Changes in Cortisol and Dehydroepiandrosterone in Women Victims of Physical and Psychological Intimate Partner Violence

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Background: Although intimate partner violence (IPV) has a great impact on women's health, few studies have assessed the consequences on physiologic responses.

Methods: Women abused by their intimate male partners either physically (n = 70) or psychologically (n = 46) were compared with nonabused control women (n = 46). Information about sociodemographic characteristics, smoking, pharmacologic treatment, lifetime history of victimization (childhood and adulthood), and mental health status (depression, anxiety, and posttraumatic stress disorder, PTSD) was obtained through structured interviews. Saliva samples were collected at 8 am and 8 pm for 4 consecutive days to determine morning and evening basal levels of cortisol and dehydroepiandrosterone (DHEA).

Results: Women who were victims of IPV had more severe symptoms of depression, anxiety, and incidence of PTSD and higher levels of evening cortisol and morning and evening DHEA compared with control women. Intimate partner violence was the main factor predicting the alterations in hormonal levels after controlling for age, smoking, pharmacologic treatment, and lifetime history of victimization. Mental health status did not have a mediating effect on the impact of IPV on hormonal levels.

Conclusions: This study shows that both physical and psychological IPV have a significant impact on the endocrine systems of women.

Key Words: Anxiety, cortisol, dehydroepiandrosterone, depression, intimate partner violence, posttraumatic stress disorder

Most studies on the impact of intimate partner violence (IPV) on women's health focus on mental health, with a low proportion assessing its impact on physical health (reviewed in Martinez et al 2003). Regarding mental state, many studies show that abused women have increased prevalence of depression, posttraumatic stress disorder (PTSD), and chronic anxiety states (Campbell 2002; Campbell et al 1996; Golding 1999; Martinez et al 2003; Woods 2000). Studies on physical health show increased psychosomatic symptoms (e.g., back pain) and higher incidence of chronic illnesses (e.g., gastrointestinal and other complaints) (Campbell et al 2002; Coker et al 2000; Hamberg et al 1999; Lown and Vega 2001).

To date, there are only two studies on the consequences of IPV on physiologic responses such as the endocrine and immune systems, even though these may have considerable implications for the health status of women (Constantino et al 2000; Seedat et al 2003). The only study on endocrine changes in women victims of IPV reports alterations in the hypothalamic-pituitary-adrenal function, with these women having lower morning levels of cortisol than control women (Seedat et al 2003). Other victims of violence also show alterations in cortisol levels (De Bellis et al 1994). For example, sexually or physically abused children have altered (higher or lower) basal cortisol levels in the morning (Cicchetti and Rogosch 2001; King et al 2001), and women with a prior history of rape may respond to a further rape with a lower cortisol response than those experiencing rape for the first time (Resnick et al 1995; Yehuda et al 1998).

The assessment of the impact of IPV on women's health has focused on physical and sexual violence, with few studies paying attention to psychological violence alone despite the finding that this type of violence can be as devastating as, if not more so, than physical violence (Aguilar and Nightingale 1994; Coker et al 2000; Follingstad et al 1990; O'Leary 1999).

Major depression (MDD) is associated with alterations in both cortisol and dehydroepiandrosterone (DHEA; Goodyer et al 1996; Michael et al 2000; Parker et al 2003; Sachar et al 1985). Many studies, carried out primarily on inpatients, demonstrate increased evening levels of cortisol in MDD (Gold et al 1988; Parker et al 2003; Rubin et al 1996). Altered steroid levels may not only be state-dependent but may also represent a risk factor for subsequent onset of MDD. For example, higher cortisol levels in the morning in nondepressed adult women increased the risk of MDD following an adverse life event (Harris et al 2000). On the other hand, PTSD has been associated with low levels of cortisol in men (Yehuda 2002; Yehuda et al 1996), and comorbid depression and PTSD has been associated with lower levels of cortisol than MDD alone (Oquendo et al 2003). Studies have found DHEA to be both lower and higher in depressed compared with control subjects (Goodyer et al 1996; Heuser et al 1998; Michael et al 2000); however, evidence from both adults and adolescents suggests that the current psychosocial environment has no discernible effect on either cortisol or DHEA (Goodyer et al 1996; Harris et al 2000). Whether this applies to other, less normative situations, such as recent or current IPV, has not been extensively studied, yet such changes, if they occur, might have considerable implications for the current or future health of women victims.

