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Male Violence, Stress, and Neuroendocrine Parameters in Pregnancy: A Pilot Study

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Stress during pregnancy has been associated with a number of adverse outcomes. This study compared and correlated neuroendocrine parameters in women (n = 8) who self-reported battering during their pregnancy to those in women who did not (n = 8). Women who identified themselves as having a violent relationship with an intimate partner were recruited from a rural midwestern community. They were matched on age, self-reported ethnicity, parity, gestational age, and personal and family income with nonbattered controls. Midgestational measures of self-reported stress levels showed that battered women reported markedly higher levels of anxiety and depression. Neuroendocrine levels were not different between groups (battered vs. nonbattered); however, the relationships among hormones were different between groups. In nonbattered women, adrenocorticotropic hormone (ACTH) and cortisol levels were correlated but not in battered women. Beta endorphin and ACTH levels in battered women showed a significant linear relationship but not in nonbattered women. These results suggest that the maternal experience of stress alters the relationship of hypothalamic-pituitary-adrenal-placental axis hormones despite the lack of absolute differences in blood levels.

Key words: stress, posttraumatic stress disorder, pregnancy, neuroendocrine parameters, HPA-placental axis, male violence

It has been assumed that stress has adverse consequences on pregnancy and pregnancy outcome. However, studies of the effects of stress during pregnancy do not consistently demonstrate that stress affects pregnancy outcome (Hoffman & Hatch, 1996; Lobel, 1994; McLean, Hatfield-Timajchy, Wingo, & Floyd, 1993; Paarlberg, Vingerhoets, Passchier, Dekker, & Van Geijn, 1995). Possible reasons for these inconsistent results include use of nonstandardized stress instruments, incomplete conceptualizations of stress, temporal measurement errors, and failure to control medical risk and other confounding factors (Lobel, 1994). Another problem is the lack of a clear connection between psychosocial stress and the biological pathway linking maternal psychosocial stress to pregnancy outcomes. Moreover, unlike in animal models,

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human studies have failed to control for specific causes of stress.

Epidemiological evidence suggests that the prevalence of battering during pregnancy varies, with estimates between 0.9% and 20.1% in the United States (Gazmararian et al., 1996). Violence during pregnancy creates a condition of psychological and physical stress for women. Complications of pregnancy are more common for abused women, ranging from lower birth weight infants, first- and second-trimester bleeding, low weight gain, and anemia to fetal distress, fetal death, and a higher risk for being the victim of homicide (Campbell, Poland, Waller, & Ager, 1992; Reel, 1997). However, mechanisms linking stress with adverse pregnancy outcomes are poorly understood.

Animal studies have shown that application of stress can result in alterations in maternal hormone profiles, in particular, corticotropin releasing hormone (CRH), Beta endorphin (BE), adrenocorticotropic hormone (ACTH), and cortisol. In human studies, elevated levels of placental CRH have been linked with adverse outcomes of pregnancy such as preterm birth and pregnancy-induced hypertension (Chrousos, Torpy, & Gold, 1998; Korebrits et al., 1998; Liapa et al., 1996). Therefore, a plausible pathway for the biological effects of stress such as violence in pregnancy is through the alterations of the hypothalamic-pituitary-adrenal-placental (HPA-placental) axis.

Normal pregnancy is characterized by hypercortisolism, with levels similar to those seen in patients with severe depression or anorexia nervosa or in strenuously exercising athletes (Chrousos, 1999; Chrousos et al., 1998). Alterations in the HPA-placental axis may include increased placental secretion of CRH. Robinson, Emanuel, Frim, and Majzoub (1988) demonstrated that in vitro cultured placental tissue cells exposed to glucocorticoids up-regulate CRH mRNA production. Petraglia and colleagues (1991) replicated this study and verified that in vitro exposure of placental cells to glucocorticoids stimulated CRH mRNA, resulting in an increase in CRH production. In vivo effects of betamethasone on increased CRH production were demonstrated by Marinoni, Korebrits, Di Iorio, Cosmi, and Challis (1998). This ability of cortisol to increase CRH production is opposite from that observed at the level of the hypothalamus where elevated glucocorticoid levels decrease the portal hypophyseal concentration of CRH. Elevations in maternal cortisol are thought to result in higher levels of CRH due to placental production.

The purpose of this pilot study was to compare and correlate self-reported stress and HPA-placental axis neuroendocrine parameters of pregnancy at midgestation in rural women who experienced physical abuse during their pregnancy and to compare results to those for women who did not experience abuse. It was hypothesized that women who experienced physical abuse within the childbearing year would be more stressed than women who did not experience battering. It was also hypothesized that women who were more stressed would demonstrate higher levels of cortisol and CRH. The data from the battered women were compared to data from nonbattered pregnant women from the same community matched for age, parity, income, self-reported ethnicity, and gestational age. This study was a descriptive design with a small convenience sample.

