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The psychobiology of stress and intimate partner violence

Ilona S. Yim*, Yasmin B. Kofman

Department of Psychological Science, University of California, Irvine, 4562 Social and Behavioral Sciences Gateway, Irvine, CA 92697-7085, USA

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ABSTRACT

Exposure to intimate partner violence (IPV) negatively affects health outcomes, however, the biopsychosocial pathways underlying this relationship are not well understood. We conducted a systematic review of research published from 2000 through 2018 on biological and psychological stress-related correlates and consequences of IPV exposure. Fifty-three publications were included. The biological and psychological literatures have evolved separately and remain distinct. The biological literature provides emerging evidence of stress-related endocrine and immune-inflammatory dysregulations that are in line with patterns typically observed among chronically stressed individuals. The psychological literature provides strong evidence that IPV is associated with psychological stress, and that psychological stress follows new instances of IPV. Larger scale, integrative studies using prospective study designs are needed to more carefully map out how IPV influences victims both biologically and psychologically, and how these biopsychological changes, in turn, affect the health of victims over time.

1. The psychobiology of stress and intimate partner violence

Intimate partner violence (IPV) is a type of domestic violence defined by the Centers for Disease Control and Prevention as "physical violence, sexual violence, stalking, and psychological aggression (including coercive acts) by a current or former intimate partner" (Breiding et al., 2015). It is a global public health problem that occurs across age, genders, and sexual orientation, permeating racial, cultural, geographic, socioeconomic, educational and religious boundaries (Huecker and Smock, 2018). The World Health Organization (WHO), in a new and interactive violence prevention information system (Burrows et al., 2018), estimates the mean worldwide prevalence at a staggering 40% for women (psychological: 41%, physical: 32%, and sexual IPV: 18%) and at 15% for men (psychological: 51%, physical: 17%, and sexual IPV: 7%). There is also evidence from systematic reviews (Alhabib et al., 2010; Garcia-Moreno et al., 2006; Semahegn and Mengistie, 2015) that points toward a large range in prevalence rates based on a range of factors, including, most prominently, the IPV definition used (e.g., IPV type: sexual, physical, psychological), the severity of cases included (e.g., severe assault, IPV of any severity), and the population from which the study sample was drawn (e.g., legal or medical settings, domestic violence shelters, general population); prevalence estimates of individual studies ranged between 2% and 78%.

The experience of IPV is highly stressful for victims (Jones et al., 2001). Stress exposure typically does not end after victims leave the abusive relationship, but typically continues and often exacerbates. For example, survivors may experience continued abuse, violence or intimidation from the abuser, and secondary stressors including emotional and financial losses, stress related to single-parenting, testifying in court proceedings, or being the sole provider for a child (Anderson and Saunders, 2003). Exposure to IPV also negatively affects health outcomes. Aside from higher mortality due to homicide and suicide (McLaughlin et al., 2012; Stockl et al., 2013) as well as injury and disability directly resulting from the abuse (Coker et al., 2000; Guth and Pachter, 2000), IPV victims on average have poorer mental health (e.g., depression, anxiety, PTSD), sexual, reproductive (e.g., HIV, pregnancy outcomes), and gastrointestinal health, they report more chronic pain, demonstrate poorer health behaviors, and are at heightened risk of substance abuse (Coker et al., 2000; Huecker and Smock, 2018; Plichta, 2004; Stewart and Vigod, 2017).

This literature suggesting that IPV is a stressor and is associated with heightened stress and poor health outcomes is important. However, it is equally important to understand the biopsychosocial pathways leading from IPV to disease. While overwhelming empirical evidence in the broader stress literature suggests that stress and health are linked and that biopsychosocial variables are important moderators in this relationship (Cohen et al., 2007; Tsigos and Chrousos, 2002), few studies tested these associations as they relate to IPV. However, findings from the broader stress literature cannot easily be applied to the context of IPV. For all types of stressors, but maybe particularly so for IPV, it is necessary to consider the emergence of disease processes in the context of an integrative theoretical framework that takes into account contextual and historical factors in addition to acute stressful events (Epel et al., 2018).

* Corresponding author.
E-mail address: ilona.yim@uci.edu (I.S. Yim).

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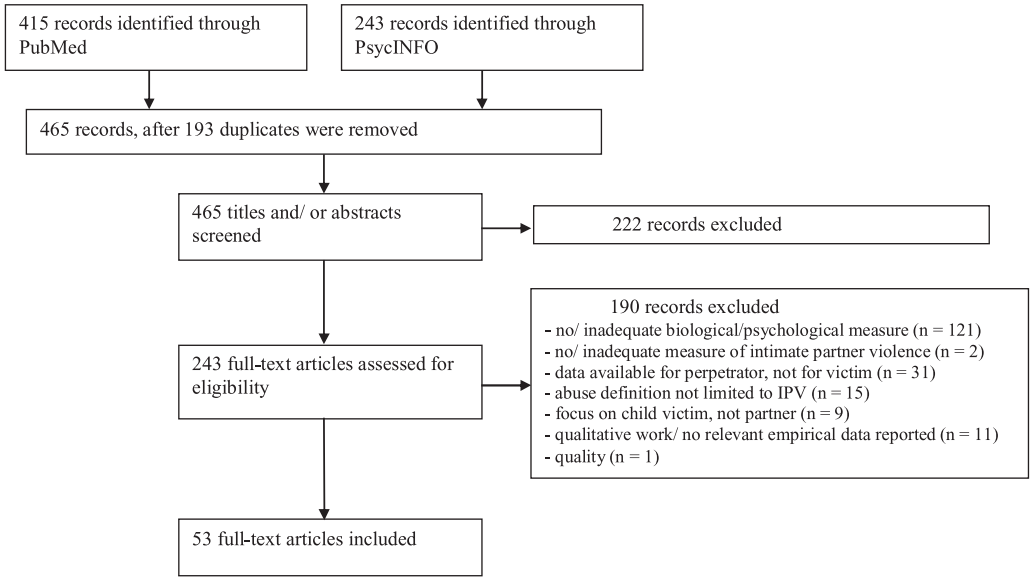

Fig. 1. Flow chart following guidelines in the PRISMA statement (Moher et al., 2009).

One example of what makes IPV-related stress unique is what has become widely known as the cycle of violence—a period of growing tension culminating in an act of violence followed by a phase of relative calm which is once again followed by increasing tension (Walker, 1979). Other aspects of the IPV experience to consider include the intensity and duration of IPV, whether IPV occurs in the context of victims' prior lifetime exposure to abuse (e.g., child abuse, non-IPV violence), whether other stressors co-occur, whether posttraumatic symptoms are present, how stressful a victim perceives their situation to be, and whether a victim is still in an intimate relationship with the abuser. Of note, while empirical studies have often conceptualized IPV as a highly stressful experience—which, undoubtedly, it is—few studies included an actual measure of stress. Given the complexity of the IPV, it can be expected that IPV-related stress will fluctuate and that neither biological nor psychological measures of stress obtained at a single time point are reflective of the overall IPV experience.

Much work remains to be done to develop a thorough understanding of the complex biopsychosocial pathways linking IPV exposure to poor health outcomes. This systematic review of stress-related biological (i.e., endocrine, immune/ inflammatory) and psychological (i.e., perceived stress, life event stress, chronic strain) correlates and consequences of IPV is an attempt to set the stage and encourage future work on this topic.

2. Method

2.1. Search strategy

PubMed and PsycINFO were searched systematically, according to criteria set forth in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Moher et al., 2009). Our key term in PubMed was "intimate partner violence [mesh]", and the equivalent search term in PsycINFO was "'intimate partner violence' OR 'spousal abuse OR spouse abuse OR dating violence [in MAINSUBJECT]". These key terms were combined with the search terms biological, "stress, psychological", endocrin*, immunolog*, inflammat*, cortisol, adrenocorticotr*, corticotr*, thyroid*, HPA axis, HPG axis, oxytocin, endorphin, gonadal, gonadotrop*, estrogen, estradiol, estrone, progesterone, prolactin, testosterone, and cytokine.

2.2. Selection criteria

Studies were considered if they were published in peer-reviewed, English language journals. Only empirical studies on human subjects were considered, but no limits were set for date of publication in the initial search. A post hoc a decision was made to include only articles published since 2000, the year in which the first identified biological paper was published. To be included in the current report, a study had to (a) include participants with current or past experiences of IPV; (b) measure or otherwise reliably establish IPV (e.g., court records); (c) measure a biological (endocrine, immune/inflammatory) or psychological variable (stress) at least once; and (d) report a statistical relationship between IPV and the biological or psychological measure. Psychological stress in this review was defined broadly to accommodate inclusion of any studies defining stress as psychological or emotional stress, life or life event stress, suffering or mental suffering, or anguish, based on the subcategories of the broad PubMed search term "stress, psychological [mesh]". We made a decision to include only studies of endocrine and immune/inflammatory measures in this review. The literatures on autonomic and genetic/epigenetic measures is fairly distinct, consists almost exclusively of studies on perpetrators of IPV, and were thus deemed beyond the scope of this review. Single case studies were excluded, as were studies reporting data exclusively for IPV perpetrators. Studies in which the effects of IPV were not reported separately from those of other types of abuse (e.g., child abuse, non-partner violence) were excluded. Studies conceptualizing stress as depression, anxiety or a combination of both, and conceptualizing stress as post-traumatic stress were also excluded. The final search was conducted on May 18, 2018.