The aim of this study was twofold: to assess the impact of IPV on basal cortisol and DHEA levels in adult women and to determine whether there was any distinction between those women exposed to both physical and psychological violence and those experiencing only the latter.
Methods and Materials

Subjects
This study is part of a larger research project on the impact of IPV on women’s health, carried out between 2000 and 2002 in a sample of 182 women from the Valencian community of Spain (Garcia-Linares et al, unpublished data). Women victims of IPV were recruited from 24-hour centers for helping women, located in the three provinces of the community (Alicante, Castellon, and Valencia). Control women, who lived in a nonviolent intimate partner relationship, were contacted through women’s clubs. All participants were of Spanish nationality. The study was approved by the University of Valencia research ethics committee, and informed written consent was obtained from all participants at the outset.

Procedure
The study consisted of a structured interview in which four trained female psychologists asked women about their lives and health. In general, each woman was interviewed 4–6 times by the same psychologist, with each session taking 1.5 hours. Additionally, women were asked to provide saliva samples for hormonal assays.

Questionnaires
A comprehensive questionnaire was designed for a face-to-face interview. The majority of questions were devised to collect objective reports of facts. The questionnaires from which information for the study was obtained are described as follows.

Control Variables. Information about the age, level of education, incidence of smoking, and pharmacologic treatment (antidepressants, benzodiazepines, estrogens and progestagens, glucocorticoids, and lithium) was obtained.

Violence Perpetrated by an Intimate Male Partner. A questionnaire was constructed to obtain detailed information about the different types of violence (physical, sexual, and psychological) perpetrated by the batterer. Each type of violence consisted of one or more of the acts described in the following paragraphs. Women were asked to answer yes or no to the incidence of each act.

1. Physical violence included punches, kicks, slaps, pushes, bites, and strangling.
2. Sexual violence included forced hetero sexual sex (vaginal or anal penetration, oral sex from female to male partner or from male to female partner, objects inserted in vagina or anus); forced homosexual sex, sex with animals, prostitution, or public sex; physical violence during sexual intercourse (bites, kicks, blows, and slaps); threats to hit the woman or children if rejecting sex, including threats with knives, guns, or other weapons; involvement of children in forced sex or children’s witnessing of sexual attacks; and use of pornographic films and photographs.
3. Psychological violence included verbal attacks (insults, humiliations), control and power (isolation from family and friends; impeded decision making, economic abandonment), pursuit and harassment, verbal threats (woman and family’s life threatened, threats regarding the custody of children, intimidating phone calls), and blackmail (economic or emotional).

Control women were also asked the questions to ensure that they had had no experience of violence in any intimate partner relationship.

Saliva Samples
Saliva samples for the analysis of cortisol and DHEA levels were also collected. The participants provided a minimum of .5 mL of saliva in a plastic tube twice a day (between 8 and 9 AM and between 8 and 9 PM) for 4 consecutive days, starting the fourth day after the beginning of menstruation. Saliva samples were frozen in women’s freezers and brought to the Department of Psychobiology in a mobile freezer, where they were kept frozen at −21°C. All samples were sent to the Department of Anatomy of the University of Cambridge, England, for analysis.

Hormone Assays
Cortisol was measured by validated ELISA on 20 μL samples of saliva (antibody, Cambio, Cambridge, United Kingdom) without extraction (intra-assay variation: 4.1%; interassay: 7.6%); DHEA was measured by validated radioimmunoassay on 333 μL samples after extraction into hexane/ether (4:1; antibody Bioclin [Westmeath, Ireland]; intra-assay variation: 5.1%; interassay: 11.2%). Details are given in Harris et al (2000). Data from the four daily morning and evening collections were summed to give a mean value at each time point.

