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HPA-axis activity and the moderating effect of self-esteem in the context of intimate partner violence in Cameroon

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ABSTRACT

Background: The experience of intimate partner violence (IPV) is stressful. One objective way to monitor it is to assess victims' stress response by measuring the concentration of their salivary cortisol, the major stress hormone released by the hypothalamic–pituitary–adrenal axis.
Objective: We investigated how the IPV experienced by women in Cameroon affects their stress levels and those of their children.
Method: We recruited 50 mother–child dyads exposed to IPV and a control group of 25 mother–child dyads. All mothers completed questionnaires, including the Revised Conflict Tactics Scale to assess IPV, the Sense of Coherence Scale, and the Self-Esteem Scale, to assess their psychological resources. Mothers were asked to collect 3 saliva samples from themselves and 3 from their children on a single weekday: immediately after waking up, 30 minutes after waking up, and 45 minutes after waking up. The total cortisol secretion over the first hour after awakening was determined by calculating the area under the curve with respect to the ground (AUCg).
Results: Mothers exposed to IPV exhibited higher total post-awakening cortisol concentrations compared with those in the control group. However, no significant difference was found between exposed and non-exposed children. In addition, higher IPV, specifically injuries, was significantly and positively associated with greater AUCg among mothers exhibiting lower self-esteem. When self-esteem was high, however, no significant effect of IPV on AUCg was observed.
Conclusions: Of particular clinical significance is that self-esteem can modulate the stress levels of women exposed to IPV, a valuable insight into the development of effective psycho-social interventions to support IPV victims in sub-Saharan Africa.

La actividad del eje HPA y el efecto moderador en la autoestima en el contexto de violencia de pareja en Camerun

Antecedentes: La experiencia de violencia de pareja (VIP) es estresante. Una forma objetiva de monitorearla es evaluar la respuesta al estrés de las víctimas midiendo la concentración de su cortisol salival, la principal hormona del estrés liberada por el eje hipotalámico-pituitario-adrenal.
Objetivo: Investigamos cómo la VIP que experimentan las mujeres en Camerún afecta sus niveles de estrés y la de sus hijos.
Método: Reclutamos 50 díadas madre-hijo expuestas a VIP y un grupo de control de 25 díadas madre-hijo. Todas las madres completaron cuestionarios, incluida la Escala de Tácticas de Conflicto revisada para evaluar la VIP, la Escala de Sentido de Coherencia y la Escala de Autoestima, para evaluar sus recursos psicológicos. Se pidió a las madres que recogieran 3 muestras de saliva de ellas mismas y 3 de sus hijos en un solo día de la semana: inmediatamente después de despertarse, 30 minutos después de despertarse y 45 minutos después de despertarse. La secreción total de cortisol durante la primera hora después del despertar se determinó calculando el área bajo la curva con respecto a la base (AUCg).
Resultados: Las madres expuestas a VIP exhibieron concentraciones de cortisol total, después del despertar, más altas en comparación con las del grupo de control. Sin embargo, no se encontraron diferencias significativas entre niños expuestos y no expuestos. Además, una mayor VIP, específicamente las lesiones, se asociaron significativa y positivamente con un mayor AUCg entre las madres que mostraban una menor autoestima. Sin embargo, cuando la autoestima era alta, no se observaron efectos significativos de la VIP sobre el AUCg.

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PALABRAS CLAVE
violencia de pareja; cortisol; AUCg; actividad del eje HPA; autoestima; sentido de coherencia; díadas madre-hijo; estrés traumático

关键词
亲密伴侣暴力; 皮质醇; AUCg; HPA轴活动; 自尊; 一致感; 母子对; 创伤应激

HIGHLIGHTS
- Victims of intimate partner violence (IPV) experience extreme stress through elevated cortisol levels.
- Our results showed that higher cortisol levels was associated with lower self-esteem and a lower sense of coherence, thus implying that self-esteem may serve as a moderator.

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Supplemental data for this article can be accessed here.

Conclusiones: Que la autoestima pueda modular los niveles de estrés de las mujeres expuestas a VIP es de particular importancia clínica, una valiosa información sobre el desarrollo de intervenciones psicosociales efectivas para apoyar a las víctimas de VIP en África subsahariana.

喀麦隆的亲密伴侣暴力中HPA轴活动和自尊的调节作用

背景: 亲密伴侣暴力 (IPV) 的经历是应激性的。对其监测的一种客观方法是通过测量受害者的唾液皮质醇 (由下丘脑-垂体-肾上腺轴释放的主要应激激素) 的浓度来评估受害者的应激反应。
目的: 我们考查了喀麦隆妇女经历的IPV如何影响她们及其子女的应激水平。
方法: 我们招募了遭受IPV的50个母子对和25个母子对的对照组。所有母亲均完成了问卷调查,包括评估IPV的修订版冲突策略量表, 评估其心理资源的一致感量表和自尊量表。要求母亲在一个工作日内从她们自己和孩子那里收集3份唾液样本:醒来后立即, 醒来后30分钟和醒来后45分钟。醒来后第一个小时的皮质醇总分泌量通过计算相对地面曲线下面积 (AUCg) 确定。
结果: 与对照组相比, 遭受IPV的母亲醒来后皮质醇的总浓度更高。但是, 遭受和未遭受的儿童之间未发现显著差异。此外, 较高的IPV, 特别是受伤, 与自尊较低母亲的AUCg显著正相关。然而, 当自尊很高时, 没有观察到IPV对AUCg的显著影响。
结论: 特别的临床意义是, 自尊可以调节遭受IPV女性的应激水平, 是对开发有效的社会心理干预措施以支持撒哈拉以南非洲IPV受害者的宝贵见解。

