the flattest evening slope. The Problematic CAR Group (LP3) is particularly interesting, because the women's CAR decreases. CAR is typically interpreted as a naturally occurring stress—an anticipatory reaction to the day; thus, these women do not seem to have this preparatory physiological response. Decreased CAR has been linked to chronic stress (Fries et al., 2005; Hellhammer & Wade, 1993) and early loss of a significant other (Meinlschmidt & Heim, 2005). Consistent with this, the Problematic CAR group (LP3) did have the second highest levels of both pregnancy and postpartum IPV. But high stress was not always associated with a decreasing CAR among the groups in our sample. The Highest Stress/Normal Diurnal Slope Group (LP4) had the most severe chronic stress and a flat CAR (not decreasing) with a normal diurnal slope. Compare this with the Physiologically Under-Responsive Group (LP1) who had low levels of IPV, clinical levels of depression, borderline clinical levels of anxiety, no PTSD, and a slightly decreasing CAR and a flat diurnal slope.

We did not find a Resilient Group in our data as we predicted; that is, a group with high stress, low psychopathology, and normal diurnal cortisol secretion. This is surprising because resilience trajectories have been identified in adults (see Bonanno, 2012). However, research has only associated cortisol secretion with one or two factors related to resilience (e.g., Simeon et al., 2007), and the research has not used person-oriented methods. We also did not find evidence of a Physiologically-Activated Group; that is, a group with high/moderate levels of stress, below clinical-cutoff levels of all mental health symptoms, and dysregulated cortisol secretion. We expected to see such a group based on person-oriented research conducted with infants finding that such groups exist (Garcia, Bogat, Levendosky, & Lonstein, 2014; Towe-Goodman, Stifter, Mills-Koonce, & Granger, 2012). In the infant studies, it is hypothesized that this group maintains an outward level of calm, while evidencing dysregulated physiological stress responses–a pattern that might keep the child "under the radar"; thus, providing benefit when living in a household with IPV. It may be, however, that adults do not have this profile.

However, although not all of the hypothesized groups emerged in our analysis, we have confidence in these profiles because we were able to validate 4 of them using variables that have been associated with IPV, mental health, and/or patterns of cortisol release. We could not include the Highest Stress/Normal Diurnal Slope Group (LP4) in the analyses because of the small number of women it comprised ($n = 3$). The Healthy Group (LP2) had better parenting, better physical health, and less antisocial behavior compared to the other groups. This would be expected given their profile of low levels of IPV and below threshold mental health problems as well as the expected CAR and diurnal slope based on studies of "healthy" samples.

For the other 3 groups, the levels of the validating variables fluctuated considerably. For example, the Moderate Psychopathology/Normal Diurnal Slope Group (LP5) fared the worst on all indices of parenting, antisocial behavior, and physical health, even though their levels of IPV exposure were only moderate, compared to other groups, and their diurnal cortisol production most resembled that of the Healthy Group (LP1). The Moderate Psychopathology/Normal Diurnal Slope Group (LP5), relative to the other groups, seemed to be driven by clinical levels of psychopathology, especially PTSD. The profile of women in this group highlights the utility of looking at co-occurring environmental risk and mental health to understand links between biological/psychological stress profiles and outcomes.

The Physiologically Under-Responsive Group (LP1), which had psychopathology levels comparable to the Problematic CAR Group (LP3), but did not have its comparable high levels of IPV, exhibited a slight decrease in CAR and displayed worse parenting and more antisocial behavior than the Healthy Group (LP2). These negative outcomes are likely tied to the co-occurrence of mental health problems and HPA axis dysregulation, such that one factor perpetuates the other. For example, Powell and Schlotz (2012) found that higher CAR was associated with attenuated psychological distress in response to the stressors experienced that day (and lack of CAR was associated with more psychological distress), whereas Gartland, O'Connor, Lawton, and Bristow (2014) reported that appraisals of high stress

predicted lower CAR the following morning.

The Problematic CAR Group (LP3) did not exhibit distinguishing differences on the validating variables. They were in the mid-range of physical health, and not distinctly different from the other groups on any other variables. As noted, decreased CAR has been associated with chronic stress and early loss experiences. It is especially robust among individuals who experience multiple types of loss (Meinlschmidt & Heim, 2005). We did not measure early loss of significant others in our research. Future research might include early loss as a variable when determining profiles.