Statistical Analyses
The three groups of women (nonabused, physically abused, and psychologically abused) were compared with respect to age and depression and anxiety (trait and state) scores using one-way analysis of variance (ANOVA) and with respect to the level of education, the incidence of childhood abuse, adulthood victimization, and the incidence of PTSD by using Pearson’s chi-square tests. Comparisons among groups with respect to the levels of

Lifetime History of Victimization
Childhood Abuse. Women were asked about the incidence of physical, sexual, or psychological abuse during their childhood. Physical abuse was defined as noted earlier. Sexual abuse included one or more of the following acts: forced sex, forced to touch male sexual organs or being touched, forced exposure to the display of sexual organs, and threats of forced sex. Psychological abuse was defined as noted earlier, but without the factors regarding child custody and impeded decision making.

Adulthood Victimization. Women were asked about their experience of violence during adulthood independently of their being battered. Physical, sexual, and psychological violence was defined as described for childhood abuse.

Mental Health
The severity of depression and anxiety and the incidence of PTSD at the time of the study was assessed. Severity of depression was measured with Beck’s Depression Inventory (BDI; Beck et al 1961), anxiety levels (both state and trait) were measured with Spielberger’s State–Trait Anxiety Inventory (STAI; Spielberger et al 1970), and the severity of PTSD symptoms was determined using a structured interview based on DSM-IV criteria (Echeburua et al 1997).
cortisol and DHEA were carried out after logarithmic transformation of the data by one-way analysis of variance and Scheffé post hoc comparisons and two-way ANOVA with the Time of Day and Group as factors. Additionally, one-way ANOVA comparison was carried out between women who were cohabiting with the batterer and those who were not at the time of the saliva collection. Correlation between hormonal levels and between mood states and hormonal variables were assessed using Pearson’s linear correlation coefficient.

To determine the effect of IPV on cortisol and DHEA levels after controlling for age, smoking, pharmacologic treatment (antidepressants, benzodiazepines, estrogens, progestagens, glucocorticoids, and lithium), childhood abuse (physical, psychological, and sexual), and adulthood victimization (physical, psychological, and sexual), hierarchical multiple regression analyses were carried out entering control variables (step 1) and incidence of IPV (step 2). To test the hypothesis of the mediating effect of the severity of depression and anxiety and the incidence of PTSD on the effect of battering on cortisol and DHEA levels, hierarchical multiple regression analyses were performed entering control variables (step 1), incidence of IPV (step 2), and score of depression or anxiety or the incidence of PTSD (step 3). The level of significance for all analyses was set at \( p < .05 \).

### Results

#### Subjects

One hundred and sixty-two women participated in this study. They were distributed into three groups: nonabused \((n = 46)\), physically abused \((n = 70)\), and psychologically abused \((n = 46)\) by their intimate male partners. There were no differences between groups in age \([F(2,159) = 0.9, p = ns]\) or educational level \([\chi^2(12, N = 162) = 12.0, p = ns]\); see Table 1. Nearly all the nonabused women (97.8%) had been cohabiting with their partners for the previous year, and the same percentage were still cohabiting during the collection of saliva samples. The percentages for the physically abused and the psychologically abused women were 81.4%, 61.4%, and 87.0%, 71.7%, respectively.

### Violence Perpetrated by the Intimate Male Partner

All women (100%) exposed to physical violence (physically abused group) had also suffered psychological violence by their intimate male partners. Furthermore, 53% of physically abused and 15.2% of psychologically abused women had also been sexually abused.

Most women of the physically abused group experienced violence by the batterer during the 12 months before the start...
of their participation in the study: 90.8% experienced physical abuse, 97% psychological abuse, and 18.5% sexual abuse. Similarly, 84.8% of the psychologically abused women experienced continued psychological abuse during the last year, and 2.2% were also sexually abused.