1. Introduction

Intimate partner violence (IPV) is a serious threat to women's well-being in all regions of the world, with approximately 30% of women aged 15 years and older being at risk of IPV in their lifetime (Krahé, 2019). The most common form of IPV includes physical abuse, sexual abuse, and psychological abuse, including verbal and emotional abuse (Campbell, 2002). In sub-Saharan Africa, IPV prevalence rates, at about 36%, are the highest in the world (McCloskey, Boonzaier, Steinbrenner, & Hunter, 2016). In Cameroon, more than half of women (52%) are affected by IPV (Institut National de la Statistique [INS], 2015). In the specific cultural setting prevailing in Sub-Saharan Africa, aggravating factors in the prevalence of IPV are gender inequality (Nazé, 2012), dowry practices (Rees et al., 2017) and attitudes of tolerance towards IPV (Uthman, Lawoko, & Moradi, 2009). Due to this long-ingrained tolerance, most women exposed to IPV rarely discuss or seek help for it (McCloskey, Williams, & Larsen, 2005).

IPV is a highly stressful experience for victims. One objective way to monitor it is to assess, for instance, the concentration of cortisol, the major stress hormone released by the hypothalamic–pituitary–adrenal (HPA) axis (Gaab, Rohleder, Nater, & Ehlert, 2005). Cortisol production naturally follows a circadian rhythm, with levels typically peaking 20–30 minutes after waking, declining rapidly over the next few hours, and declining more gradually throughout the day until reaching a low point in the late evening (Powell & Schlotz, 2012; Pruessner, Hellhammer, & Kirschbaum, 1999; Saxbe, 2008). The proper functioning of the HPA axis is crucial in helping to deal with stressors, but repeated stress has the potential to disrupt the beneficial physiological role of the HPA axis (Chrousos, 2009). Disturbance of HPA-axis activity can damage physiological functions and lead to psychological problems (DeJonghe, Bogat, Levendosky, & von Eye, 2008; Heinze, Lin, Reniers, & Wood, 2016). Thus, a better understanding of how stressors, such as IPV, influence the HPA-axis activity could be an important resource in health care.

Assessments of HPA activity in women exposed to IPV have relied mostly on the investigation of the cortisol awakening response (CAR), with mixed results. For example, some studies have indicated higher CAR in IPV-exposed women compared to the control group (Pinna, Johnson, & Delahanty, 2014; Pinto, Correia-Santos, Costa-Leite, Levendosky, & Jongenelen, 2016) and others finding lower CAR (Kim et al., 2015; Suglia et al., 2010). Several studies have highlighted the importance of the area under the curve with regard to data with repeated waking cortisol measurements (Fekedulegn et al., 2007; Khoury et al., 2015). In particular, the area under the curve with respect to ground (AUCg) is an index of overall cortisol secretion over the post-awakening period that can provide critical information on HPA-axis activity (Fekedulegn et al., 2007; Stalder et al., 2016). Yet, AUCg has so far received little attention in studies on IPV.

Maternal stress influences the behaviour of children and can be assessed using biological markers (Spratt et al., 2016). Unclear, however, is whether IPV affects children's stress response. To our knowledge, only two studies have explored the effect of IPV on the stress response of mother–child dyads through cortisol measures. Hibel, Nuttall, and Valentino (2020) investigated diurnal salivary cortisol in 221 mother–child dyads in the United States. Their results indicate that exposure to IPV was associated with heightened child waking cortisol (used as a synonym for CAR), with positive parenting as a mediator. Boeckel, Viola, Daruy-Filho, Martinez, and Grassi-Oliveira (2017) carried out a study in Southern Brazil to assess hair cortisol in a sample of 59 mother–child dyads. Their results showed no significant differences in the hair cortisol level in children of the exposed group compared to children of the control group. Taken together, previous research on children exposed to IPV, based on measures of CAR and hair cortisol, shows mixed results and further suggests the need to include protective factors and their moderating effect in understanding the response to stress. In addition, to our knowledge, no study has investigated AUCg as a measure of HPA activity in the context of IPV.

Results obtained so far on the effect of IPV on HPA-axis activity lead us to think that knowledge about the stress response of mother–child dyads exposed to IPV could be enhanced by considering other HPA-axis activity measures, like AUCg, that have been described as highly congruent across challenge, time, and sample (Khoury et al., 2015). Another important factor to take into consideration is the effect of protective factors, since HPA activity has been shown to be influenced by individual protective factors, such as self-esteem or sense of coherence (Anand et al., 2019; Gustafsson, Nelson, & Gustafsson, 2010; Sabik et al., 2019; Sun et al., 2014). Moreover, conducting this research in sub-Saharan Africa, a rarely studied region, may enable us to obtain a homogeneous sample of traumatized women and children, given the high prevalence rate of IPV in particular in Cameroon.