2.3. Selected studies

This search strategy yielded 415 hits in PubMed and 243 hits in PsycInfo, resulting in a total of 465 records after removing 193 duplicates (Fig. 1). Titles and abstracts of these articles were reviewed and 222 were excluded because they were clearly irrelevant, or, in the case of psychological papers, were published before the year 2000 (n = 40). The remaining 243 articles were more carefully examined, and 190 were excluded for various reasons. Thus, 53 articles reporting on biological and psychological stress-related processes among victims of IPV were considered in this systematic review. One article was a corrigendum of another article and the two were combined into one table entry (Johnson et al., 2008a, 2008b). A detailed description of all studies is provided in Table 1, which consists of three sections reporting studies with biological measures (Section 1), psychological measures

Table 1
Studies Relating Biological and Psychological Stress Measures with Intimate Partner Violence.

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
SECTION 1: STUDIES ON BIOLOGICAL MEASURES					
Basu et al. (2013)	88 U.S. women; 52% Cauc., 25% Afr.-Am., 8% Hisp., 7% Asian, 8% Multiracial; 51% some college; income: M = $2.3k; IPV: 86%; Incl.: 18-41 yrs; Excl.: hx of psychotic disorder or cognitive impairment, preg., breastfeeding, neuroendocrine disorder, cancer, substance abuse; Incl.: IPV past 2 yrs, ≥2 MDD, 2 PTSD sx; controls: no IPV, PTSD, mental health dx.	**Phys. IPV**(SVAWS) Cat.: yes/no	**Cort** in saliva Cont.: At interview (5:30pm), next day at 9:00pm, and following day, +0 and +45 after waking	–	n.s.
Bernard et al. (2017)	182 U.S. mother-infant dyads, M age = 25 yrs, household income: M = $1.2k, 49% w/ some college; 43% White, 33% Afr.-Am., 9% Latina, 15% Multiracial; IPV: preg.: 19%, pp: 7%, preg. and pp: 43%, no IPV: 32%. Incl.: 18-34 yrs, child 11-13 mos old, not lactating 2 hrs before test, no disorder affecting glucocorticoid release, in heterosex. romantic rel. for ≥6wk in preg., no premature delivery.	**Psych., phys. and sex. IPV** (SVAWS)[P] retrospective for preg and pp Cont.: sum	**Cort** in saliva from mother and infant[P/O] Cont.: Before, + 20 min and + 40 min after 2 min infant arm restraint witnessed by mother 12:30–4pm	–	Mother IPV and cort n.s.; More attunement (mother-baby cort corr.) at +20, + 40 min w/ low IPV; Multivar.: Attunement w/ low IPV. IPV does not moderate attunement in cross-lagged model.
Boeckel et al. (2017)	59 women from Brazil, 54% w/ and 46% w/o IPV; 100% phys. IPV, 66% sex. coercion; 94% severe psych. aggr.; 47% severe injury; age (w/, w/o IPV): M = 34 yrs, 36 yrs; educ.: M = 7 yrs, 9 yrs; mostly married/ in stable rel.; Incl.: low income, no severe illness, cognitive impairment, psychotic sx, substance abuse, corticosteroids.	**Psych. and phys. IPV, sex. coercion, and injury** (CTS2)[P] Cat.: yes/no, cont.: freq., past 12 mos	**Cort** in hair[O] Cont.	–	IPV w/ higher hair cort but no corr. btw IPV freq. and hair cort in IPV group.
Constantino et al. (2000)	24 U.S. women, 50% w/ IPV in past yr; Incl. IPV: female, > 18 yrs, seeking pro bono legal representation for IPV; Incl. control: no abuse, good rel. quality. Excl.: chronic condition influencing immune system; psychiatric treatment, psychosis, cognitive impairment.	**Actual or threatened verbal, phys., sex., psych., or economic control; seeking legal protection from IPV**[P] Cat.: yes/no, past month	**T-cell function (total mitogen response)** in serum[O] Cont.: Fasting blood draw, 9-11am	–	IPV women w/ lower total mitogen response.
Danielson et al. (2011)	75 Canadian female university students in heterosex. rel.; age: M = 20 yrs; 93% Cauc.; IPV: 53%; phys. IPV: 24%, psych: 49%.	**Phys. or psych. IPV** (CTS2)[P] Cat.: yes/no, 3 mos	**Cort, IL-6, IL-10** in plasma[O] Cont.: 1:30-5pm, + 30 min after reading/ writing about abuse or control scenario	–	Cort, IL-6, IL-10 n.s.; w/o IPV: higher IL-6, IL-10 w/ higher anger, sadness; w/ IPV: higher IL-6 w/ higher anger, sadness in abuse scenario. Higher IL-6 w/ higher IL-10 only w/ IPV.
Fernandez-Botran et al. (2011)[a]	67 postmenopausal U.S. women, 69% w/ IPV, 31% w/o or minor IPV; Incl.: No ongoing divorce-related legal issues, no recent psychiatric hospitalization, no IPV in past yr, 45-60 yrs, 12-mos cessation of menses, no chronic disease, anti-inflammatory drugs, current alcohol abuse.	**Phys. or psych. IPV, sex. coercion, injury** (CTS2)[P] Cat.: yes/no	**IL-6, sIL-6 r** in plasma, saliva and oral mucosal transudate, **CRP** in plasma[O] Cont.: 2 days, btw 8am-1pm	–	Higher CRP w/ IPV at first visit.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
Griffin et al. (2005)	84 U.S. women, 18-51 yrs old; approx. 60% Afr.-Am, 30% White; IPV: 83%; IPV w/ PTSD (n = 25), w/ PTSD and depr. (n = 37), no dx (n = 8); Incl.: Rel. w/ perpetrator ≥3 mos, IPV within 6 mos.; Excl.: Psychosis, intoxication, BMI > 35, meds affecting DST.	**Phys. or psych. IPV, injury** (CTS2)[P] Cat.: yes/no, past yr	**Cort, dex** in plasma[O] Cont.: Blood draw 9-9:15am on 2 days; 0.5 mg dex, 11 pm, day 1. Cort: both days, dex: day 2.	–	IPV w/ PTSD and w/ PTSD + depr. had lower baseline cort than IPV w/o dx and controls. Day 2 DST-cort lower in IPV + PTSD than controls. No diff. in dex metabolism.
Halpern et al. (2016)	78 U.S. women 18–64 yrs old; 47% Afr.-Am., 53% Other; Incl.: female patients in Oral Surgery Clinic.	**Exposure to IPV and injury** (PVS, PASS)[P] Cat. yes/no (PVS; lifetime), cont. (PASS; freq.), past 12 mos	**Cort, DHEA, CRP** in saliva[O] Cont.: 8am-12pm	–	Women w/ IPV had higher DHEA; cort, DHEA/cort ratio, CRP n.s.
Illangasekare et al. (2012)	196 U.S. women receiving HIV primary and gynecologic care, 46 yrs; 49% < high school, 54% not in stable rel.; 70% unemployed; 86% Afr.-Am., 14% Other; IPV: 27%; Incl.: ≥18 yrs.	**Exposure to IPV** (PVS)[P] Cat: yes/no, past yr	**CD4 count** from med. record[O] Cont.: median cells/mm^3	Depr. sx*, gynecologic appointments, race/ethn., drug use in past month, HIV-1 RNA level, age	n.s., but trend for higher CD4 cell count w/ IPV, p = .07); Multivar.: n.s.
Jewkes et al. (2015)	103 South African women aged 15-26 yrs, 89 HIV + at baseline, 14 seroconverted at 12 mos follow up; IPV: 45% emot., 41% phys., 19% sex. Women received 6-8 week intervention on HIV, reproductive and sex. health, or 3-hr information session on safer sex and HIV.	**Phys. (+severity), sex. (+severity), and emot. IPV** (WHO Viol. Against Women instrument)[P] Cat.: yes/no, lifetime or past 12 mos and during follow-up	**CD4, CD8 count** in blood[O] Cont.	Food security, alcohol and drug use*[CD4], preg., childhood trauma; 3 crude indicators of duration of HIV infection: age*, CD4/CD8 yrs of follow up*, HIV positive at baseline*	Ever emot. IPV, emot. IPV by current partner w/ faster CD4 decline; ever phys. IPV (trend for ever emot. IPV) w/ faster CD8 decline; Multivar.: Emot. IPV from current partner w/ faster CD4 decline, ever emot. IPV w/ faster CD8 decline.
Johnson et al. (2008a, 2008b)[b] *Johnson et al. (2012) is corrigendum of* Johnson et al. (2008)	2008 sample: 52 sheltered, battered U.S. women w/ and w/o PTSD; 96% psych. aggr.; 87% phys. aggr.; 62% sex. coercion; 75% injury; age: M = 34 yrs; 48% Afr.-Am., 29% White, 10% Hisp., 13% Other; 73% married/ cohabiting before shelter; 79% w/ high school, 85% unemployed; 62% w/ IPV-related PTSD. 2012: As above and extended sample of 100 women.	**Phys. or psych. IPV, sex. coercion, and injury** (CTS2 w/ added chronicity item)[P] Cat.: yes/no, month before entering shelter	**Cort** in saliva[O] Cont.: +0, +30, +45, + 60 min after waking	Age, depr.	Chronicity (Md-Split) w/ reduced AUC_G, PTSD w/ greater AUC_G in both samples; Multivar. (2012): IPV chronicity w/ lower AUC_G contr. for PTSD (n = 100); n.s. in 2008 sample.
Kim et al. (2015)	244 U.S. individuals from 122 heterosex. couples, married/ cohabitating: 86%, 50% of males w/ juvenile arrest record; ethnic minority (men, women): 11%, 16%; educ. > 12 yrs: 61%, 24%; IPV: psych: 88%, 86%, phys.: 18%, 11%; Incl.: Men recruited at 9-10 yrs old from high juvenile delinquency neighborhoods; at current wave: men 35-36 yrs old, female partners incl. in study.	**Phys. IPV** (CTS2)[P] Cont.: average	**Cort** in saliva[O] Cont.: +0, + 30 min after waking, midday, before bed; 4 consecutive days	**Psych. IPV** (CTS2; self- and partner-report averaged), women's employment*[men, linear slope, CAR], number of children in household*[men, linear slope], rel. satisfaction	More phys. IPV w/ higher midday and evening cort in women only; Multivar.: More phys. IPV w/ higher midday cort, and in women only also lower CAR, less linear decline in cort at midday, less quadratic dampening over the day.
Pantalone et al. (2012)	168 U.S. HIV + men; M age = 44 yrs; 63% White, 18% Black, 6% Am.-Indian/ Alaskan Native, 8% > 1 race; 46% w/ monthly income < $738; 75% unemployed; 63% w/ AIDS; IPV: lifetime 78%, past yr 54%, past 5 yrs 66%; psych: lifetime 73%, past yr 51%; phys.:	**Phys., psych., and sex. IPV** (CTS2)[P] Cat.: yes/no, past 5 yrs; cont.: summed ordinal freq., past yr	**CD4 cell count** from med. record[O] Cont.	–	No diff. in CD4 cell count btw men w/ and w/o phys., sex., psych., or any IPV.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
	lifetime 38%, past yr 19%; sex.: lifetime 30%, 17% past yr; Incl.: in HIV clinic, > 18 yrs, biol. male at birth, man having sex w/ men; Excl.: male-to-female transgender.				