Lifetime History of Victimization

Childhood Abuse. There was a history of childhood abuse in all three groups. Whereas 28.3%, 26.1%, and 13% of the nonabused women had a history of childhood physical, psychological, or sexual abuse, respectively, the percentages were 47.1%, 42.9%, and 38.6% for the physically abused group and 54.3%, 39.1%, and 32.6% for the psychologically abused group. These differences were statistically significant between the groups for physical abuse (χ²(2, N = 162) = 6.9, p = .05) and sexual abuse (χ²(2, N = 162) = 8.9, p = .01), but not for psychological abuse (χ²(2, N = 162) = 3.5, p = ns). The incidence of physical and sexual childhood abuse was higher than that expected in the two abused groups but not in the nonabused group.

Adulthood Victimization. Violence perpetrated toward women by others than an intimate male partner during adulthood occurred in all three groups, with significant differences between groups in the incidence of physical (χ²(2, N = 162) = 6.6, p = .05), psychological (χ²(2, N = 162) = 6.4, p = .05), and sexual violence (χ²(2, N = 162) = 6.5, p = .05). In the physically abused group, the incidence of the three types of violence observed was higher than that expected, but this was not the case for the nonabused group. In the psychologically abused group, only the incidence of sexual violence was higher than that expected.

Current Mental Health Status

There were highly significant differences between groups in the severity of self-rated depression [BDI: F(2,159) = 17.1, p < .001], state anxiety [F(2,159) = 18.3; p < .001], and trait anxiety [F(2,159) = 16.8; p < .001], and in the incidence of PTSD [χ²(2, N = 162) = 16.9; p < .001]; see Table 2. Both physically and psychologically abused groups had a higher score of severity of depression and of state and trait anxiety and a higher incidence of PTSD than the nonabused group; there were no differences between the two abused groups. Almost all women (90%) with PTSD had depressive symptomatology, ranging from mild (33.3%), moderate (26.7%), to severe (30%) depression. Only 10% of physically abused and 2.2% of psychologically abused women had a history of depression before the IPV experience.

Differences in Salivary Cortisol Between Abused and Nonabused Women

Repeated-measures ANOVA showed significant effect of Time of Day [F(1,159) = 560.1, p < .001] and a Group × Time interaction (F(1,159) = 6.3, p < .002) on salivary cortisol. There were no differences between groups in the mean morning levels of cortisol [F(2,159) = 1.2, p = ns]; see Figure 1. Mean evening cortisol, however, was significantly different between groups [F(2,159) = 6.9, p < .001]. Post hoc comparison showed that while the physically abused group had significantly higher levels of cortisol than the nonabused (p < .001), the psychologically abused group fell short of significance (p < .065); however, there were no differences between the two abused groups. A comparison of evening cortisol levels within the two abused groups between those women who were or were not depressed showed no significant difference (data not shown).

With regard to the increase in evening cortisol levels, hierarchical multiple regression analyses were carried out to control for the following variables: age, smoking, pharmacologic treatment, childhood abuse, and adulthood victimization. The analyses showed that these controlled variables, in total, did not significantly predict the increase in evening cortisol level [F(13,148) = 1.2; R² = .095; p = ns]; however, the intake of benzodiazepines by itself was identified as a significant predictor of this increase (t = 2.6, p < .01). The overall effect of IPV (nonabused vs. abused-groups) on the increase in the evening cortisol level remained highly significant even after such variables had been controlled [F(1,147) = 11.73; R² = .067; p < .001].
From the four daily morning and evening samples, the maximum and minimum value for each woman at each time point was determined. This showed that maximum levels of evening cortisol were significantly greater in the physically abused than in the nonabused group (p < .01); this difference did not reach significance for the psychologically abused group (p < .06); however, the two abused groups did not differ from each other. On the contrary, there were no significant differences in the maximum and minimum value for each woman at each time point. There was, however, no correlation between morning and evening cortisol levels (Pearson, r = -.072, p = ns).