Accordingly, to contribute to new knowledge about the HPA-axis activity of mother–child exposed to IPV, this study examines two groups, one exposed to IPV and one not exposed to IPV as a control, and aims to (1) compare cortisol levels in mothers and children of both groups; (2) test the relationship between IPV and cortisol levels in the mother–child dyads with respect to the protective factors, particularly self-esteem and sense of coherence; (3) test whether mothers' self-esteem and sense of coherence moderates the effect of IPV on total cortisol output as indicated by measures of AUCg; and (4) investigate whether mothers' AUCg predicts their children's AUCg differently in each group. Based on our recent finding showing symptoms of psychopathology, including anxiety and depression, in mothers exposed to IPV and externalized symptoms in their children (Wadji, Ketcha Wanda, Wicky, Morina, & Martin-Soelch, 2020) and on previous findings (Boeckel et al., 2017; Hibel et al., 2020), we expect 1) hyperactivity of the HPA axis, as indicated by higher cortisol levels, in the IPV-exposed mother–child dyads compared to the control group, (2) IPV to correlate positively and protective factors negatively with cortisol levels, (3) self-esteem and sense of coherence to moderate the effect of IPV on AUCg, and (4) mothers' AUCg to predict their children's AUCg.

2. Method

2.1. Participants

We recruited the IPV-exposed and control groups through the Association for the Fight against Domestic Violence (ALVF) in Cameroon. The ALVF is a non-profit organization that provides free legal advice, guidance, and support to women victims of IPV. To locate potential participants for both groups, we made phone calls based on ALVF's records, and community agents performed a door-to-door sensitization and awareness campaign for our study. The recruitment details can be found in a related study (Wadji et al., 2020).

For each mother in the exposed group, the inclusion criteria were (1) being physically, sexually, and/or psychologically abused or injured in the past 12 months; (2) having a biological child aged 2–18 who have seen and heard violent acts, seen injuries resulting from the violence, or been told about the violence in the past 12 months (if a mother had more than one child in this age range, she was asked to select the one whom she felt had been most exposed); and (3) the ability to express herself in French or English. For the control group, the inclusion criteria were (1) not having ever experienced IPV, (2) having a biological child aged 2–18, and (3) the ability to express herself in French or English. Mothers who did not speak and understand either French or English were excluded, as well as those with children older than 18.

After screening, the potential participants were invited to the ALVF premises. In total, 82 mothers came to the scheduled appointment; 4 (4.9%) refused to participate, 3 (3.7%) were excluded because of language barriers, and 75 (91.46%) agreed to participate and provide saliva samples. Thus, the final sample consisted of 75 mother–child dyads, of which $N = 50$ were exposed to IPV and $N = 25$ were not exposed to IPV and were designated the control group.

2.2. Procedure

The Ethics Committee of Cameroon approved our study (N0 2019/02/1141/CE/CNERSH/SP), which was carried out between April and June 2019.

During the initial face-to-face meeting, the participants were instructed about the importance of collecting the first sample immediately upon awakening and providing saliva samples at the sampling times. They were asked to collect saliva in their mouths for 2–5 minutes and pour it into the tubes. They were equally instructed not to eat, drink, smoke, or brush their teeth for 30 minutes before saliva collection. To increase the clarity of the procedure, the protocol was well detailed and a practical exercise on how to collect the saliva was shown to participants. In addition to face-to-face contact, take-home instructions in written form were provided. Then, each mother signed informed consent forms for themselves and their children and completed a questionnaire that included socio-demographic information, their current experience with IPV, a self-esteem scale, and a sense of coherence scale. With regard to participant adherence during salivary cortisol sample collection, all participants agreed to give saliva samples and we received all the sample (450) from all participants. Each mother was given a pack containing six labelled Salicaps (IBL International GmbH) – three for themselves and three for their children – in which to collect saliva three times on a single weekday: immediately after waking up, 30 minutes after waking up, and 45 minutes after waking up. Participants who had phones (n = 42) were instructed to set an alarm for the three sampling times. In addition, all participants recorded the commencement of the sampling in order to have a measure of the first time point immediately after awakening (average 6:30 am). No present injuries were reported during the sampling of cortisol.

2.3. Measures

Socio-demographic characteristics were assessed with a brief questionnaire about the mother's age, level of education, marital status, profession, and child's age.

2.3.1. Intimate partner violence

To assess IPV, we used the Revised Conflict Tactics Scale [CTS2; Straus, Hamby, Boney-mccoy, & Sugarman, 1996; French version by Lussier, 1997] because it has been widely used in sub-Saharan Africa to determine IPV (Goodman et al., 2019; McClintock, Trego, & Wang, 2019). The CTS2 was administered to all mothers (*N* = 75) regardless of whether they had been victims of IPV. The CTS2 consisted of 78 items exploring violence between the mother and her partner in the past 12 months with five scales: negotiation skills (e.g. 'I explained my side or suggested a compromise'), psychological abuse (e.g. 'insulted, stomped out of room, or threatened to hit me'), physical abuse (e.g. 'pushed, kicked, burned, scalded, or slapped me'), sexual abuse (e.g. 'used force, used threats … to make me have sex'), and injuries (e.g. 'felt pain, needed to see a doctor because of a fight'). The CTS2 is scored by adding the midpoints of the response categories chosen by the participant. The midpoints were 0 = 0 times, 1 = 1 time, 2 = 2 times, 4 = 3–5 times, 8 = 6–10 times, 15 = 11–20 times, and 25 = more than 20 times (Straus, Hamby, & Warren, 2003). Since there is no total score of the CTS2 and no validated cut-off score, we used the subscale scores, namely the scores for psychological abuse, physical abuse, sexual abuse, and injuries, and analysed each of the subscales of the CTS2 separately. The Cronbach's alpha coefficient for the CTS2 was 0.88.