Methods

Sample

The sample comprised 8 women who self-reported battering during their pregnancy and 8 matched nonbattered control women. Women were recruited from several counties in a rural midwestern state. Women who identified themselves as victims of male violence were recruited through the local media, obstetrician and midwifery offices, and flyers placed throughout the community. Women voluntarily contacted the researcher using a toll-free number. Neuroendocrine levels increase throughout pregnancy, so a gestational age range of 23 to 28 weeks was chosen to limit the variability caused by increasing gestational age. The inclusion criteria for battered women were (a) 18 years of age or older, (b) read and speak English, (c) have received prenatal care before 20 weeks of gestation, (d) pregnant with one fetus, and (e) screen positive for battering. Battering was considered positive if women answered yes to any of the following questions from the Abuse Assessment Screen (Soeken, McFarlane, Parker, & Lominack, 1998):

1. Within the past year, have you been hit, slapped, kicked, or otherwise physically hurt by someone?
2. Since you've been pregnant, have you been hit, slapped, kicked, or otherwise physically hurt by someone? or
3. Within the past year, has anyone forced you to have sexual activities?

Exclusion criteria were history of diabetes, chronic hypertension, or threatened abortion in the current pregnancy.

A total of 32 women contacted the researcher about the study. Twenty of these identified themselves as having been abused within the year prior to the contact. Twelve women met the criteria for inclusion and were screened into the study. Reasons for exclusion for the remaining women in violent relationships were as follows: (a) 3 were no longer pregnant, (b) 2 were of advanced gestational age, (c) 1 planned to terminate the pregnancy, (d) 1 was pregnant with twins, and (e) 1 called at 5 weeks gestation and opted to call back later but did not. Four women who were screened failed to show up for their study appointment. During the initial phone contact, 1 of these women indicated that she might have to move to a different shelter for her protection.

A purposive sample of nonbattered women that resembled the age, ethnicity, parity, and gestational age of the battered women participating was recruited from physician and midwifery offices. Income was also considered in matching the controls. Women were approached by their providers and told that they met the requirements to be controls in this study. Their providers invited them to call the researcher. Women considered as controls underwent the same screening procedure but answered no to all questions regarding battering on the screening tool. Ten women called the researcher, and 8 of these were chosen as controls. Of the women not selected as controls, one had a history of hypertension in her pregnancy; another did not match the battered women at the time of her call.

Procedure

After the initial phone contact and screening, women were asked to meet the researcher at the regional hospital, as it was centrally located, staffed with security guards, and was an expected place for pregnant women to go by themselves. Informed consent and release of information for medical records pertaining to the target pregnancy were obtained. Following a 20-min rest period, the researcher performed blood collection. All venous samples were obtained with a single attempt. According to Wadhwa, Dunkel-Schetter, Chicz-DeMet, Porto, and Sandman (1996), the venipuncture does not significantly influence the measurement of HPA hormones following a 20-min rest period. Because pituitary and adrenal components are known to fluctuate in a diurnal pattern, samples were collected between 1400 and 1600 hr. These hours are consistent with other cross-sectional studies of stress in pregnancy and do not reflect either peak or nadir levels of HPA hormones.

Blood samples (approximately 20 ml) were collected from the antecubital space into siliconized EDTA vacutainers, gently inverted with the anticoagulant and protease inhibitor, and placed immediately on ice. Chilled blood samples were centrifuged in a refrigerated centrifuge at 2,000 xg for 10 min. Plasma was decanted to cryovials containing protease inhibitor, then frozen at –70 °C until analysis.

Participants self-administered the questionnaires in the presence of the researcher. Medical risks, gestational age, date of birth, and weight of the baby were gleaned from prenatal care records, which the researcher obtained from the health care providers. Hospital records were obtained for birth information except in the case of 1 participant, who delivered out of the area. In that instance, the date of birth was retrieved from the hospital where the baby was born but no further information was available.

The study was approved by the Institutional Review Board at the University of Washington. The researcher gave special attention to safety by not contacting women by phone and by providing to all participants instructions on how to contact law enforcement if their situation was dangerous and the names of domestic violence advocates in their area (if requested). A note-

book of safety literature was offered to all participants at the conclusion of the study. Women were reimbursed $50 for their time.