One-way ANOVA comparison of abused women who cohabited with the batterer at the time of saliva collection with those who did not showed no significant differences in either morning or evening cortisol levels [morning: F(1,147) = .176, p = ns; evening: F(1,147) = .16, p = ns]. More restricted analysis of physically abused women with respect to cohabitation also showed no differences [F(1,69) = .008–1.64, p = ns]. Similar results were found in the psychologically abused group [F(1,45) = 1.64–1.82, p = ns].

One-way ANOVA comparison of control women with childhood abuse (n = 23) with those without (n = 23) showed no differences in cortisol [morning: F(1,45) = 2.12, p = ns; evening: F(1,45) = .82, p = ns].

Differences in Salivary DHEA Between Abused and Nonabused Women

Repeated-measures ANOVA showed a significant effect of Time of Day on DHEA levels [F(1,159) = 181.8, p < .001] but no Group × Time interaction [F(1,159) = .56, p = ns]. Both morning and evening DHEA were different between groups [F(2,159) = 5.2, p < .006; F(2,159) = 6.1, p < .005, respectively]; see Figure 2. Overall, there was a high positive correlation between morning and evening DHEA (Pearson, r = .82, p < .001). Scheffé comparisons showed that morning DHEA was higher in psychologically abused women than in the nonabused group (p < .01), although differences did not reach significant levels for the physically abused group (p = .065); however, there were no differences between the two abused groups. Evening DHEA was significantly higher in both abused groups than in the nonabused one (physically abused: p = .05, psychologically abused: p = .004). The two abused groups did not differ. Analysis of daily variations in the four morning and evening DHEA samples (maximum and minimum values) showed no significant differences between groups.

Hierarchical regression analysis showed that the total controlled variables significantly predicted the increase in morning DHEA [F(13,148) = 3.575, R² = .299, p < .001] with age (t = -5.022, p < .001) and adulthood psychological victimization (t = -2.048, p < .05) having an independent effect. The controlled variables also had an effect on evening DHEA [F(13,148) = 2.179, R² = .161; p < .02] with age (t = -3.014, p < .003) and intake of benzodiazepines (t = 2.231, p < .027) having an independent effect. None of the other controlled variables were identified as individual predictors. The effect of IPV (nonabused vs. abused women) on both morning and evening DHEA levels remained highly significant even after these variables had been controlled [morning: F(1,147) = 7.132, R² = .035, p < .008; evening: F(1,147) = 9.865, R² = .053, p < .002].

One-way ANOVA comparison of control women with childhood abuse (n = 25) with those without (n = 25) showed no differences in DHEA levels [morning: F(1,45) = .05, p = ns; evening: F(1,45) = 2.13, p = ns]. As for cortisol, there was no effect of cohabitation at the time of saliva collection on DHEA levels [morning: F(1,115) = .26, p = ns; evening: F(1,115) = 1.08, p = ns].

Correlations Between Cortisol and DHEA Levels

The analysis of correlation between cortisol and DHEA levels showed a positive correlation between mean evening cortisol and both morning and evening mean DHEA levels (morning DHEA r = .28, p < .001; evening DHEA r = .48, p < .001).

Correlations Between Mental Health Status and Hormonal Levels

There was a negative correlation between morning cortisol and severity of depression (r = -.24, p < .002) but a positive correlation with evening cortisol (r = .17, p < .03); see Table 3. State anxiety was negatively correlated with morning cortisol (r = -.21, p < .007), and trait anxiety was negatively correlated with morning cortisol (r = -.30, p < .001) but positively correlated with evening cortisol (r = .22, p < .005). There were no significant correlations between depression, anxiety, and DHEA levels. Finally, there was no correlation between total PTSD score and hormonal levels.
Testing the Mediating Effect of Depression, Anxiety, and PTSD on Cortisol and DHEA Levels