Pico-Alfonso et al. (2004)	162 Spanish women; M age approx. 45 yrs.; IPV: 72%; phys: 43%, psych: 28%, sex.: 19%; Incl.: controls w/o lifetime IPV.	**Phys., psych. and sex. IPV** (author-developed interview)[P] Cat.: yes/no, past yr	**Cort, DHEA** in saliva[O] Cont.: btw 8-9am and 8-9pm, 4 consecutive days starting 4th day after menstruation onset	Age*^{DHEA}, educ., smoking, meds (antidepr., benzodiazepines*$^{cort,\ DHEA\ pm}$, estrogen, progestogens, glucocorticoids, lithium), childhood abuse, adult non-IPV abuse*$^{DHEA\ am}$	IPV w/ higher pm cort (sig. for phys., trend for psych. IPV), higher am and pm DHEA (sig. for phys. and psych. IPV in pm cort; psych. IPV sig. for am cort, phys. IPV trend); Multivar.: confirms sig. findings.
Pinna et al. (2014)[b]	104 U.S. women recruited from battered women's shelters, age M = 34 yrs; 46% Afr.-Am., 41% Cauc., 9% Biracial; Incl.: IPV in past mos; Excl.: smoking, corticosteroids.	**Phys., or psych. IPV, sex. coercion, and injury** (CTS2) w/ added chronicity item and severity of injuries Cat.: yes/no, month before entering shelter	**Cort** in saliva Cont.: +0, +30, +45, + 60 min after waking; AUC_G and AUC_I computed	–	Chronicity of IPV w/ lower AUC_G.
Pinto et al. (2016)	149 Portuguese female victims of severe IPV; M = 36 yrs; 36% married; 49% live w/ perpetrator, 51% live in shelter; Incl.: ≥18 yrs, w/ children 4-10 yrs old, IPV reported to authorities. Excl.: psychotherapy, psychosis, intoxication, preg.	**Phys. and psych. IPV** (CTS2), chronicity of minor and severe IPV[P] Cont.: sum	**Cort** in saliva[O] +0, + 30 min after waking; Cont. and cat. (no CAR: decrease/ no change; low CAR: increase < 2.5 nmol/L; CAR: ≥ 2.5 nmol/L)	Age, location (shelter vs. home), educ., abuse hx, PTSD, psych. distress, soc. supp.)	Cat.: No CAR group w/ more phys. and psych. IPV; Multiple regression, cont.: Chronicity of severe IPV w/ flatter CAR.
Rice and Records (2008)	34 U.S. mothers within 24 hrs of giving birth; 18-45 yrs old; IPV: 50%; Emot. IPV: 71%, phys. IPV 24%, phys. and sex. IPV: 6%; Excl.: Conditions affecting health or cort.	**Emot., phys., and sex. IPV** (AMA, SVAWS)[P] Cat.: yes/no for positive AMA or SVAWS ≥ 5, past yr	**Cort** in saliva[O] Cont.: 8-9am, day of discharge	–	No sig. group diff. (n.s. trend for higher cort in women w/ IPV, $p = .06$).
Robertson Blackmore et al. (2016)	171 U.S. women w/ singleton preg.; age M = 25 yrs; 47% Afr.-Am., 30% White, 7% Hisp./Latina, 16% Other; Mean educ.: 13 yrs; IPV: 21%; Excl.: med. cond. and meds impacting cytokines, high med. risk (e.g., preg. drug use), adverse obstetric outcomes, psychotic disorder hx.	**Lifetime IPV** (author-developed)[P] Cat.: yes/no	**IL-6, TNF-α** in serum[O] Cont.: 8am–4pm	Age, race, marital status, parity, early preg. BMI, smoking, drinking, depr. sx at 32 wks' GA, trauma unrelated to IPV	Women w/ IPV had higher TNF-α at 18 wks' GA; Multivar.: Women w/ IPV showed less variation in IL-6 across preg. and had a more sig. drop in IL-6 from 6 wks to 6 mos pp.
Saxbe et al. (2015)	122 U.S. parents within 2 yrs of birth; IPV: 43%, > 1 type of IPV: 26%; 95% married/ cohabiting; age M = 29 (mothers), M = 32 (fathers); Incl.: Mothers: 18-40 yrs, Afr.-Am., Latina or White.	**Phys. and psych. IPA freq.** (HITS) w/ added item on **domination/ emot. control**[P] Cont.: freq., past yr	**Cort** in saliva[O] Cont.: +0, + 30 min after waking, bedtime	Ethn.*$^{within-couple\ corr.}$, income, parity*^{slopes}, breastfeeding, wake time, age of index child, preg. status, poverty level, rel. satisfaction, dyadic adjustment	Mother-reported IPV w/ flatter diurnal decrease in women and men and greater within-couple corr. of cort.
Seedat et al. (2003)	38 U.S. women, age (IPV/controls): M = 36 yrs/ 41 yrs, Cauc.: 64%/ 88%, married: 9%/56%, educ.: M = 13 yrs/15 yrs; IPV: 58%; Incl. IPV: left abusive rel. > 4 mos but < 2 yrs ago, sex. or phys. IPV; Incl control: no trauma hx; Excl.: psychotic, bipolar, substance abuse, attention deficit, or neurological disorder, psychotropic meds, steroids.	**Negotiation, phys., psych., sex. IPV, and injury** (CTS2)[P] Cont.: sum	**Cort, NPY** in plasma[O] Cont.: 9am–12pm	–	IPV w/ lower cort compared to controls, no effect of trauma. NPY n.s.
Stene et al. (2013)	5593 Norwegian women age 30-60 yrs in population-based cohort study; 87%	**Phys., sex., psych. IPV** (adapted NorVold Abuse	**Total and HDL cholesterol, triglycerides** in serum[O]	–	Phys. and/or sex. IPV w/ low HDL cholesterol and elevated triglycerides.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IVP P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
	no IPV; 6% w/ psych. IPV only; 7% phys. and/or sex. IPV; Excl.: Cardiovascular disease, drug use at baseline.	Questionnaire)[P] Cat.: yes/no, lifetime	Cat.: high, borderline, normal (cholesterol, triglycerides); low, borderline, normal (HDL cholesterol)		
Woods et al. (2005)	138 U.S. women, 91% w/ IPV, controls, 18-59 yrs old; 51% Cauc., 36% Afr.-Am., most IPV women w/ high school, M income = $15k-20k, most controls w/ college, M income = $40k-45k. *Note: 120 women incl. in structural equation modeling.*	**Phys., sex. IPV, threat of viol.** (SVAWS), **emot. IPV** (ISA-non-phys. subscale**), risk of homicide** (DAS)[P] Cont. (SVAWS); cont. (ISA-non-phys.); cat. (DAS)	**CD4, CD8, CD19, CD16/56 N K cell counts** in blood[O] Cont.: Baseline and PHA activated	Childhood maltreatment*, PTSD sx*, current smoking*, age, race, income, BMI, **length of abusive rel.**, salivary cort (diff. score of 10 pm and 8am on next day)	Structural path analyses: Latent IPV var. w/ immune status through direct paths from IPV to PTSD and from PTSD to immune status. No direct effect IPV on immune status; Regression: CD4, CD8 cells, and NK cell efficacy predicted by phys. and emot. IPV, threats of viol. and risk of homicide.
SECTION 2: STUDIES ON PSYCHOLOGICAL MEASURES					
Agrawal et al. (2014)	734 young U.S. preg. women; 77% Black, 49% ≤19 yrs, almost half w/o high school degree; 17% emot., 8% phys., 3% sex. IPV at 6 mos pp; 25% emot., 9% phys., 4% sex. IPV at 12 mos pp; Incl.: 14–25 yrs, < 24 wks' GA, no severe med. problems.	**Phys., sex., and emot. IPV** (adapted from CTS) at 6, 12 mos pp[P] Cat.: yes/no, past 6 mos	**Perc. Stress** (10-item PSS), **Parental Stress** (Parental Stress Index) Cont.: 6, 12 mos pp[O]	Age, educ., race, STD hx, employment, rel. status, intervention group	Mothers w/ IPV at 6 and 12 mos w/ highest perc. and parental stress. Mothers w/o IPV at 6 mos but w/ IPV at 12 mos w/ increased perc. and parental stress. No IPV w/ decrease in parental stress btw 6-12 mos.
Al-Modallal et al. (2012)	101 women from Jordan, 25-35 yrs old, 87% married; Incl.: ≥18 yrs, married or engaged.	**Worksite harassment** (9 items, based on U.S. General Accounting Office DV report)[P] Cat.: yes/no, lifetime	**Chronic arousal** (DASS – Stress Subscale)[O] Cont.: total then doubled	–	Workplace harassment w/ higher stress.
Al-Modallal (2012)	267 women in refugee camps in Jordan, 16-63 yrs old (M = 31 yrs), mostly married w/ children, some school, 86% housewives, 20% preg.; 77% contr. behaviors, 53% emot. IPV, 48% emot./ contr. behaviors; Incl.: were/ had been married, not accompanied by intimate partner, no depr., stress or anxiety meds.	**Contr. behaviors** (WHO Multi-Country Study on Women's Health and DV against Women), **Emot. IPV** (4-items)[P] Cat.: yes/no	**Chronic arousal** (DASS – Stress Subscale)[O] Cont.: total then doubled	–	Women exposed to contr. behaviors and/ or emot. IPV had higher stress.
Arriaga and Schkeryantz (2015)	98 U.S. college students, M age = 19 yrs, 69% female, 84% white, 9% Asian/ Asian-Am., 4% Hisp./ Latino; Incl.: In romantic rel. w/ ≥1 incident of IPV.	**Psych. IPV** (Psych. Aggr. Scale)[P] Cont.: sum	**Rel. stress** (10-items)[O] Cont.: Every 2 wks for 10 wks	Sex, pre-aggr. personal distress*, pre-, post-aggr. couple functioning, new psych. IPV perpetration	Rel. stress sig. w/ IPV in less committed couples.
Caetano et al. (2007)	774 U.S. individuals from 387 married, cohabiting couples; Incl.: Hisp., ≥ 18 yrs.	**Phys., sex. IPV** (adapted CTS2)[O] Cat.: yes/no, past yr	**Acculturation Stress**[P] Cont.	Alcohol volume, binge drinking	Simple corr. and multivar.: Higher acculturation stress w/ more IPV in men and women.
Chu et al. (2010)	134,955 U.S. women around the time of preg. (PRAMS study); 4% current partner, 5% former partner, and 5% both current and former partner IPV 12 mos before preg.; 3% current partner, 3% former partner, and 4% both current and former partner IPV during most recent preg.	**Phys. IPV** (4 items from PRAMS questionnaire) in 12 mos before preg. and throughout preg.[O] Cat.: yes/no	**Exposure to stressful events** (drug/ alcohol problem of someone close; separation/ divorce; self/ partner lost job; cannot pay bills; moving; homeless; partner went to jail)[P] Cat.: yes/no, each event	Preg. wantedness*, Medicaid-covered delivery*, unmarried*, maternal race*, educ., age, paternal educ.	Divorce, drug use, and partner job loss w/ higher IPV in univariate and multivar. models; mother job loss sig. only in univar. model.
Coker et al. (2017)	2376 U.S. women aged 18-79 w/ biopsy-confirmed incident, primary cancer; Incl.: 18-79 yrs., added to cancer registry in past yr.	**Interference w/ care** (abbreviated Partner Interfering Behaviors in Cancer Care)[P] Cat.: yes/no, high/low	**Perc. Stress** (3 items from 4-item PSS)[O] Cont.: sum; retrospective for stress 2-3 mos after dx, month before study	Contr.: age, income, smoking, state of residence, cancer site, **lifetime IPV (phys., sex, emot.)**, partner supp., cancer stage, comorbid conditions, treatment; Other vars: depr. sx*, spiritual well-being*, functioning (phys., soc./ family, emot., work/ life)	Partner interfering behaviors w/ increased perc. stress in simple comparisons and multivar. model.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