Measures

Battering

Battering was measured using three instruments that determined the severity and frequency of battering. The Danger Assessment (DA) tool is a two-part instrument developed by Campbell (1986) from retrospective studies on intimate-partner homicides. Battered women, shelter workers, law enforcement officers, and clinical experts on battering supported its content validity. Convergent validity was supported by correlation with the Index of Spouse Abuse, Conflict Tactics Scale, and abuse-related injury. Internal reliability ranges from .60 to .86, and the tool has been used with African American and Hispanic women (McFarlane, Greenberg, Weltge, & Watson, 1995; McFarlane, Parker, & Soeken, 1996; McFarlane, Parker, Soeken, & Bullock, 1992). In Part 1, women are asked to fill out a calendar for the previous year with the approximate dates of battering and to assign a severity score to each event on the continuum of 1 to 5. A score of 1 corresponds to "slapping, pushing; no injuries and/or lasting pain," whereas a score of 5 corresponds to "use of weapon; wounds from weapon." When two descriptions of violence apply to the same incident, women are instructed to assign the higher number. This portion of the assessment tool is used to aid recall of and decrease minimization of abuse and is not scored.

The second part of the DA tool asks the woman to answer yes or no to each of 15 questions related to factors found to be associated with higher risk for femicide. Questions include, "Is there a gun in the house?" and "Does he ever try to choke you?" Yes answers are totaled for the score. Discriminate group validity is established with an average score of 9.3 for abused women treated in emergency departments versus a score of 0.75 for women who are not battered.

The Partner Abuse Scale—Physical (PASPH) is a 25-item scale that measures the magnitude of perceived physical abuse received from a partner. The Partner Abuse Scale—Nonphysical (PASNP) is a 25-item scale that measures the magnitude of perceived

nonphysical abuse received from a partner. The scales are similar except that the behaviors on each scale relate to the relevant form of abuse. Participants are asked to estimate the amount of time their partners engage in abusive behavior toward them, from 1 being *none of the time* to 7 being *all of the time*. The PASPH includes items such as "My partner forces me to have sex" and "My partner beats me so hard I must seek medical help." Items on the PASNP include "My partner belittles me intellectually" and "My partner screams and yells at me." The formula to score the forms yields a score in the range of 0 to 100. PASPH and PASNP consistently show a reliability coefficient of .90 or better and validity of .60 (Hudson, MacNeil, & Dierks, 1995).

Stress

The 27-item Prenatal Life Events Scale (PLES) developed by Lobel (1997) measures the number of life events that have happened to the participant or someone close to her since she has been pregnant and her perception of how each event affected her. Women rate the degree to which each event was undesirable or negative on a 4-point scale that ranges from 1, *not at all*, to 4, *very much*. This scale yields two measurements: the total number of life events and a mean life-event distress score. The life-event distress score is computed by averaging the distress rating for all of the events.

Yali and Lobel (1999) developed the Pregnancy Distress Questionnaire (PDQ), which measures the extent to which a woman is concerned about different aspects of her pregnancy on a Likert-type scale running from 0, *not at all*, to 4, *extremely*. Twelve items represent normal changes and concerns, such as body shape and size and altered relationships. The responses are summed to create a pregnancy distress score. The PDQ achieved an internal consistency of .81.

The 10-item version of the Perceived Stress Scale (PSS), developed by Cohen (Cohen, Kamarck, & Mermelstein, 1993), was also used to measure stress. The PSS utilizes a Likert-type scale with responses to questions about how often the participant has felt a particular way about nonspecified stress over the past month ranging from 0, *never*, to 4, *very often*. Questions include, for example, "In the last month, how often have you been upset because of something that

happened unexpectedly?" and "In the last month, how often have you felt nervous and 'stressed'?" Test-retest reliability was .71, and internal consistency was .63 to .79 in a sample of 108 ethnically diverse pregnant women (Cohen et al., 1993).

The state form of the State Trait Anxiety Inventory (STAI) was also administered (Spielberger, 1983). The STAI is a widely used and validated instrument and has been used in other studies of prenatal stress (Killingsworth-Rini, Dunkel-Schetter, Wadhwa, & Sandman, 1999; Neter, Collins, & Dunkel-Schetter, 1995; Spielberger, Gorsuch, & Lushene, 1970). This 20-item scale asks women to rate the extent to which they are experiencing anxiety-related symptoms "right now, at this moment." Responses range from 1, *not at all*, to 4, *very much*.

The Center for Epidemiological Studies Depression tool (CES-D) is a widely used and validated instrument to measure depressive symptoms in the general population (Radloff, 1977). The scale consists of 20 items that represent the clinical syndrome of depression. Items ask participants to recall symptoms from the past week and rate them according to how many days they experienced these. The scale does not rate physical symptoms of depression, which is appropriate in pregnancy. Positively worded items are reverse scored and summed.