There were several limitations to this research. Based on the Miller et al. (2007) meta-analysis, we focused our attention on several factors associated with changes in cortisol secretion including timing/chronicity of stress (i.e., IPV) and mental health sequelae that result from that stress. We had an excellent assessment of mental health sequelae, including depression, PTSD, and anxiety. However, recruiting participants with variations in timing/chronicity of IPV proved more challenging. Although pregnancy IPV was more frequent for most groups than postpartum IPV, the differences in frequency between the two time points were negligible. The similar levels of pre and postpartum IPV in all but the smallest profile may reflect reality; that is, few women who do not experience IPV during pregnancy then go on to experience it in the first year of the child's life. Perhaps women do not have the energy or motivation, as they cope with the challenges of a newborn child, to find a different relationship; or perhaps they find a new, positive relationship without violence. We did not collect data that would allow us to understand why so few women have a pattern of no pregnancy IPV and some postpartum IPV. However, we do know that, in our sample, the abuse (or lack thereof) typically stays at the same level across the two years. These characteristics of the sample limit our understanding of how timing/chronicity of stress affects maternal cortisol secretion and mental health.

A second limitation is the small number of individuals who had extremely high levels of pregnancy and postpartum IPV—LP4. As stated earlier, this is an interesting and important group of women. Their clinical levels of mental health problems were very similar to those women in Group 5, who experienced only moderate levels of IPV, but their cortisol pattern was unique—an almost flat CAR and a typical diurnal slope. Perceptions of stress may influence the psychological and physiological response to stress. For example, as noted above, Gartland et al. (2014) found that self-reported stress on one day predicted CAR the next morning, and other research indicates that stressfulness appraisals affect depression over and above the frequency and severity of IPV (Martinez-Torteya, Bogat, von Eye, Levendosky, & Davidson, 2009). Future research should assess perceptions of stress as well as determine whether this small group we found in our analysis can be validated.

A third limitation may be the reliability of the cortisol data. Although the correlation between raw scores used in the CAR variable was significant; the correlation between the log-transformed difference scores was not. As noted in the Methods, this is a problem faced by many researchers. At the time of data collection, our cortisol protocol followed best practices (collecting multiple day cortisol samples) while also taking into account logistical issues such as (1) the importance of adherence to saliva collection timing, (2) the burden of collecting multiple saliva samples from the participants, (3) the safety of the women participating in our research, and (4) the cost of assaying the samples. For these reasons, we collected CAR data over two consecutive days and evening data only once, knowing that many research studies collect only one day of cortisol data. Recent research indicates that multiple days (perhaps as many as six) are needed to garner the highest reliability (e.g., Stalder et al., 2016). In addition, to reduce cost and participant burden, suggestions have been made to develop alternative cortisol indices (e.g., Doane, Chen, Sladek, Van Lenten, & Granger, 2015).

Finally, although we believe strongly in the importance of creating biobehavioral profiles, we recognize that this is not the only way the data might be analyzed. Future research might conduct the analysis in two parts—the stress (IPV) and mental health variables in one analysis and the cortisol variables in another. Class memberships can then be crossed and significant cells identified (Bergman, Nurmi, & von Eye, 2012). These cells would represent the connections between risk patterns and cortisol patterns.

In summary, our findings point to the need for research that will enable us to understand person-specific differences that affect diurnal cortisol secretion in reproductively active women as well as other populations. As we noted at the outset of this article, research finds evidence for both hypo- and hyper cortisol secretion as a result of stress. The search for factors (other than the stress itself) that might influence cortisol production has led to contradictory findings throughout the literature. We suggest that the data are telling us something important: there are subgroups of individuals who have specific profiles that describe their responses to stress. We know, for example, that not everyone develops PTSD as a result of exposure to a traumatic stressor. There the research admits to individual variation. However, we are arguing here that the associations among stress, mental health sequelae, and cortisol production are also diverse; there are not generic, average responses. Variable-oriented research has consistently found contradictory results, and it will continue to do so, because there is tremendous heterogeneity in individuals' psychological and physiological responses to stress. Any given research sample may or may not include all or the most important subgroups of individuals. In other words, we propose that the quest for a specific, universal answer to understanding the associations among stress and its psychological and physiological manifestations is misguided. More person-oriented research is needed.

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