2.3.2. Psychological protective factors in mothers

Self-esteem was assessed with the Rosenberg Self-esteem Scale [EES; Rosenberg, 1965; French version by Vallieres & Vallerand, 1990]. This scale comprises 10 items that measure self-esteem, i.e. one's positive and negative feelings about oneself. Items are rated on a four-point Likert-type scale, from 1 = 'strongly disagree' to 4 = 'strongly agree.' Higher scores indicate higher levels of self-esteem. The total scores ranged from 10 to 40. The Cronbach's alpha coefficient for the EES scale was 0.60.

Sense of coherence was measured with the 13-item Sense of Coherence Scale [SOC-13, Antonovsky, 1987; French validation by Gana & Garnier, 2001]. The items were rated on a seven-point Likert-type scale ranging from 1 = 'never have this feeling' to 7 = 'always have this feeling.' The SOC-13 consists of three subscales: comprehensibility, manageability, and meaningfulness. The total scores ranged from 7 to 91. High scores indicate a high sense of coherence. The Cronbach's alpha was 0.63.

2.3.3. Salivary cortisol measures

We received six samples per mother–child dyad. The participants were told to bring the samples immediately after collection to the ALVF premises. After collecting all the samples, the researcher took about 20 minutes to transport them to the refrigerator. Before shipment, all samples were kept cool in a refrigerator for a few days in Yaoundé (Cameroon). Afterwards, the samples were sent to Fribourg (Switzerland), where they were frozen and stored at −20°C before being sent to Dresden (Germany) for analysis and assaying in the Laboratory of Biopsychology of the Technical University of Dresden, Germany (Luminescence Immunoassay, IBL). Before centrifugation, 14 samples out of 450 were found to be insufficient for cortisol extraction. After thawing, the SaliCaps were centrifuged at 3,000 rpm for 5 min, which resulted in a clear supernatant of low viscosity. Salivary concentrations were measured using commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany).

2.4. Data analysis

All analyses were conducted using IBM Statistical Package for the Social Sciences (SPSS) 25. The analysis was performed using the subscale scores of the CTS2. We tested the normality of the distribution and the homogeneity of variance on the raw data using the Shapiro–Wilk and Levene's tests before performing the statistical procedures. The visual inspection of the histogram showed a skewed distribution for cortisol values, IPV scores, and protective-factor scores. Hence, we performed correlation analysis using Spearman's test and examined differences between the IPV-exposed group and the control group using the Mann–Whitney test. When discarding outliers from analysis, the Shapiro–Wilk tests conducted on the cortisol values showed a normal distribution. Thus, outliers were removed and cortisol values were not log-transformed before analysis.

Linear mixed-effects models, which are often used for their ability to handle missing data (Gueorguieva & Krystal, 2004) and suitability for repeated measurements (Detry & Ma, 2016), were estimated using maximum likelihood. Regarding the assumptions for the multilevel models, we checked the residuals of our models – that is, the linearity, normality, and equal variance of residuals. To prevent multicollinearity among predictor variables as well as to have more stable multilevel models, we group-mean-centred the IPV scores, protective factor scores, mothers' AUCg, and children's' AUCg, according to Field (2013). Given that age is a known determinant of cortisol response (Tyrka, Price, Marsit, Walters, & Carpenter, 2012), we equally controlled for a potential covariate to be included in the regression model as we examined the effect of the mother's and the child's ages.

As an index of HPA activity, the total cortisol secretion over the first hour after awakening was determined by calculating the area under the curve with respect to the ground (AUCg) according to the formula described by Pruessner, Kirschbaum, Meinlschmid, and Hellhammer (2003).

To test our first and second research hypotheses, in Model 1, we considered mothers' and children's ID as the random effect and group as the fixed effect. The three measurement times points for cortisol values were entered separately in the model to create the factor Time to enable us to investigate the rate of change of cortisol over time. To be more specific, linear component was added into the models as fixed effect as recommend Field (2013) given that time points are nested within people. In Model 2, we added IPV scores, protective factor scores, and the interaction between IPV and protective factors to Model 1. To test our third research hypothesis, we used Hayes's (2018) PROCESS version 3.4 for SPSS to determine the moderating role of protective factors on the effect of IPV on mothers' and children's AUCg. Finally, for our fourth research hypothesis, in Model 3, we considered children's ID as a random intercept and the group and mothers' group-mean-centred AUCg the fixed effects. The fixed effects were included together. To be more specific, we ran three models: the first looked at group differences between the IPV-exposed group and the control group (Model 1 Formula: y_{ij} = γ00 + γ10 *(Group)ij + γ20 *(Time) ij + μ0j + εij), the second examined mothers' and children's stress responses as a function of IPV and protective factors (Model 2 Formula: y_{ij} = γ00 + γ01* (IPV_cent)ij + γ02*(protective factor_cent)ij + γ03* (IPV_cent * protective factor_cent)ij + γ10 *(Group) ij + γ20 *(Time)ij + μ0j + εij), and the third focused on stress response in children as a function of the stress response of mothers (Model 3 Formula: y_{ij} = γ00 + γ04*(AUCg _mother_cent)ij + γ10 *(Group) ij + γ20 *(Time)ij + μ0j + εij). The models are detailed in the supplementary material.