Neuroendocrine Parameters

CRH, ACTH, BE, and cortisol, which reflect the HPA-placental axis, were measured. Student's t test was used to compare mean levels of stress and neuroendocrine parameters between groups. Visual analysis was utilized to explore the corelationships of these parameters because of the small sample size.

Plasma cortisol. Plasma cortisol levels were measured using a competitive antibody-coated tube radioimmunoassay (RIA; American Laboratory Products Company, Windham, NH). Plasma samples (25 ul) and ^{125}I-labeled cortisol (500 ul) were added to the antibody-coated tubes and incubated for 45 min in a 37 °C water bath. The aspirated antibody-bound ^{125}I-radio-labeled tubes were then counted in the ICN Biomedical Isoflex gamma counter. The assay has 9.3% cross-reactivity with corticosterone; less than 5%

cross-reactivity with 11-deoxycortisol, cortisone, and prednisone; and less than 1% cross-reactivity with eight other naturally occurring steroids. The inter- and intra-assay coefficients of variance (CVs) were less than 12% with a minimum detectable level (95% confidence) of 0.22 ug/dL.

Plasma ACTH. Plasma levels of ACTH were measured using a commercially available RIA (Nichols Institute Diagnostics, San Juan Capistrano, CA). The antiserum employed has less than 0.001% cross-reactivity with Beta endorphin and ACTH fragments. Samples were assayed in duplicate (200 ul per assay tube). ACTH ^{125}I-antibody solution (100 ml) was added to the samples, vortexed, and incubated at room temperature for 20 ± 2 hr after the addition of an avidin-coated bead. The solid matrix was washed with buffered surfactant in phosphate-buffered saline to remove unbound components and the bound radio-labeled antibody complex was quantified using a gamma counter. The ACTH assay has a minimal detectable level of 1.0 pg/ml with a CV of 3.0% (intra-assay) at 35 pg/ml and a CV of 7.8% (interassay) at 36 pg/ml.

Plasma BE. Plasma levels of BE were determined using a commercially available solid-phase two-site immunoradiometric assay (IRMA; Nichols Institute Diagnostics). The antiserum has 16% cross-reactivity with beta-lipotropin at 500 pg/ml, less than 0.03% cross-reactivity with ACTH at 900 ng/ml, and less than 0.01% cross-reactivity with related opiates at 5 mg/ml. Samples were assayed in duplicate (200 ul per assay tube). ^{125}I-anti-BE (rabbit) solution (100 ul) was added to each tube and vortexed. The reaction was initiated by adding one anti-BE (rabbit) coated polystyrene bead to the assay tube followed by a stationary incubation at room temperature for 20 ± 4 hr. The beads were then washed twice with phosphate-buffered saline and aspirated to dryness. The labeled antibody complex bound to the solid phase was measured using a gamma counter. The Allegro Beta-Endorphin Immunoassay system has a minimal detectable dose of 10 pg/ml (95% confidence limit) with CV = 4.1% (intra-assay) and CV = 9.0% (interassay) at the highest concentrations expected in the present study.

Table 1.   Demographics of Battered and Nonbattered Pregnant Women

| | Group | | |
	Battered ($n = 8$)	Nonbattered ($n = 8$)	2-tailed p
Age (mean years ± SD)	22.5 ± 4. 3	23.0 ± 3.5	.801
Personal income			.766[b]
None	3	2	
<12,000	4	4	
12,000-24,000	1	2	
Family income (dollars)			.615[b]
None	1	1	
<12,000	3	3	
12,000-24,000	4	2	
25,000-37,000	0	1	
38,000-50,000	0	1	
Partnering status			.522[a]
Single	1	2	
Partnered	7	6	
Gravida			.590[a]
Primigravid	2	3	
Multigravid	6	5	
Para			.417[b]
Nulliparous	4	3	
Primiparous	3	4	
Multiparous	1	1	
Gestational age[c] (mean days ± SD)	177.8 ± 12.0	182.5 ± 8.1	.370

NOTE: Student's t test for independent samples is reported.
a. Pearson chi-square, Fischer's exact 2-sided = 1.
b. Pearson chi-square.
c. Gestational age on the day of the study.