Hierarchical multiple regression analysis to test the mediating effect of mood states on evening cortisol levels showed no effect of either depression \( (F(1,146) = .12; R^2 = .001; p = ns) \), state anxiety \( (F(1,146) = .97; R^2 = .006; p = ns) \), trait anxiety \( (F(1,146) = 1.85; R^2 = .01; p = ns) \), or PTSD \( (F(1,146) = 1.38; R^2 = .008; p = ns) \). Similarly, there was no mediating effect for depression, anxiety, or PTSD on DHEA levels: depression \( (F(1,146) = .001; R^2 = .001; p = ns) \), morning DHEA: \( (F(1,146) = .37; R^2 = .002; p = ns) \), state anxiety \( (F(1,146) = .72; R^2 = .004; p = ns) \), evening DHEA: \( (F(1,146) = .67; R^2 = .004; p = ns) \), trait anxiety \( (F(1,146) = .2; R^2 = .001; p = ns) \), evening DHEA: \( (F(1,146) = .24; R^2 = .001; p = ns) \), or PTSD \( (F(1,146) = .004; R^2 = .001; p = ns) \); evening DHEA: \( (F(1,146) = .21; R^2 = .001; p = ns) \).

Discussion

This study shows that women victims of IPV (battered women) have higher levels of evening cortisol and higher levels of both morning and evening DHEA than control women. Furthermore, they have a markedly higher score of severity of depression and state and trait anxiety and a higher incidence of PTSD than control subjects. On the other hand, although battered women and control subjects were well-matched for age and education level, the incidence of childhood abuse and adulthood victimization was higher in the former. Thus, this made it necessary to consider whether the lifetime history of victimization or the mental state was responsible for the endocrine changes observed in the battered women.

Increased evening cortisol is characteristic of current depression (Dalh et al 1991; Plotsky et al 1998). Therefore, although depression was more frequent in both the physically and psychologically abused women, this factor did not seem to account for the evening hypercortisolism. As expected, however, there was a positive correlation between the severity of current depressive symptoms and evening cortisol, but there was no significant difference in evening cortisol between those battered women who were or were not depressed. This suggests that either the experience of IPV (particularly physical violence) or some genetic feature distinguishing this group of women (which seems intrinsically unlikely) was responsible for this endocrine feature of battered women. Elevated evening cortisol is present in other conditions besides depression, including food deprivation and anorexia, which are also associated with this endocrine pattern (Murphy 1991). Our previous studies have shown no consistent associations between state or trait anxiety and salivary cortisol (Goodyer et al 2000, 2001; Harris et al 2000), and these mood states did not contribute to the endocrine differences found in the study between battered and control women. We did find a positive correlation between severity of trait anxiety and evening cortisol, however, even though this could not account for the differences between abused and control groups. Posttraumatic stress disorder has been associated with lowered cortisol in men (Yehuda et al 1996), and there are reports that PTSD or similar stressors increase cortisol in women (for example, Rasmusson et al 2001). There was no evidence from our results that its presence played a part in determining evening cortisol levels. Almost all women (90%) with PTSD in our group had depressive symptomatology, which made it difficult to assess the relation between PTSD alone and cortisol levels. It did not appear, however, that current mental state was associated with the differences we found in evening cortisol between women victims of IPV and control subjects.

On the other hand, although battered women had higher incidence of lifetime history of victimization than control subjects, both during childhood and as adults, these experiences did not seem to account for the increase in evening cortisol. It should be noted that some degree of what is now defined as physical or psychological abuse was a common childrearing practice in Spain at the time when our subjects were children. This explains the high levels (50%) in the control group; however, the nature of the IPV that women had experienced had a moderate effect. Elevated evening cortisol was most marked in physically abused women, whereas the psychologically abused group was not significantly different from control subjects; the two abused groups did not differ from each other, however. A finer-grained analysis of the cortisol data in our study showed that the evening hypercortisolism was associated with increased maximum ("peak") values; that is, battered women (particularly those suffering physical violence) experienced intermittently higher levels of cortisol in the evening, which accounted for the overall higher mean value. By contrast, minimum values were unchanged, showing that the daily variation in evening cortisol was increased in battered women.