Duke and Cunradi (2011)	100 U.S. farm workers; 96% Mexican-born, 61% female, M age = 36 yrs, 52% w/ primary educ.; Males: 14% moderate and 8% severe/moderate IPV; females: 10% moderate and 7% moderate/severe IPV; Incl.: paid work in agriculture in past 30 days, ≥18 yrs, spouse not present at recruitment/ data collection.	**Phys. IPV** (CTS2)[O] Cat: yes/no; none, moderate, moderate to severe	**Migrant Farmworker Stress Inventory**[P] Cont.: sum	–	Farmworker stress and IPV n.s.; farmworkers had overall high levels of stress.
Edwards and Sylaska (2013)	391 U.S. LGBTQ youth in same-sex romantic rel.; M age = 21 yrs, 49% male, 44% female, 5% genderqueer, 2% trans-man/woman; 72% Cauc., 9% Hisp./Latino, 8% multiracial, 6% Afr-Am., 5% Asian/ Pacific Islander; 16% psych., 20% phys. 14% sex. IPV; 72% sex. orientation-related IPV.	**Phys., sex. and psych. IPV** (CTS2)[O] Cat.: yes/no	**Minority Stress** (internalized homonegativity, sex. identity concealment, stigma, sex. minority-related victimization)[P] Cont.: sum; cat.: victimization: yes/no	–	Psych. IPV w/ more internalized homonegativity.
Ely and Otis (2011)	188 adult U.S. abortion patients, about 25 yrs old, 87% no college degree, 77% white, 20% Afr.-Am.; 14% emot. IPV, 6% phys. IPV, 4% sex. IPV; Incl.: ≥18 yrs, seeking abortion services.	**Phys., sex. and psych. IPV** (Phys., nonphys. subscales of Brief Adult Assessment Scale)[P] Cont.: sum, past month; Cat.: yes/no	**Personal Stress** (Subscale of Brief Adult Assessment Scale)[O] Cont.: sum	–	More personal stress w/ more phys., sex. and psych. IPV.
Ferreira et al. (2017)	8453 women from population-based Australian LG Study on Women's Health; 45-50 yrs old, 85% partnered; 13% IPV.	**Ever in viol. Rel.** (single item)[P] Cat.: yes/no	**Perc. Stress** (PSS)[O] Cat.: stress/no stress	–	Highest stress w/ IPV and caregiving, lower w/ IPV or caregiving, lowest w/o IPV or caregiving.
Finegood et al. (2017)	185 U.S. parents, 92% mothers, M age = 31 yrs (SD = 7), most Hisp./ Latino, 68% w/ annual household income < $21k); 17% phys. IPV, 66% psych. IPV.	**Phys. and psych. IPV** (CTS2)[P] Cont.: average	**Parenting daily hassles, financial hardship**[O] Cont.: mean	Educ., income, anxiety*, attentional bias toward threat	More IPV w/ more hassles in simple comparisons and multivar. models, financial hardship n.s.
Finneran and Stephenson (2014)	1575 internet-recruited, U.S. men who have sex with men, 61% < 30 yrs, 63% White, 43% Latino, 19% Black, 11% Other; 9% phys. IPV, 4% sex. IPV.	**Phys. and sex. IPV** (based on IPV definitions)[O] Cat.: yes/no	**Minority stress** (internalized homophobia, homophobic discrimination, racism)[P] Cont.: index	Age*[phys. IPV], race, sex. identity, educ.*[phys. IPV], employment status, HIV status	Homophobic and racist discrimination w/ phys. and sex. IPV; Multivar.: Homophobic discrimination w/ phys. and sex. IPV, racist discrimination w/ sex. IPV.
Heaman (2005)	680 Canadian women who delivered live, singleton infant, 14-45 yrs (M = 27), 52% White, 38% Aboriginal, 7% Asian; 37% emot./phys. IPV, 2% sex. IPV.	**Phys., sex. and emot. IPV** (AAS)[O] Cat.: yes/no, in preg. or yr prior to preg.	**Perc. stress** (4-item PSS), **SLE** (Prenatal Psychosocial Profile subscale)[P] Cont. and cat.: PSS > 10, SLE > 26	Marital status*, age, income, educ., smoking, alcohol use, illicit drug use*, prenatal care, self-esteem, moving*, partner supp.*, other supp., vaginal bleeding, bladder infection*, paid job, Aboriginal race/ ethn.*	IPV w/ higher per. (cont.) and SLE (cont. and cat.); Multivar.: Higher SLE score w/ more phys. IPV. Note: perc. stress not in multivar. model.
Jose and Novaco (2016)	136 female U.S. IPV victims, M age = 32 yrs, 62% Hisp./Latina, 20% European/ White, 5% Afr.-Am./ Carribean; Incl.: female, > 18 yrs old, seeking temporary restraining order; 79% phys. IPV w/o weapon; 24% phys. IPV w/ weapon; 34% sex. IPV; 66% threat to be killed/ harmed.	**IPV freq.** (5 items reflecting **phys. and sex. IPV**)[P] Cont.: freq., past 6 mos	**Perc. stress** (4-item PSS)[O] Cont.: sum	Age, marital status, employment, ethn., soc. supp. (count of friends, perc. supp. total), resiliency*	Assoc. btw stress and IPV freq. n.s. in simple corr. and regressions.
Kaslow et al. (2000)	200 U.S. Afr.-Am. men and women, 18-64 yrs in trauma hospital for nonfatal suicide attempt or non-emergency med. problems (controls).	**Phys. and non-phys. IPV** (ISA) Cont.: sum	**Life hassles, racist events** (latent var.) Cont. (hassles): sum; Cont. and cat. (racist events): sum for stressfulness, yes/no past yr/lifetime	–	All corr. btw. IPV and stress factors n.s.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
Kim-Godwin et al. (2014)	289 Latino migrant and seasonal farmworkers in the U.S., 47% female, 57% married, M age = 32 yrs (range: 16-68)	**Phys. and psych. IPV tendency** (HITS)[O] Cont.: sum	**Migrant Farmworker Stress Inventory.**[P] Cont.: sum	Sex, time in the U.S., alcohol abuse index, depr. index*	Stress and IPV n.s. in regression and path model.
Kingston et al. (2016)	8542 Canadian new mothers btw 5-14 mos pp; Incl.: ≥15 yrs, delivered baby in 3 mos prior to participating in Canadian Census of Population, living w/ infant at time of survey.	**"Any" and "severe" phys. and sex. IPV** (adapted from Canadian Viol. Against Women Survey)[O] Cat.: yes/no	**SLEs** (13 events), **perc. stress** (single item) in yr prior to preg[P] Cat.: 0-2 vs. ≥ 3 SLEs, not/ somewhat vs. very stressful (PSS)	Age*, marital status*, household income*, aboriginal ethn.*, soc. supp.*$^{\text{any IPV}}$, depr. dx/ prescription*, new med. condition*$^{\text{any IPV}}$, abortion hx*$^{\text{any IPV}}$, smoking*, alcohol*, street drugs, folic acid*$^{\text{severe IPV}}$	"Any" and "severe" IPV w/ ≥ 3 SLEs and w/ "very stressful" rating in unadjusted and adjusted models.
Kutin et al. (2017)	17,050 adults, > 18 yrs old, 78% female, from population-based study in Australia; 16% (men) and 7% (women) economic abuse.	**Economic Abuse** in current or prior rel.[O] Cat.: yes/no, lifetime (since age 15)	**Financial stress** (household cash flow problems)[P] Cat.: no, moderate, high stress	Age, marital status, educ.*$^{\text{women}}$, employment, personal income, disability, health status, financial resilience, **phys. IPV*, emot. IPV***	Moderate/ high financial stress w/ more economic abuse. In logistic regression only high stress in women sig., contr. for phys. and emot. IPV.
Mitchell et al. (2006)	143 U.S. low-income Afr.–Am. women, 21-64 yrs old, w/ 8-12 yr old children; 45% IPV in past yr, 55 no IPV; Incl.: IPV in past yr or no lifetime IPV, no life-threatening med. condition, not actively psychotic.	**Phys. and Non-phys. IPV** (ISA)[P] Cat.: yes/no	**Parenting Stress** (Parenting Stress Index - short)[O] Cont.: sum	–	IPV w/ higher parenting stress.
Rodríguez et al. (2010)	210 U.S. preg. Latina women followed into pp period, M age = 29 yrs (w/ IPV), 27 yrs, (w/o IPV), mostly married, foreign-born; 44% w/ IPV at baseline.	**Phys., sex. and emot. IPV** (modified AAS)[P] Cat.: yes/no, lifetime	**Perc. Stress** (4-item PSS)[O] Cont.: sum; preg: > 3 mos GA, 7, 13 mos pp	–	More perc. stress w/ IPV at each time point.
Schumacher et al. (2010)	445 U.S. married/ cohabiting participants before and after Hurricane Katrina, 56% female, M age approx. 50 yrs, household income: 43% < $40k; 83% White, 15% Afr.-Am./Black; IPV: Women: 34% psych., 4% phys. pre-Katrina, 45% psych., 8% phys. post Katrina; Men: 37% psych., 12% phys. pre-Katrina, 43% psych., 11% phys. post Katrina; Incl.: > 18 yrs, living in Mississippi pre Katrina.	**Psych. and phys. IPV** (4 questions)[O] Cat.: yes/no, 6 mos before and 6 mos after Katrina	**SLEs specific to Katrina** (8-item scale), assessed 6 mos after Katrina[P] Cont.:sum	Age*$^{\text{psych. IPV}}$, marital status*$^{\text{psych. IPV}}$, educ.*$^{\text{psych. IPV}}$, sex, **pre-Katrina psych.* and phys. IPV***$^{\text{*psych. IPV}}$	Higher IPV after Katrina. Higher psych. and phys. IPV w/ more SLEs. SLE x sex interaction: post-Katrina phys. IPV highest in women > 90$^{\text{th}}$ stress percentile.
Thananowan and Vongsirimas (2016)	562 women from Thailand hospitalized for gynecological health problems; 21% w/ IPV; 17% phys., 12% sex., 13% emot. IPV; Incl.: 15-65 yrs, currently living w/ or separated from intimate partner, gynecological dx, inpatient, no complicated health care needs.	**Phys., sex. and emot. IPV** (AAS, ISA)[P] Cat.: yes/no (AAS), cont.: sum (ISA), past yr	**The Stress Test** (20-item questionnaire)[O] Cont.: sum	Cervical cancer*, soc. supp.*, self-esteem*$^{\text{indirect through soc. supp.}}$, depr. sx*	Higher IPV w/ higher stress; Path model: Stress mediates link btw IPV and cervical cancer. Indirect effect of IPV on stress through lower soc. supp.
Theran et al. (2006)	398 U.S. women of low or middle income, M age = 34 yrs (range: 17-54), 70% White/ Cauc., 17% Black/ Afr.-Am., 6% multiple ethn., 5% Hisp./Latina; 81% some high school; IPV: phys.: 64%, emot.: 84%.	**Phys.** (modified CTS2) **and emot. IPV** (shortened IPA)[P] Cat.: yes/no, past 6 mos	**Stressfulness of LEs** occurring in past 6 mos[O] Cont.: sum	–	Higher IPV w/ more LE-related stress in current and ex-partners; Multivar.: Current and former partner phys. IPV w/ stress contr. for emot. IPV. Emot. IPV contr. for phys. IPV only for current partner IPV.
Van Parys et al. (2015)	1894 preg. women from Belgium recruited in antenatal clinic; IPV overall: 16%, phys.: 3%, sex.: 1%, psychol.: 15%; Incl.: > 18 yrs, preg.	**Phys., sex.** (adapted AAS), **and psych. IPV** (WHO Questionnaire)[O] Cat.: yes/no (preg. or yr prior to preg.)	**Subjective stress** (Schar Subjective Stress Scale)[P] Cont.: sum	Depr.*, anxiety, self-esteem, mastery, worry	More IPV w/ more stress in simple comparisons and multivar. analyses.