Plasma CRH. CRH was determined by RIA using a commercially prepared kit (Peninsula Laboratories, San Carlos, CA). Plasma samples (1 to 2 ml) were extracted with three volumes of ice-cold methanol, mixed, allowed to stand for 10 min at 4 °C, and then centrifuged at 1700 xg for 20 min at 4 °C using the modified method of Linton and colleagues (1995). The pellets were washed with 0.5 ml methanol, and the combined supernatants were dried down (Savant SpeedVac concentrator, Savant Instruments Inc., Holbrook, NY). Reconstituted samples in assay buffer were incubated with anti-CRH serum (human) for 48 hr at 4 °C followed by 24-hr incubation with ^{125}I-CRH. Labeled and unlabeled CRH was collected by immunoprecipitation with goat anti-rabbit IgG serum and normal rabbit serum after incubation. After adding 0.5 ml of assay buffer, samples were centrifuged at 1700 xg for 20 min at 4 °C and the aspirated pellets were quantified using a gamma counter. The CRH assay has less than 0.01% cross-reactivity with ovine and sauvagine, 36% cross-reactivity with bovine CRH, and nondetectable reactivity with human ACTH. The intra- and interassay CV ranged from less than 5% to less than 15%, respectively.

Results

As shown in Table 1, the two groups of women were well matched in demographic variables and gestational age. Each group consisted of 4 Caucasian women and 4 Native American women. Women in violent relationships reported higher levels of physical and nonphysical abuse and scored higher on the DA tool (Table 2). Women in violent relationships were more depressed, perceived more stress, and had higher state anxiety scores than nonbattered women (Table 3). Pregnancy distress and prenatal life events scores were higher in the abused group, although the difference in the pregnancy distress scores was not statistically significant. Prenatal life events and associated

Table 2. Assessment of Battering

| | Group | | | | |
Instrument	Battered	Nonbattered	2-tailed *p*	Power	*D*
PASPH	20.65 ± 14.49 (5-48)	0 ± 0	.001	.96	2.015
PASNP	57.5 ± 20.3 (19-72)	0.63 ± .9 (0-2)	<.001	1.0	3.958
DA	7.63 ± 2.2 (5-11)	0.5 ± 0.54 (0-1)	<.001	1.0	4.451

NOTE: Mean ± *SD*. Minimum-maximum score in parentheses. Student's *t* test for independent samples is reported. PASPH = Partner Abuse Scale—Physical (Hudson, MacNeil, & Dierks, 1995); PASNP = Partner Abuse Scale—Nonphysical (Hudson et al., 1995); DA = Danger Assessment tool (Campbell, 1986); power = post hoc; *D* = effect size.

Table 3. Comparison of Stress Scores Between Battered and Nonbattered Pregnant Women

| | Group | | | | |
Instrument	Battered (*n* = 8)	Nonbattered (*n* = 8)	2-tailed *p*	Power	*D*
PDQ	20.4 ± 5.7	14.5 ± 5.7	.06	0.49	1.035
PSS	26.6 ± 5.5	10.5 ± 5.1	<.001	1.0	3.036
SSTAI	48.3 ± 6.0	26.1 ± 4.2	<.001	1.0	4.287
CES-D	30.4 ± 11.0	10.1 ± 4.2	<.001	0.99	2.438
PLES	11.0 ± 4.1	5.1 ± 5.3	.026	0.64	1.245
PLED	3.2 ± 0.3	2.2 ± 0.5	<.001	0.99	2.425

NOTE: Mean ± *SD*. Student's *t* test for independent samples is reported. PDQ = Pregnancy Distress Questionnaire (Yali & Lobel, 1999); PSS = Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1993); STAI = State/Trait Anxiety Inventory (Spielberger, 1983), CES-D = Center for Epidemiological Studies–Depression (Radloff, 1977); PLES = Prenatal Life Events Scale; PLED = Prenatal Life Events Distress (Lobel, 1997); power = post hoc; *D* = effect size.

distress did differ significantly between these groups, with more events happening to the battered women and people close to them and these women feeling more bothered by those events as compared to nonbattered women.

As shown in Table 4, mean levels of ACTH, BE, cortisol, and CRH did not differ significantly between the two groups. Scatterplots were generated to explore the relationships between hormones. Figure 1 demonstrates that there was no relationship between ACTH and cortisol in the battered women ($r = -.01$), which differs from the nonbattered women ($r = .59$). In contrast, Figure 2 shows that ACTH and BE were significantly related to each other in battered women ($r = .75$, $p = .03$) but not in nonbattered women ($r = .29$, $p = .48$).

Discussion

The hypothesis that women in abusive relationships during the childbearing year would be more stressed than women who were not in abusive relationships was clearly supported in this study. Women in abusive relationships were shown to be highly stressed in this sample compared to women who were not in abusive relationships. However, the hypothesis that CRH and cortisol levels would be elevated was not confirmed. Although the results of the present study validated that battered women report higher levels of stress, anxiety, and depression (Campbell et al., 1992; Reel, 1997), few differences in the level of HPA-placental axis hormones were noted. However, interrelationships among hormones suggest that the patterns of hormones may be altered in highly stressed women.