3. Results

Socio-demographic characteristics, IPV exposure, and AUCg measures according to group are presented in Table 1. The two groups (IPV-exposed and control) significantly differed at the marital-status level (U = 290.0, $z = -3.85$, $p < .001$), but no significant difference was found regarding mothers' and children's ages and mothers' level of education and profession (all $p > .074$). Furthermore, no significant difference was found with respect to mothers' psychological resources (all $p > .216$). Finally, as expected, IPV-exposed women reported higher rates of physical abuse (U = 156.5, $z = -4.26$, $p < .001$), sexual abuse (U = 186.5, $z = -4.60$, $p < .001$), and injuries (U = 340.5, $z = -3.4$, $p = .001$) compared to the control group.

3.1. Control of potential covariates

We controlled for potential covariates, including the mother's and child's ages. Our results indicate that the mother's and child's ages were not associated with cortisol measures (r_s = 0.064, p = .350, and r_s = 0.020, p = .773, respectively); thus, these variables were not considered further in the analyses.

3.2. Differences in cortisol levels between IPV-exposed and control groups

The results of the Mann–Whitney test showed higher total output of cortisol (AUCg) among IPV-exposed mothers compared to the control group (U = 3968, $z = -3.014$, $p = .003$). No significant difference was found in AUCg of children in the IPV-exposed and control groups (U = 4693.5, $z = -1.056$, $p = .291$).

We computed a first linear mixed model (Model 1). For mothers, our results showed a significant effect of group on cortisol levels ($B = -2.593$, t(215) = −3.724, $p = .000$), but the linear time effect was not significant ($B = 0.019$, t(218) = −1.098,$p = .273$). For children, our results showed a significant effect of linear time on cortisol levels ($B = -0.902$, t(212) = −1.407, $p = .04$), but the effect of group was not significant (B= −0.011, t(212) = −.734, $p = .464$). Tables presenting each model separately are presented in the supplementary material.

Table 1. Demographic characteristics, violence exposure, AUCg measures, and Mann–Whitney analysis comparing the exposed and the control groups.

		Exposed group		Control group		Mann–Whitney analysis	
		N	%	*N*	%	U	*p*
Mother's age, M (SD, Min–Max)		37.86 (± 9.14, 22–58)		37.28 (± 4.08, 26–44)		604.5	.927
Child's age, M (SD, Min–Max)		10.71 (± 4.47, 2–18)		8.64 (± 3.76, 2–15)		447	.074
Mother's level of education							
Primary education		25	51.0	11	44.0	450.5	.170
Secondary education		15	30.6	8	32.0		
University level		4	8.2	6	24.0		
Mother's matrimonial status							
Married	Not in the process of separation	15	30.6	20	80.0	290	.000*
	In the process of separation	11	22.4	1	4.0		
Single		13	26.5	3	12.0		
Divorced		4	8.2	0	0		
Widow		2	4.1	1	4.0		
Cohabitation		3	6.1	0	80.0		
Mother's profession							
Teacher		3	6.1	7	28.0	553.5	.486
Business		1	2.0	0	20.0		
Secretary		3	6.1	0	12.0		
Homemakers		23	46.9	5	12.0		
Trader		10	20.4	3	8.0		
Cultivator		2	4.1	0	4.0		
Hairdresser		3	6.1	3	4.0		
Student		1	2.0	2	8.0		
Hotelkeeper		1	2.0	0	4.0		
Laundress		1	2.0	0	28.0		
Accountant		0	2.0	1	20.0		
Pastor		0	6.1	1	12.0		
Seamstress		1	2.0	2	12.0		
Nurse		0	6.1	1	8.0		
Mother's Psychological resources							
SOC scores		*48.44 (±10.21)*		*51.70 (±8.37)*		*370.5*	*.216*
EES scores		*27.71 (±5.05)*		*27.20 (±2.58)*		*423.5*	*.376*
CTS2 scores							
Negotiation skills		72.07 (±49.06)		124.96 (±20.26)		210	.000*
Psychological abuse		66.53 (±47.58)		49.96 (±22.89)		360.5	.189
Physical abuse		75.38 (±70.64)		10.17 (±13.31)		156.5	.000*
Sexual abuse		37.86 (±33.78)		7.56 (±16.79)		186.5	.000*
Injuries		9.77 (±18.24)		.12 (±.33)		340.5	.001*
AUCg measures							
AUCg measure Mother		7.75 (±5.70)		5.15 (±2.37)		3968	.003*
AUCg measure Child		7.25 (±4.74)		6.35 (±3.71)		4693.5	.291

U: Mann–Whitney coefficient, M (SD, Min–Max): Mean (standard deviation, minimum–maximum), *p*: *p*-value, *N*: frequency, %: percentage, *: significant values, SOC: Sense of coherence scale, EES: Self-Esteem scale, CTS2: Revised Conflict Tactics Scale, AUCg: Area Under the Curve with respect to ground.