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Table 1 (*continued*)

Authors (Date)	Participants[c]	Measure of IPV P = Predictor, O = Outcome	Biol./Psych. Measure(s)[d]	Control variables/ Other Predictors, Final Model	Major Finding(s)
Willie et al. (2016)	296 U.S. preg. adolescents and young adults, M age = 19 yrs (SD = 1.6), 72% unemployed, 40% Black, 40% Hisp., 21% White, IPV: 31%.	Current **phys., sex. and emot. IPV** (CTS2)[P] Cat.: yes/no, current and lifetime	**Urban Soc. Stress,** latent var. (SLEs, discrimination, neighborhood problems, family stress) [P] Cont.: sum, past 6 mos	Age; Path model also incl. nonpartner viol. (predictor), and phys. and mental quality of life in preg. and pp[*for some models](outcomes)	Higher IPV with more stress in simple comparisons and path model (both IPV and urban soc. stress are predictor vars.).
Yan and Chan (2012)	937 Chinese coupled individuals, 42% female, M age = 69 yrs (range: 60–100), 16% attended high school, 78% w/o income, lifetime IPV phys.: 7%, sex. 3%, psych. 54%, prior yr phys.: 3%, sex.: 1%, psych.: 36%; Incl.: > 60 yrs, married/ cohabiting.	**Phys., sex., and psych. IPV** (CTS2)[O] Cat.: yes/no, prior yr and lifetime	**Stressful conditions (Personal and Rel. Profile)**[P] Cont.: sum	Prior yr conflict w/ children in law, substance abuse, parental viol. in childhood*, criminal hx, domination, jealousy*, anger management, soc. supp.	Stressful conditions w/ higher psych. prior yr IPV in simple comparisons and multivar. analyses (results not reported for lifetime IPV).
Zavala (2013)	1104 U.S. police officers, 14% female, 64% white, 60% married.	**Phys. IPV** (single question)[O] Cat.: yes/no, lifetime	**Police strain** (9 items)[P] Cont.: sum	Parental viol.*, child maltreatment*, neg. emotions*, sex, race, educ., marital status*, length of employment, rank*, viol. values	Police strain n.s. in simple comparisons and multivar. model predicting IPV.
STUDIES ON BIOLOGICAL AND PSYCHOLOGICAL MEASURES					
Newton et al. (2011)[a]	68 U.S. women, M age = 55 yrs; 61% w/ household income < $40k; 85% White, 15% Afr.-Am.; IPV psych: 100%, phys.: 78%, sex.: 65%, stalking: 53%, injury: 62%; Incl.: 45-60 yrs, divorce/ separation hx, postmenopausal. Excl.: Current legal issues (divorce), psychiatric hospitalization in past 6 mos, suicidal, current IPV, chronic disease, inflammatory meds, alcohol abuse, drugs.	**Phys., sex. IPV, and injury** (CTS2), **stalking** (National Viol. Against Women Survey)[P] Cat.: yes/no	Biol.[O]: **IL-6** (circulating, PHA-stimulated, LPS-stimulated), **CRP** in blood Psych.[P]: **SLEs** (48-item scale) in past yr, **perc. stress** (PSS) in past 1 month Cont.; SLE, PSS: sum	BMI*, depr. sx, PTSD sx	More phys. IPV w/ lower PHA-stimulated IL-6; more stalking w/ higher CRP. No assoc. btw SLEs or perc. stress and IPV; Multivar.: More phys. IPV w/ lower PHA-stimulated IL-6 scores, more stalking w/ higher CRP marginal.
Talley et al. (2006)	16 U.S. preg. women, 50% Cauc., 50% Nat.-Am., 50% w/ self-reported IPV; Incl.: > 18 yrs, prenatal care before 20 wks' GA, singleton preg.	**Battering** (Danger Assessment tool), **phys. and non-phys. IPV** (Partner Abuse Scale)[P] Cat.: yes/no, past yr (battering); cont.: severity	Biol.[O]: **Cort, ACTH, BE, CRH** in plasma Psych.[O]: **SLE** (Prenatal LE Scale – number of events, distress score), **Perc. Stress** (PSS) Cont.; SLE: freq., sum, PSS: sum	–	No sig. group diff. for biol. measures. Sig. higher SLE and perc. stress in women w/ IPV.