Women in violent relationships identified several risk factors for femicide (the killing of women) on the

Table 4.   Comparison of Neuroendocrine Parameters for Battered and Nonbattered Pregnant Women

	Group		2-tailed *p*	Power	*D*
	Battered (*n* = 8)	**Nonbattered (*n* = 8)**			
ACTH (pg/ml)	27.32 ± 14.06	33.09 ± 10.69	.37	0.14	0.462
BE (pg/ml)	35.50 ± 17.62	26.26 ± 9.15	.21	0.23	0.658
Cortisol (µg/dl)	17.78 ± 3.22	17.91 ± 5.44	.96	0.05	0.029
CRH (pg/ml)	61.08 ± 16.8	59.46 ± 34.2	.94	0.05	0.06

NOTE: Mean ± *SD*. Student's *t* test for independent samples is reported. Power = post hoc; D = effect size; ACTH = adrenocorticotropin; BE = beta endorphin; CRH = corticotropin releasing hormone.

DA tool. Comparing battered women who were battered during pregnancy with those not battered during pregnancy, Campbell, Soeken, McFarlane, and Parker (1998) reported their DA scores as 5.62 and 2.91, respectively. Sharps and colleagues (2001) found that of women murdered by an intimate partner (*n* = 311) who were with the perpetrator during pregnancy, 23% were beaten during pregnancy. The women in the current study had a mean DA score higher than those in Campbell's group. It is possible that the women in the current study were in relationships that were extremely dangerous, more dangerous than others reported in the literature.

Physical and nonphysical abuse scores for the battered women in the current study were comparable or high when compared to other published measures of abuse during pregnancy in diverse populations. In a prospective cohort analysis of 691 African American, Hispanic, and White urban pregnant women, McFarlane and colleagues (1992) described White women as more severely abused relative to other groups (PASPH, mean = 22.72; PASNP, mean = 32.16). The lowest severity of physical and nonphysical abuse was for African American women (PASPH, mean = 12.20; PASNP, mean = 20.48). Native American women were not represented in their sample. Future inquiry should include Native American women and recruit sufficient numbers to identify how membership in this group affects their safety.

Women in both groups expressed concern about their pregnancies on the PDQ. Battered women were closer to "moderately" bothered by aspects of their pregnancy, whereas the nonbattered women were closer to a score of 1, which corresponds to "a little" bothered. The nonbattered group scored very close to the women in Yali and Lobel's (1999) study of 167

White, highly educated, upper- to middle-class married women at 24 weeks gestation.

State anxiety scores for women in abusive relationships were high compared to Spielberger's (1983) normative sample of working adult females ages 19 to 39. In contrast, nonbattered women's anxiety scores were lower than these published norms and lower than those in other studies in pregnancy (Dunkel-Schetter et al., 2001; Lobel, Dunkel-Schetter, & Scrimshaw, 1992). The STAI measured how women felt "right now, at this moment," a focus that may have reflected a state of vigilance that women in abusive relationships adopt for their safety.