3.3. Effect of IPV and protective factors on mothers' cortisol levels

In the IPV-exposed group, the Spearman rho test showed a significant positive correlation between the injuries reported on the IPV scale and AUCg (r_s = 0.261, p = .002). Similarly, the Spearman rho test indicated that in IPV-exposed women, higher AUCg was associated with lower self-esteem (r_s = −0.485, p = .000) and lower sense of coherence (r_s = −0.221, p = .02). No significant association was found in the control group (r_s = −0.084, p = .502, and r_s = −0.198, p = .111, respectively).

The linear mixed model (Model 2) was computed with IPV as a fixed effect and protective factors as covariates. With self-esteem as a covariate, the results indicated a significant negative effect of group (B = −2.361, t(179) = −3.63, p = .000), a positive effect of IPV-related injuries (B = 0.044, t(179) = 2.188, p = .03), a negative effect of self-esteem (B = −0.366, t(179) = −4.637, p = .000), and a negative effect of the interaction between injuries and self-esteem (B = −0.008, t(179) = −2.874, p = .005). The linear time effect was not statistically significant (p = .220). With sense of coherence as a covariate, our results showed a significant negative effect of group (B = −2.131, t (144) = −3.207, p = .002), a positive effect of physical violence on IPV (B = 0.012, t(144) = 2.173, p = .031), and a significant negative effect of the SOC-13's meaningfulness subscale (B = −0.255, t (144) = −3.84, p = .000). The linear time effect ((B = 0.016, t(144) = 0.988, p = .325) and the interaction effect between physical violence and the SOC-13's meaningfulness subscale were not significant (B = 0.000, t(144) = 0.846, p = .399).

Based on these preliminary analyses, a further moderation analysis showed that the relation between IPV (specifically injuries,) and AUCg was moderated by self-esteem (R^2 = 37.79, F(3, 57) = 11.54, p = .000), as reported in Figure 1. The moderation component

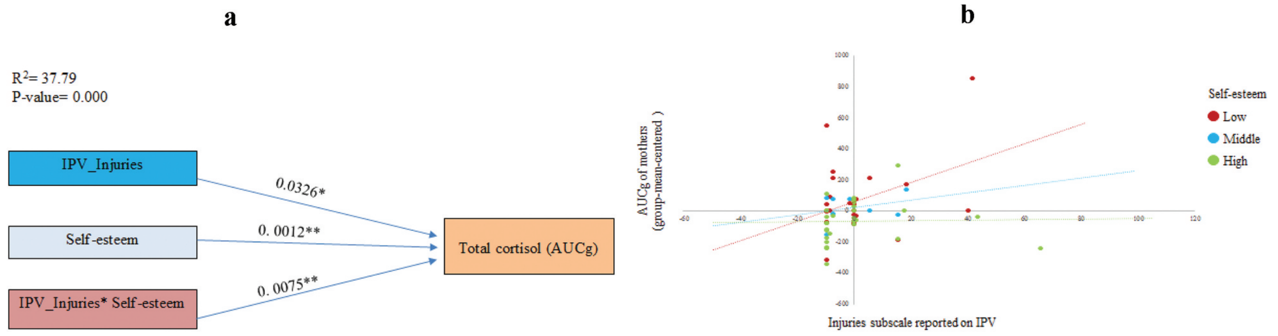

Figure 1. Moderating role of self-esteem in the effect of IPV on the AUCg measures of mothers: (a) A significant overall regression model was found for the moderating effect of self-esteem on the relationship between injuries as reported on IPV and AUCg in mothers. Specifically, a significant effect was found between injuries on IPV and AUCg, as well as between self-esteem and AUCg. Finally, the effect of the interaction between injury and self-esteem on AUCg was also significant. (b) Higher IPV, specifically injuries, was significantly and positively associated with greater AUCg among mothers exhibiting lower self-esteem. When self-esteem was high, however, no significant effect of IPV on AUCg was observed. Legend: R^2: amount of variance explained, p: *p*-value, IPV: intimate partner violence, IPV_Injuries: subscale injury reported on IPV, *: interaction term, AUCg: Area Under the Curve with respect to ground for mothers.

explained 37.79% of the variance. Higher IPV (specifically injuries) was significantly and positively associated with greater AUCg among mothers exhibiting lower self-esteem ($w = -3.0$, t = 2.91, $p = .005$). When self-esteem was high, however, no significant effect of IPV on AUCg was observed ($w = 3.0$, t = 0.99, $p = .32$).

3.4. *Effect of IPV and protective factors on children's AUCg*

Our results showed no significant correlation between IPV and children's AUCg in either group (all *p*-values > 0.110). The Spearman rho test indicated that, in the IPV-exposed group, the higher AUCg of children was associated with mothers' lower self-esteem ($r_s = -0.300$, $p = .001$) and with lower comprehensibility on the SOC-13 ($r_s = -0.266$, $p = .002$). In the control group, no significant association was found between the AUCg of children and protective factors (all $p > .221$).