Note. AAS = Abuse Assessment Screen, Afr.-Am. = African-American; aggr. = aggression; Am. = American; AMA = American Medical Association; assoc. = association/ associated; biol. = biological; Cauc. = Caucasian; cont. = continuous; contr. = controlling; corr. = correlation; cort = cortisol; CS = Cross-Sectional; CTS = Conflict Tactics Scale; DAS = Danger Assessment Scale; DASS = Depression Anxiety Stress Scales; depr. = depression/ depressive; dex = dexamethasone; diff. = difference; DV = domestic violence; dx = diagnosis; educ. = education; emotional = emot.; ethn. = ethnicity; excl. = exclude; freq. = frequency; Hisp. = Hispanic; HITS = Hurt, Insult, Threaten, Screamed at; hr(s) = hour(s); hx = history; incl. = include; IPA = intimate partner aggression; IPV = intimate partner violence; ISA = Index of Spouse Abuse; LE(s) = life event (s); LG = longitudinal; LGBTQ = Lesbian, gay, bisexual, transgender, queer, questioning; MDD = major depressive disorder; med. = medical; meds = medications; mos = months; multivar. = multivariate; Nat.-Am. = Native American; sig. = significant; perc. = perceived; phys. = physical; PRAMS = Pregnancy Risk Assessment Monitoring System; preg. = pregnant/ pregnancy; psych. = psychological; PSS = Perceived Stress Scale; PTSD = posttraumatic stress disorder; PVS = partner violence screen; PASS = Partner Abuse Symptoms Scale; rel. = relationship; sex. = sexual; soc. = social; SLE(s) = stressful life event(s); supp. = support; SVAWS = Severity of Violence Against Women Scales; var. = variable; viol. = violence; w/ = with; w/o = without; yr(s) = year(s).

[a,b] Studies using overlapping samples marked with the same superscript letter; [c]Number of participants reflects those included in relevant analyses and may differ from the total number of participants in the original study; exclusion criteria are summarized and some generic criteria are not mentioned (e.g., incompetent to give consent, language proficiency); ethnicities of groups ≥ 4% are reported. [d]Only measures for which a statistical comparison with IPV was reported are listed.

(Section 2), and studies reporting biological and psychological measures (Section 3).

Sample sizes ranged from 16 to 134,955 (M = 3675.0, SD = 18,783.6). Studies including biological measures had smaller sample sizes, ranging from 16 to 244 (M = 111.3; SD = 60.2), excluding one unusually large, population-based study of 5593 Norwegian women (Stene et al., 2013). Studies not including biological measures were larger, ranging from 98 to 134,955 (M = 6538.7, SD = 25,435.1). Most studies were conducted in the U.S. (37 studies; 69.8%), followed by Canada (3 studies; 5.7%), Australia and Jordan (2 studies each, 3.8%). Thirty-seven studies (69.8%) included only females, two studies (3.8%) only males, and the remainder had mixed samples. Participant ages ranged widely, including teenagers as young as 14 years (Agrawal et al., 2014; Heaman, 2005) and adults up to 100 years old (Yan and Chan, 2012). Some studies focused on special populations, including pregnant women, new parents, refugees, members of racial and sexual minority groups, and HIV positive (HIV+) women and men. Nineteen studies (36.5%) measured IPV with the Revised Conflict Tactics Scale (CTS2; Straus et al., 1996), which taps into dimensions of negotiation, psychological aggressions, physical assault, sexual coercion, and injury. Other frequently used measures include the Severity of Violence Against Women Scales (SVAWS; Marshall, 1992), the Index of Spouse Abuse (ISA; Hudson and McIntosh, 1981), and the Abuse Assessment Screen (AAS; Soeken et al., 1998).

3. Results

3.1. Review of biological stress studies

The literature reviewing and critically discussing stress-related dysregulations in biological systems is rather large and comprehensive (Miller et al., 2009; Nicolaides et al., 2015). However, relatively few reviews have addressed this question as it specifically relates to IPV, including an older review of biological dysregulations for IPV-related PTSD (Woods, 2005), and a more recent scoping review of physiological, neuroanatomical, and behavioral correlates of IPV (Wong et al., 2014). One review discussed dysregulations in biological systems among IPV perpetrators (Pinto et al., 2010). We were unable to locate a review of stress-related biological dysregulations in IPV victims. All identified studies are listed in Table 1, Section 1.

3.1.1. Endocrine studies

Of the 16 studies assessing the link between an endocrine measure and IPV, all but one included a measure of cortisol, a stress-responsive hormone of the hypothalamus pituitary adrenal (HPA) system. Two studies measured dehydroepiandrosterone (DHEA), and one study each assessed adrenocorticotropic hormone (ACTH), corticotropin releasing hormone (CRH), beta-endorphin, neuropeptide Y, cholesterol, and triglycerides.

3.1.1.1. Cortisol. Most studies assessed cortisol concentrations under baseline conditions. One subset assessed baseline cortisol levels repeatedly across the day, usually within the first hour of the day (cortisol awakening response, CAR; Pruessner et al., 1997). Two studies of women living in domestic violence shelters found that abuse chronicity was associated with lower overall cortisol secretion (area under the curve with respect to ground; AUCg) in response to waking (Johnson et al., 2008a, 2008b; Pinna et al., 2014). Johnson et al. (2008b), providing updated analyses on an expanded sample, suggesting that these findings hold in a multivariate model, controlling for PTSD. Pinto et al. (2016), in a sample partially overlapping with Johnson et al. (2008a, 2008b), found more physical and psychological IPV among individuals who did not evidence cortisol increases within 30 min of waking compared to individuals with moderate (< 2.5 nmol/L) or high (≥ 2.5 nmol/L) cortisol increases, and Kim et al. (2015) found evidence of a lower CAR in female, but not male victims of physical IPV. Two studies found no evidence for an association between the CAR and IPV comparing female IPV survivors and controls (Basu et al., 2013), and among new parents (Saxbe et al., 2015).

Two of the above studies also obtained estimates of diurnal cortisol trajectories. Kim et al. (2015) found more physical abuse with higher midday cortisol in IPV victims. Females also showed less of a linear decline at midday and less non-linear dampening of cortisol throughout the day, suggesting flattened cortisol trajectories. Saxbe et al. (2015) found that physical IPV was associated with flatter diurnal cortisol trajectories among new parents, as well as a stronger within-couple correlation of cortisol. Similarly, women with experiences of physical IPV showed increased evening but unchanged morning cortisol levels, compared to women without IPV, a finding replicated at trend level for psychological IPV (Pico-Alfonso et al., 2004).

Several studies measured cortisol only once, either in saliva (Halpern et al., 2016; Rice and Records, 2008) or plasma (Griffin et al., 2005; Seedat et al., 2003; Talley et al., 2006). As expected given the large intra-individual variability in cortisol, most of these studies report on the absence of a significant association between cortisol and IPV. However, two small studies found lower morning cortisol levels among women with compared to women without IPV (Seedat et al., 2003), and among IPV survivors with PTSD compared to IPV survivors without PTSD or healthy controls (Griffin et al., 2005). One study of 59 women assessed cortisol in hair, a method used to capture more chronic exposure to stress (see Russell et al., 2012). Women with IPV had significantly higher hair cortisol, although a dose-response relationship in terms of abuse frequency was not detected (Boeckel et al., 2017).