Perceived stress was high for women in abusive relationships compared to both the nonbattered group and published norms for the PSS. According to Cohen and Williamson (1998), women selected at random nationwide in the age group of 18 to 29 (*n* = 1,406) reported a mean score of 13.7 ± 6.2. Nonbattered women in the current study scored lower than these norms, but this finding is consistent with Lobel and colleagues' (1992) study of pregnant women who also rated themselves lower than these published norms. It has been speculated that pregnant women may be somewhat immune to stress based on the finding that late in pregnancy, women's response to CRH challenge produced blunted responses in ACTH and cortisol (Schulte, Weisner, & Allolio, 1990). Because this measure asked women to rate stress over the previous month, higher levels may be associated with appraisals of chronic stress. The combination of high levels of state anxiety and perceived stress suggested that these battered women were both chronically and acutely stressed and that, in their situation, they are not at all immune, in a psychological sense, to stress.
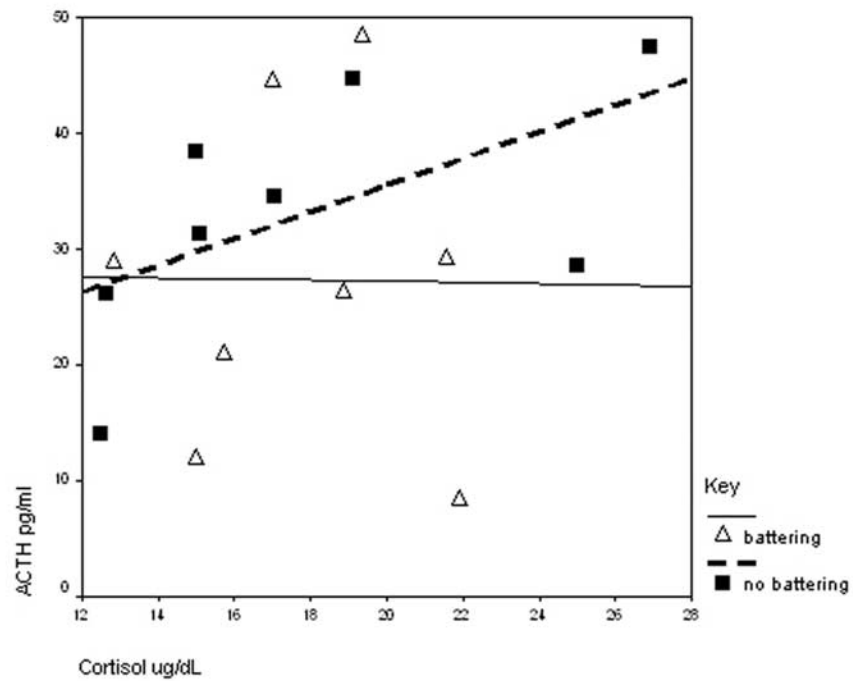
Figure 1. Scatterplot of adrenocorticotropic hormone (ACTH) and cortisol levels for battered and nonbattered pregnant women.
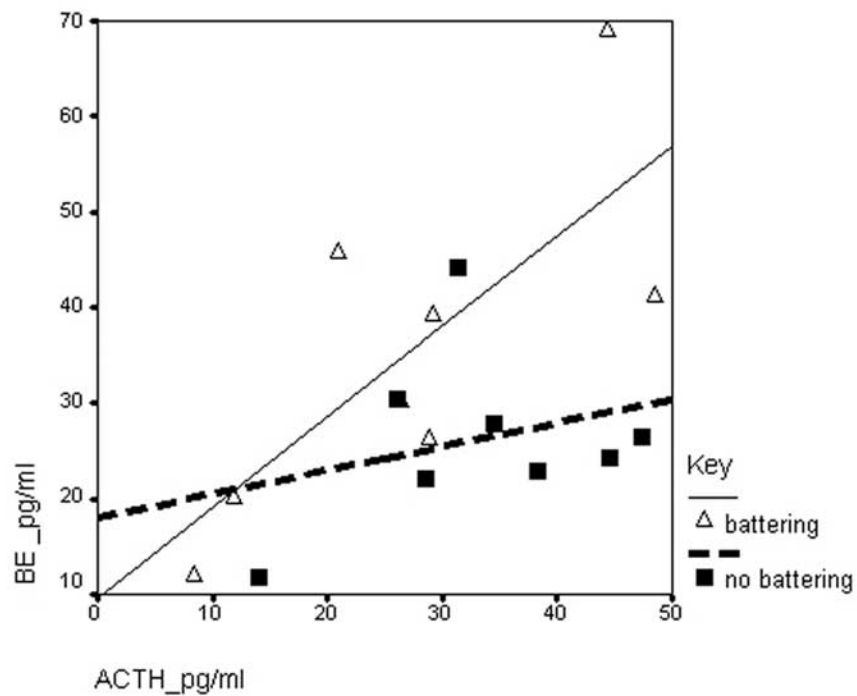

Figure 2. Scatterplot of Beta endorphin and adrenocorticotropin hormone (ACTH) levels for battered and nonbattered pregnant women.

Depression levels were extraordinarily high for the abused women in the current study. The Center for Epidemiological Studies group suggests that a cutoff point of 16 on the CES-D be implemented for diagnosis of clinical depression (Radloff, 1977). The battered women, with the exception of 1, exceeded this criterion, whereas only 1 woman in the nonbattered group scored 16 on the CES-D. The rest were well below that level. Evaluation of depressive symptoms may be a way for practitioners to augment their screening for abuse. For prenatal care to be effective, women with this level of depression should be recognized as requiring intervention by their health care providers.

If paper-and-pencil tools can characterize an experience, women in this study represented the embodiment of stress. Self-reported stress measures for the group of women in violent relationships demonstrated extreme stress when compared to women of similar age, partnering status, income, parity, medical risk, and ethnicity. Overall, women in the battered group were more anxious and depressed, found the situations in their lives more overwhelming, experienced more adverse events, and were bothered more by those events. This finding is consistent with other studies of battering in pregnancy (Campbell et al., 1992; Campbell et al., 1999).