The linear mixed model (Model 2) was computed with IPV as a fixed effect and protective factors as covariates. With self-esteem as a covariate, the results showed no significant effect. With sense of coherence as a covariate, however, the results indicated a significant negative effect of the SOC-13's comprehensibility subscale ($B = -0.126$, t(170) = −2.016, $p = .045$) and a significant positive effect of the interaction between sexual violence and comprehensibility ($B = 0.006$, t(170) = 2.024, $p = .045$). The effects of sexual violence, linear time, and group were not significant (all *p*-values > 0.576).

3.5. *Predictive effect of mothers' AUCg on children's AUCg*

In Model 3, with children's cortisol as a function of mothers' AUCg, The effect of time, group and mothers' AUCg was not significant ($B = -0.010$, t(204) = −.620, $p = .536$, $B = -1.094$, t(204) = −1.672, $p = .096$, and $B = -7.510933E-6$, t(204) = −0.005, $p = .996$, respectively).

4. Discussion

This study examined the effect of IPV on the HPA-axis activity of mother–child dyads exposed to IPV in Cameroon. In line with our hypotheses, our results indicate that IPV-exposed mothers presented higher total post-awakening cortisol concentrations compared to the control group. However, we did not find significant group differences between exposed and nonexposed children. The most interesting finding was that higher AUCg in IPV-exposed mothers and children was associated with lower self-esteem and a lower sense of coherence, suggesting that self-esteem could moderate the effect of IPV on stress response for IPV-exposed mothers.

For the first research hypothesis, we examined the differences in cortisol levels between the IPV-exposed and control groups. The results showed a significant effect of group on mothers' cortisol levels. In other words, hyperactivity of the HPA axis, as indicated by higher cortisol levels, was found in the IPV-exposed mother–child dyads compared to the control group. No significant group difference was found, however, between exposed and nonexposed children. These results are similar to those of a study by Boeckel et al. (2017), who investigated hair-cortisol concentrations in female IPV victims and their children in Brazil. The lack of significant differences in the total cortisol concentration of children in both groups may be related to increased social support or the quality of the mother–child relationship. In fact, previous studies have indicated strong social support in African communities, which may have a stress-buffering effect on children. For example, Sharer, Cluver, Shields, and Ahearn (2016) highlighted the power of siblings' support in the mental health of children, while Humm, Kaminer, and Hardy (2018) showed the importance of maternal, paternal, and overall family support in reducing the effect of IPV. The quality of the mother–child relationship is also an important factor that has been shown to reduce the effect of IPV on the child's development (Letourneau et al., 2013). We suggest that future research on stress response pay attention to these factors.

For the second research hypothesis, we investigated the relationship between IPV and cortisol levels, as well as the correlation between protective factors and AUCg, particularly self-esteem and sense of coherence. In accordance with our hypothesis, the analysis showed a significant positive correlation between the injuries and physical violence scores reported on the Revised Conflict Tactics Scale (CTS2) and mothers' AUCg. This tends to confirm the detrimental effect of IPV on the resulting stress in women exposed to this type of violence. Furthermore, we found that higher cortisol levels was associated with lower self-esteem and a lower sense of coherence in the IPV-exposed group compared to the control group. This finding is consistent with those of previous studies (Chen, Osika, Dangardt, & Friberg, 2017; Shaheen et al., 2020) and indicates that self-esteem and sense of coherence are important mechanisms underpinning the development of stress-related resilience (Chen et al., 2017; Eriksson & Lindström, 2006; Mc Gee, Höltge, Maercker, & Thoma, 2018; Pham, Vinck, Kinkodi, & Weinstein, 2010).

For children in both groups, no significant correlation was found between IPV and cortisol levels. In addition, no significant moderating effect of maternal protective factors, including self-esteem and sense of coherence, was observed, in the relationship between IPV and children's cortisol levels. Nevertheless, as was the case with IPV-exposed mothers, the cortisol levels of children in the IPV-exposed group was associated negatively with their mothers' self-esteem and sense of coherence. This result suggests an association between mothers' protective factors and children's stress response. Indeed, children's development has been associated with their relationship or interaction with their parents usually the mother (Letourneau, 2001).

For the third research hypothesis, we investigated the moderating effect of self-esteem and sense of coherence in the relationship between IPV and AUCg. We found a moderating effect for self-esteem. In fact, in the IPV-exposed group, higher IPV (specifically injuries) was significantly and positively associated with greater AUCg among mothers with lower self-esteem. When self-esteem was high, however, no significant effect of IPV on AUCg was observed. In this cultural context, self-esteem might be a high-order resilience factor and a plausible psychological mechanism through which adversity, including IPV, may become embedded in the activities of the hypothalamic–pituitary–adrenal (HPA) axis. The high AUCg of the IPV-exposed mothers could potentially be linked to some patterns of low self-esteem, such as lower self-worth (Gruenewald, Kemeny, Aziz, & Fahey, 2004), social isolation (Leary, Tambor, Terdal, & Downs, 1995), high level of rumination (Di Paula & Campbell, 2002), scarce motivation or negative moods (Heimpel, Wood, Marshall, & Brown, 2002).

For the fourth research hypothesis, we examined the predictive effect of mothers' AUCg on children's AUCg. In both groups, the result was not significant. In fact, there was no evidence that mothers' AUCg predicts children's AUCg. This is in accordance with the conclusion of Boeckel et al. (2017), who assessed hair cortisol and proved the absence of an association between cortisol levels in mothers and those of their children in Southern Brazil. Perhaps other factors may mediate the relationship between mothers' and children's AUCg, including parenting style or practices (Hibel et al., 2020).