Three studies investigated cortisol under experimentally stimulated or pharmacologically suppressed conditions. One study of 75 Canadian university students that oversampled for women in abusive relationships found no association between IPV and a single, stimulated cortisol sample 30 min after reading and writing about an abuse scenario (Danielson et al., 2011). Similarly, a study of 182 mother-infant dyads found no differences in salivary cortisol responses between women with and without IPV who witnessed their infants participating in an arm restraint stressor (Bernard et al., 2017). However, in dyads with low IPV, mother and infant cortisol predicted each other, suggesting higher HPA axis attunement. Finally, one study found greater cortisol suppression to a low dose dexamethasone test among IPV survivors with PTSD diagnosis, compared to IPV survivors with PTSD and comorbid major depression or healthy controls (Griffin et al., 2005).

3.1.1.2. Other hormones. Talley et al. (2006), who reported no group differences in cortisol between women with and without IPV in 16 pregnant women, similarly found no group differences for CRH, ACTH, and beta-endorphin. A lack of association also emerged in the single study testing the link between IPV and neuropeptide Y, a neurohormone regulating noradrenergic function (Seedat et al., 2003). Two studies found higher DHEA levels in IPV victims compared to controls in morning and evening saliva samples (Halpern et al., 2016; Pico-Alfonso et al., 2004).

One large, population-based cohort study of more than 5000 Norwegian women 30–60 years old and free of cardiovascular disease at the time of recruitment found that those with lifetime experience of physical and/ or sexual IPV (but not with psychological IPV alone) had lower high-density lipoprotein cholesterol and elevated triglyceride levels, compared to women without IPV (Stene et al., 2010). Moreover, IPV survivors were prescribed more antihypertensive drugs, had a higher incidence of abdominal obesity and smoking, and a slightly increased 10-year estimated risk for cardiovascular disease, providing evidence for a potential link between IPV and cardiovascular disease risk.

3.1.1.3. Summary. Endocrine studies have almost exclusively focused on cortisol, and findings are generally consistent with previous reports

suggesting flatter diurnal cortisol trajectories with lower morning cortisol, higher evening cortisol, and higher diurnal cortisol output in chronically stressed individuals (Miller et al., 2007). DHEA appears to be increased in IPV victims. Finally, the sole study assessing cholesterol and triglycerides is one of the rare examples of studies linking IPV with biological measures as well as disease outcomes.

3.1.2. Immune/ inflammatory studies

Ten studies tested how immune/ inflammatory markers, including proinflammatory (IL-6, TNF-α) and anti-inflammatory (IL-10) cytokines, C-reactive protein (CRP), an overall marker of systemic inflammation, and blood cell count, may be associated with IPV.

3.1.2.1. Cytokines. One study of postmenopausal women not exposed to IPV in the past year found that circulating IL-6 levels did not differ between women with and without a lifetime history of IPV (Fernandez-Botran et al., 2011). However, in this same sample, lower PHA-stimulated IL-6 was found among women with a history of physical IPV, and this association was most pronounced with severe assault history (Newton et al., 2011). A study of pregnant women no overall group differences in IL-6, but higher TNF-α at 18 weeks' gestational age in women with compared to women without a lifetime history of IPV. However, women with IPV showed less variation in IL-6 across pregnancy and a greater decrease of IL-6 from six weeks to six months post partum (Robertson Robertson Blackmore et al., 2016).

One study tested the association of IPV with IL-6 and IL-10 thirty minutes after reading and writing about an abuse or control scenario (Danielson et al., 2011). Neither stimulated IL-6 nor IL-10 levels differed between women with and without IPV. For women without IPV, higher IL-6 and IL-10 were associated with more anger and sadness in both scenarios. For women with IPV, this association emerged only for IL-6 in the abuse scenario, suggesting that a reminder stimulus of the abuse may be needed to elicit the expected associations between cytokines and emotions in women with IPV.

3.1.2.2. C-reactive protein. One study of postmenopausal women found higher plasma CRP with IPV, but only at one of two study visits (Fernandez-Botran et al., 2011). In the same sample, Newton et al. (2011) reported marginally higher plasma CRP with a history of stalking by an intimate partner. A study assessing CRP in saliva found no group differences based on IPV (Halpern et al., 2016).

3.1.2.3. Blood cell count. Woods et al. (2005) found a strong direct path from a latent IPV variable to PTSD symptoms, and another strong direct path from PTSD symptoms to immune status, operationalized as CD4, CD8, and CD19 lymphocyte count. The structural path model also tested the path from childhood abuse to PTSD and a similar association was not found, despite a strong correlation between childhood abuse and IPV. Regression analyses further showed that physical violence, emotional abuse, threats of violence, and risk of homicide, but not sexual violence were associated with CD4 and CD8 cell counts, as well as natural killer (NK) cell efficacy. A small study found that the total mitogen response was lower in women with compared to women without IPV (Constantino et al., 2000).

The remaining three studies tested the influence of IPV on CD4 and/ or CD8 cells counts among HIV + women and men. Two studies abstracted the CD4-cell count from medical records, using the closest available record to the date of the study visit in 1196 women (Illangasekare et al., 2012) and 168 men (Pantalone et al., 2012), and neither study found a significant association with IPV. In a longitudinal study of 103 HIV + women, however, CD4 and CD8 cell counts were measured (Jewkes et al., 2015). Women with current partner emotional IPV showed faster CD4 declines and women with a lifetime history faster CD8 declines compared to women without IPV. However, similar associations were not reported for physical or sexual abuse.

3.1.2.4. Summary. Few studies investigated immune/ inflammatory dysregulations associated with IPV. Two studies provided evidence that group differences in IL-6 may only be detected under specific conditions such as after in vitro stimulation or in terms of reduced variability across pregnancy. A study of postmenopausal women is one of the few to suggest that some IPV-related cytokine dysregulations may still be present years after women leave the abusive relationship. Finally some studies suggest that IPV-related changes in immune/ inflammatory processes may accelerate PTSD and HIV-progression.

3.2. Review of psychological stress studies

IPV is a significant and chronic psychological stressor and is conceptualized this way in many studies. Still, few studies included measures of psychological stress. We identified a scoping review of behavioral IPV responses defined as fear, pain and emotion regulation (Wong et al., 2014) and a systematic review of risk factors for IPV perpetration (Capaldi et al., 2012), but were unable to locate a review paper specific to psychological stress experiences in IPV victims. We identified 30 studies testing the link between psychological stress and IPV, including studies of perceived stress (n = 11), life-event stress (n = 8) and chronic strain (n = 17). All studies are listed in Table 1, Section 2.

3.2.1. Perceived stress

The majority of studies assessed perceived stress with a version of Cohen's Perceived Stress Scale, which measures "the degree to which situations in one's life are appraised as stressful" (Cohen et al., 1983; p. 385; see Table 1, Section 2 for details). One longitudinal study of 734 young new mothers, found that the emergence of IPV in the second half of the first postpartum year was paralleled by an increase in perceived stress, whereas the perceived stress of women with dissipating IPV or without IPV remained unchanged, providing a rare example of prospective work (Agrawal et al., 2014). Most other studies of perceived stress similarly found a positive association with IPV, including a well-controlled study of 2376 female cancer patients in which cancer care interference by an intimate partner was associated with perceived stress, above and beyond any association explained by physical IPV (Coker et al., 2017), a study of 188 U.S. abortion patients (Ely and Otis, 2011) and a study of 8453 middle-aged Australian women (Ferreira et al., 2017).

Positive associations between perceived stress and IPV were also found in studies conducted around the time of pregnancy, including a longitudinal study of 210 U.S. Latinas assessed in pregnancy and at seven and 13 months post partum (Rodríguez et al., 2010) and one cross-sectional study of 16 U.S. women (Talley et al., 2006). Two studies of 1894 pregnant Belgian women (Van Parys et al., 2015) and 8542 Canadian new mothers (Kingston et al., 2016) found similar associations which remained significant in multivariate models, adjusting for sociodemographic and health related variables. A study of 680 Canadian new mothers found an association between perceived stress and IPV only when perceived stress was conceptualized as a continuous variable (Heaman, 2005).

Two studies found no significant association between perceived stress and IPV. Jose and Novaco (2016) recruited women seeking legal protection from IPV through a temporary restraining order, and found no association between perceived stress and a factor score including physical and sexual IPV. The incidence of physical abuse with (23.5%) and without (79%) a weapon, sexual abuse (33.8%), threats to be killed or physically harmed (66.2%), and emotional abuse (98.5%) was exceptionally high in this sample. Similarly, Newton et al. (2011) found IPV unrelated to perceived stress in a sample that universally endorsed emotional abuse and reported rates of 52% or higher for physical violence, sexual violence, stalking, injury, police contact for safety, and being sheltered for safety.

3.2.2. Stressful life events

Life event studies can provide insight into how IPV might increase in prevalence or severity when additional stressful life events are present. One particularly interesting study surveyed 445 individuals residing in the 23 southernmost counties of Mississippi in the six months prior to Hurricane Katrina, a natural disaster hitting the region in August 2005 and displacing almost 500,000 residents within a few days (Schumacher et al., 2010). Participants were asked about psychological and physical IPV in the six months before and after the hurricane. Both types of IPV increased after Hurricane Katrina and were positively associated with the number of Katrina-related stressful life events. For physical IPV, a stress by sex interaction suggested that IPV risk was highest among women who scored above the 90th percentile in hurricane-related life events.

Four studies investigated the association between life events and IPV occurring around the time of pregnancy and consistently suggest increased life event stress with increased IPV. The largest of these studies found that divorce, drug or alcohol use by someone close, and the partner's job loss were associated with increased physical IPV, controlling for other life stressors in 134,955 U.S. women around the time of pregnancy (Chu et al., 2010). A well-controlled study of 680 pregnant women found increased life event stress with increased physical, but not sexual or emotional violence (Heaman, 2005). Similarly, a study of 8542 new mothers found that IPV was increased among women endorsing three or more of a list of 13 life events compared to women endorsing fewer events (Kingston et al., 2016). Finally, a small study found more life events and higher stress resulting from those events among women with IPV (Talley et al., 2006).