Depression is also related to alterations in the HPA system (Chrousos, 1992). Nonpregnant women with depression may exhibit either hyper- or hyposecretion of CRH. Blunted ACTH and normal cortisol responses to the administration of exogenous CRH are sometimes used as indicators of depression (Chrousos, 1992).

According to Chrousos et al. (1998), the placental secretions of HPA-placental axis hormones control hypercortisolism in pregnancy. In this small sample, CRH levels in battered women were similar to those of the nonbattered women. Battered women appeared to have less variability at rest in cortisol levels, which may be a protective mechanism for the placental secretion of CRH during pregnancy. According to Schoof and colleagues (2001), the human placenta oxidizes maternal cortisol into cortisone, inactivating it with an enzyme, 11Beta-hydroxysteroiddehydrogenase-2 (11B-HSD2). 11B-HSD2 increases as gestation progresses to handle the cortisol load. Perhaps the basal variability is important because elevated, but not

lower, levels could exceed the capacity of the placenta to oxidize cortisol.

Importantly, the relationship of ACTH to cortisol levels in battered women differed from that in nonbattered women, that is, there was no correlation between the level of ACTH and the level of cortisol. The dysregulation of cortisol and ACTH was not an expected finding. This feature has been demonstrated in posttraumatic stress disorder (PTSD) in nonpregnant humans (van der Kolk, 2001). Seng (2002) suggested that PTSD could mediate adverse pregnancy outcomes more strongly than stress alone. In normal pregnancy, adrenal activation results in positive feedback to the production of CRH by the placenta. Stress is expected to amplify this effect. In this battered population, ACTH levels did not demonstrate any relationship to cortisol level, suggesting the possibility of fatigued adrenal glands, incapable of mounting a response to ACTH. It is possible that this lack of relationship could be reflective of the chronicity or severity of battering, and it should be followed up.

Post hoc power analysis demonstrated that even with a small sample size, the parameters of stress studied using scales unrelated to pregnancy showed a large effect size and firmly established battered women as experiencing more stress. Pregnancy-related scales were less powerful; however, the PDQ scale would have achieved 80% power to predict a difference with 16 participants. Because the levels of HPA-placental hormones did not show a large mean difference, power was diminished. However, differences in levels of ACTH and BE could be established with 80 and 40 participants, respectively. Power analysis on the correlation difference of ACTH and cortisol between groups revealed that 37 participants would have provided 80% power to detect a difference.

Conclusion

The limitations of this study include the small sample size, multiple measures, and consequent restrictions of statistical tests. For example, correlations of individual measures of stress and neuroendocrine parameters could not meet the assumptions of a regression analysis. Additionally, there was no attempt to control for the current state of the battered women's relationships; that is, whether they were still living in

their abusive relationships, fleeing their relationships, or successfully being protected from the abuser.

Even though the sample size limits the interpretation of these findings, the ACTH/cortisol effect demonstrated in this small sample of battered women in pregnancy is profound. Future studies should control for onset of abuse during pregnancy, as the possibility exists that chronic exposure to battering could alter hormonal relationships. Longitudinal studies should focus on the consequences of the ACTH/cortisol response pattern on CRH levels at term and postnatally with respect to length of gestation, adverse pregnancy outcomes, and postpartum depression.

This small sample of women was recruited from a rural area. Women in rural areas face specific hardships in finding protection from batterers, such as high visibility in the community; long distances to shelters, friends, or other resources; and attitudes that prevent disclosure (Johnson & Elliott, 1997). This feature of the study may also limit the generalizability of these findings and may account for the finding that women in this study were in highly dangerous situations.

These data were collected over a year's time by a single researcher. Strategies that would increase the recruitment of women might include using an urban population with several researchers to educate practitioners about the signs of violence in pregnancy. An urban setting would make visibility of the study safer for women in violent relationships.

It is not sufficient to rely solely on mean levels or a one-time measure of HPA-placental axis hormones when studying stress of this magnitude in pregnancy. Therefore, longitudinal measurements of these parameters will add to our understanding of stress and PTSD in pregnancy. A conceptual framework that considers the concept of PTSD as a feature of stress in pregnancy will help guide the inquiry. Future studies that focus on the relationship of neuroendocrine parameters in specific situations of stress in pregnancy would provide more sensitive information about the patterns of neuroendocrine function in the presence of stress or PTSD in the presence of the hormone-producing placenta. Additionally, alterations in the HPA-placental axis in response to chronic and severe life-threatening stressful stimuli should be investigated to better understand the consequences of intervention.

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