Our results showed a high level of psychological abuse reported in both groups. On one hand, this result could be explained by the lower internal consistency of the psychological/emotional abuse subscale of the CTS2 since it comprises a smaller range of behaviours describing psychological aggression and a lack of comprehensiveness (Ro & Lawrence, 2007). On the other hand, another explanation could be related to one form of interaction inside the couple that is widespread in Cameroon. In this particular cultural context, evidence suggests that psychological violence is ranked first before sexual and physical violence (Noutakdie Tochie et al., 2020) and is said to have some specificities, like the denigration of the victim's intellectual capacities or sexual talents, sulking, and the man's refusal to eat (Bopda, 1997). Therefore, this result can suggest that the control group was potentially subjected to emotional abuse. In this context, however, it may be extremely difficult to find women who have not been victims of abuse.

Overall, the results of our study show that IPV-exposed mothers present higher HPA-axis activity, as measured by AUCg, compared to the control group. This is consistent with the results of previous studies that have used hair cortisol or determined the cortisol awakening response (CAR). The present study also contributes to the existing knowledge by showing the moderating effect of self-esteem in the relationship between IPV and AUCg in mothers exposed to IPV.

4.1. Limitations

This study, carried out in sub-Saharan Africa, has limitations. First, our research protocol for cortisol assessment was a minimum protocol of three measurements per person on a single day. This limitation should be taken into account when interpreting the data, since the salivary cortisol is prone to substantial intra-individual variability and limited reliability (Stalder et al., 2016), in particular when it is linked to trait variables, such as self-esteem and sense of coherence. In this particular context, however, many challenges prevented us from collecting saliva for more than one day. Misconceptions and superstitious beliefs are known to greatly hamper research involving biological material in Africa (Tindana & Wasunna, 2014). This was true for our research: collecting saliva was negatively perceived, and participants tended to feel uncomfortable about giving saliva samples for research. Furthermore, during data collection, some women were molested by their partners because of their participation in the study. Second, this study was cross-sectional, and we did not address social support, which is a well-known protective factor in Africa (Howell, Thurston, Schwartz, Jamison, & Hasselle, 2018). We focused on internal maternal protective factors, such as self-esteem and sense of coherence. Future studies could address social support and the extent to which it can moderate the effect of IPV on AUCg. Third, we did not measure the quality of the mother–child relationship or parental style, which, according to Hibel et al. (2020), can influence the effect of IPV on HPA-axis activity. Fourth, we only controlled for the compliance of the participant for the first time point. Given the context of the study, it was not possible to control for sample timing accuracy, and the lack of objective strategies for the verification of awakening and sampling times should be taken into account when interpreting the data. Moreover, we did not control for confounding factors, such as menstrual cycle, body mass index, smoking, or physical activity, that are known to have an effect on HPA-axis activity, nor did we make corrections for multiple comparisons. Fifth, the control group was potentially subjected to emotional or psychological abuse. Lastly, we used the conflict tactics scale (CTS2) to measure current IPV, which examines only acts and focuses on conflict situations (Straus, Gelles, & Steinmetz, 2006). Using the CTS2, however, allowed for comparisons with previous research in sub-Saharan Africa (Goodman et al., 2019; McClintock et al., 2019) and Brazil (Boeckel et al., 2017).

4.2. Relevance and implications of findings

Despite the aforementioned limitations, the present study highlights the moderating role of self-esteem in the effect of IPV on AUCg in IPV-exposed women in Cameroon. To our knowledge, this is the first study to investigate the effect of IPV on HPA-axis activity in mother–child dyads exposed to IPV in a non-Western context. We believe that it adds to the literature on IPV in sub-Saharan Africa, especially in Cameroon, where more than half of women are affected by IPV. As for the present study's strengths, it first compared two groups that differed in IPV exposure and stress-response levels. Second, it used a multilevel analysis. Previous studies investigating the relationship between IPV and cortisol level used a correlation or mediation analysis, despite the data's hierarchical or nested structure. This study's data-analysis plan provided a high potency and estimation of group effects simultaneously with the effects of group-level predictors.

The results showed that maternal protective factors, particularly self-esteem and sense of coherence, may help reduce the effect of IPV on the stress response of IPV-exposed mothers. This provides insight into ways to improve existing and design new care and intervention programmes for victims of IPV and their children in sub-Saharan Africa. One strategy could be to increase protective factors, such as self-esteem and sense of coherence, among abused women. Furthermore, intervention programs for IPV should also consider its effect on children's well-being and address its effect on both generations.

5. Conclusion

The present study provides a novel understanding of the effect of IPV on the HPA-axis activity of IPV-exposed mother–child dyads in sub-Saharan Africa. An important finding pertains to the moderating role of self-esteem in the effect of IPV on mothers' cortisol levels, as evidenced by the association found between lower self-esteem with higher AUCg in mothers in the IPV-exposed group. Indeed, future research could address the moderating or mediating role of external maternal resilience factors, such as social support, quality of the mother–child relationship, or quality of parenting. It would also be interesting to explore further the long-term effect of IPV on epigenetic mechanisms in this context.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The data that support the findings of this study are openly available in [FORS] at https://forsbase.unil.ch/, reference number [**1227**].

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