It is noteworthy that morning cortisol was unchanged in battered women. These results differ from those of Seedat et al (2003), which were based on a much smaller sample (22 abused women and 16 control subjects; 10 of the abused women had PTSD and 12 had never had it). Furthermore, abused women were free from the abusive relationships for more than 4 months and less than 2 years; cortisol was measured only in the morning (9–12 AM) from blood samples that were not collected in the women’s normal environment.

Elevated levels of salivary cortisol in the morning is a risk factor for subsequent MDD in both adult women and adolescents (Goodyer et al 2001; Harris et al 2000). This factor was not found in our sample of battered women, suggesting that morning cortisol did not contribute to the increased incidence of depression, although whether individual differences in morning cortisol earlier in life—before they had been exposed to the battering experience—might play a part in the affective response to subsequent IPV remains unknown and would require a different type of study. There is some evidence that morning cortisol increases during the 30-60 min after awakening (Federman et al 2004; Puerssner et al 1999). It is unlikely that sleep patterns and “endogenous” morning cortisol cancelled each other out in the three groups, although we had no data on wake times. Similar to our findings with evening cortisol, trait (as well as state) anxiety seem to be related to morning cortisol. In the light of results from other studies (described earlier in the article), the relation between current mood state and cortisol requires further exploration.

We also observed elevated DHEA in both morning and evening salivary samples in physically and psychologically abused women. This is not characteristic of depression, which is associated with lower levels of DHEA in the morning (Michael et al 2000). This finding reinforces the supposition that the endocrine patterns we observed in battered women are not simply the result of associated and consequent affective (e.g., mood) state. Unlike cortisol, DHEA declines markedly with age (Orenreich et al 1992), but battered and control women were well-matched for age, and controlling for age did not alter the association between higher DHEA and both physical and psychological IPV. Unlike cortisol, however, there was a significant association between
morning DHEA levels and adulthood psychological victimization. This analysis does suggest a rather different relationship between psychological variables and DHEA than exists for cortisol. Benzodiazepine intake was also associated with higher evening DHEA, although whether this is a causal relationship, and, if so, in what direction, remains uncertain. Elevated DHEA has also been found to be associated with increased risk of depression in adolescents but not in adult women (Goodyer et al 2001), so whether this endocrine factor plays a part in the increased incidence of depression in our battered women is also uncertain. We did find, however, that DHEA was not associated with the presence of depression, anxiety, or PTSD, and thus the pattern of raised DHEA is unlikely to reflect current affective state.

The increased incidence of depression, anxiety, and PTSD we observed in the battered women who participated in our study confirms previous findings and suggests that our sample was similar to those of other studies. Dysphoria and depression is common in battered women across ethnic groups (Campbell et al 1996; Clements and Sawhney 2000; Torres and Han 2000). Psychological violence can be as damaging as physical violence (Street and Arias 2001), although our findings suggest that the endocrine consequences of the latter may be somewhat greater. Similar to other reports, we found a high incidence of sexual violence associated with both physical and psychological IPV (Marshall and Holtzworth-Munroe 2002). Posttraumatic stress disorder is common in battered women, particularly those suffering sexual violence (Bennice et al 2003). Because a high proportion of our battered women had experienced either recent or current abuse, we cannot know whether the endocrine features we describe represent a stress reaction to this abuse or a more persistent state of stress that might outlast active physical or psychological violence. What our findings show is that both physical and psychological IPV apparently results in changes in cortisol and DHEA in women victims, both hormones having been implicated in mental health and neural functioning. For example, raised cortisol can sensitize the brain to other noxious or adverse events. Brain injury is relatively common as part of the IPV (Valera and Berenbaum 2003). Whether the endocrine features of battered women we describe add to this injury or have longer-term consequences for either the physical integrity of the brain or affective or cognitive function is now a question of considerable interest. Attempts to establish the impact that IPV—a form of chronic, often inescapable, social stress—has on women victims need to take into account the whole spectrum of the organism functioning from physiologic alterations to mental and physical health.

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