One study tested the association between IPV and the stressfulness of life events occurring in the past six months among 398 low and middle income women in the U.S. (Theran et al., 2006). Physical IPV contributed to stress above and beyond the effects of emotional abuse irrespective of whether it was committed by a current or former partner, but emotional IPV contributed independently to stress only if it was committed by a current partner. Two studies found no significant association between racial events and IPV (Kaslow et al., 2000), and between life events and IPV among 68 postmenopausal women endorsing very high rates of IPV (Newton et al., 2011).

3.2.3. Chronic strain

The 17 studies testing the link between chronic strain and IPV measured minority-related strain (n = 6), parenting strain (n = 3), relationship and financial strain (both n = 2), work-related strain (n = 1), and chronic strain broadly defined (n = 4).

3.2.3.1. Minority-related strain. Two studies tested the association between IPV and stress among mixed-gender, primarily Mexican-heritage migrant and seasonal farmworkers in southeastern North Carolina (Kim-Godwin et al., 2014) and Southern California (Duke and Cunradi, 2011). Both studies report an IPV incidence around 20%, overall very high stress levels, and the absence of a link between stress and IPV. The absence of an association between IPV and stress, conceptualized as both life hassles and racist events, was also reported in a sample of 200 adult, low-income African-American men and women (Kaslow et al., 2005). While raw data for stress scores are not reported, it is likely that stress levels in this sample were high because recruitment occurred at a Level 1 trauma hospital, to which 50% of the sample reported for a nonfatal suicide attempt.

In contrast, the two studies conceptualizing minority stress based on sexual orientation found higher IPV with increased stress. In a study of 1575 U.S. men having sex with men, homophobic discrimination was associated with physical IPV, and racist discrimination with physical and sexual IPV (Finneran and Stephenson, 2014). In a sample of 391 U.S. youth in same-sex romantic relationships, psychological, but not physical or sexual IPV were associated with internalized homonegativity (Edwards and Sylaska, 2013).

A single study tested the link between acculturation stress and physical and sexual IPV, and reported a positive association, controlling for alcohol consumption (Caetano et al., 2007).

3.2.3.2. Parenting strain. A longitudinal study of 734 young new mothers (Agrawal et al., 2014), showed that parenting stress decreased from 6 to 12 months post partum among mothers without IPV. In contrast, parenting stress remained constant and occurred at an overall higher level in mothers with IPV at 6 months and/or 12 months post partum. Higher levels of IPV were similarly associated with increased parenting strain among 143 low-income African-American women (Mitchell et al., 2006) and 185 U.S. parents living in poverty (Finegood et al., 2017).

3.2.3.3. Relationship strain. One longitudinal study of relationship stress and psychological IPV among 98 U.S. college students suggests that increases in IPV are accompanied by perceptions of increasing relationship stress only among individuals who were less committed to each other, but not among highly committed individuals (Arriaga and Schkeryantz, 2015). This finding implies that individuals in highly committed relationships may be less likely to recognize aspects of their relationship as abusive and therefore experience "invisible harm" (Arriaga and Schkeryantz, 2015, p. 1341). A study capturing stress as personal and relationship stress found a positive association with prior year physical, sexual and psychological IPV among 937 Chinese married or cohabiting men and women between 60 and 100 years old (Yan and Chan, 2012).

3.2.3.4. Financial strain. Finegood et al. (2017), who found parenting hassles with increased IPV, did not report a similar association between financial hardship and increased physical and psychological IPV. However, a study that conceptualized IPV as economic abuse found a correlation between moderate or high financial strain and increased economic abuse (Kutin et al., 2017). In a multivariate model this association remained significant only for women reporting high financial strain, controlling for sociodemographic, health-related and financial variables as well as for physical and emotional IPV both of which also emerged as individual predictors.

3.2.3.5. Work-related strain. In a study of 1104 U.S. police officers, strain from police work was not associated with IPV in simple correlations or in a multivariate model controlling for other sociodemographic, employment and violence-related variables (Zavala, 2013).

3.2.3.6. Chronic strain. Studies on chronic strain consistently suggest a positive association with IPV. One study conceptualized chronic strain as urban social stress, a latent variable incorporating stressful life events (individual strain), family stress (interpersonal strain), discrimination and neighborhood problems (community strain), and found a significant association between increased urban stress and physical, sexual, and psychological IPV in 296 pregnant adolescents and young women (Willie et al., 2016). Worksite harassment by a current or former intimate partner was also associated with increased chronic arousal among 101 married or engaged young women from Jordan (Al-Modallal et al., 2012). A study by the same author found increased arousal with emotional IPV or controlling behavior by an intimate partner among 267 women visiting health care centers in refugee camps in Jordan (Al-Modallal, 2012). One study stands out for testing the mediational role of stress in the link between IPV and disease (Thananowan and Vongsirimas, 2016). In 562 women from Thailand hospitalized for gynecological problems, stress mediated the association between prior year IPV and cervical cancer. Moreover, IPV was associated with less social support, and social support with less stress, highlighting the protective role of social support in this relationship. Similar associations were not found for other types of

gynecological problems, including ovarian or endometrial cancers, and findings need to be interpreted with caution.

3.2.4. Summary

Overall, and as expected, studies fairly consistently suggest a positive association of IPV with perceived stress, life event stress, and chronic strain. Studies with null findings were more likely to include high stress or severe IPV samples, including migrant workers, women seeking restraining orders and suicide survivors. Particularly convincing evidence for a link between psychological stress and IPV comes from the few studies taking a longitudinal approach, including evidence linking the number of Hurricane Katrina-related stressors with IPV, or the lack of the expected decrease in parenting strain among IPV-exposed mothers. Another finding that stands out suggests that IPV-related stress is attributed to the relationship only among women in less but not in more committed relationships, a finding with practical implications for supporting women enmeshed in close abusive relationships.

3.3. Review of studies including a biological and psychological stress measure

Two studies included biological and psychological stress measures (Newton et al., 2011; Talley et al., 2006), and individual findings are discussed in the respective sections above (see Table 1, Section 3). In one study, biological measures (not IPV) were considered the outcome variable of interest, and information about how biological and psychological stress measures may jointly be affected by IPV are not available (Newton et al., 2011). The other study, a small report of 16 pregnant women with and without IPV (Talley et al., 2006), found significant group differences for perceived stress and life events, but not for HPA axis hormones. This study suggests that effect sizes are higher for psychosocial comparisons (range of D's: 1.2–3.0) than for biological comparisons (range of D's: 0.03 – 0.66), and is the only study to provide this comparative information. However, neither study provides information about whether and how biological and psychological processes interact or jointly contribute to negative health outcomes.

4. Discussion

The goal of this systematic review was to provide a comprehensive overview and critical discussion of biological (i.e., endocrine and immune/inflammatory) and psychological (i.e., psychological stress) correlates and consequences of IPV. Of the 52 studies included, 22 included a biological measure of stress, 28 a psychological measure of stress, and only two studies included a measure of both. Thus, it is fair to conclude that the biological and psychological literatures of IPV and stress have evolved separately and remain distinct. While disciplinary studies are valuable and add to our understanding of IPV, evidence from the broader stress literature suggests that a more complex approach to measuring stress is necessary to adequately understand the association between stress and disease (Epel et al., 2018). Below, we first discuss the biological and psychological literatures separately and then proceed with recommendations to advance this literature henceforth.

Biological studies have small sample sizes, and the limited statistical power precludes the use of more advanced statistical approaches that have become standard in the psychological literature. While the use of larger sample sizes may be cost prohibitive in some cases, we encourage stress researchers conducting large biobehavioral studies to thoughtfully include measures of IPV in their work. In terms of endocrine studies specifically, studies almost exclusively considered the effects of IPV on cortisol, which is likely to be just one of many biological measures affected by IPV. Moreover, many studies used only single measures of cortisol, and unsurprisingly yielded mostly null findings. Among the studies more carefully measuring cortisol, such as those assessing cortisol awakening responses and day profiles, findings fairly consistently fall in line with evidence from the broader stress literature suggesting flatter diurnal cortisol trajectories and higher diurnal cortisol output with chronic stress (Miller et al., 2007).

The two studies measuring the link between IPV and stimulated cortisol pointed toward the absence of any association. However, the use of a single stimulated cortisol sample (Danielson et al., 2011), and of stress protocols that are not ideal for stimulating the HPA axis, such as reading and writing about an abuse scenario (Danielson et al., 2011) and witnessing their infant's arm restraint stressor (Bernard et al., 2017) may have precluded the emergence of significant associations. Stress reactivity has been hypothesized to at least partially explain the individual differences in the association between stress and disease (Cohen and Manuck, 1995; Lovallo and Gerin, 2003), and we argue that studies using stress protocols reliably inducing cortisol responses, such as the Trier Social Stress Test (Kirschbaum et al., 1993), will produce important knowledge about IPV-related dysregulations in HPA axis function.

Similar to the endocrine literature, the limited number of studies on individual immune/inflammatory markers makes it difficult to draw firm conclusions. Overall, it appears as though IPV is not reliably associated with baseline measures of individual cytokines or C-reactive protein, an overall marker of systemic inflammation, despite some positive findings. We note an emerging trend suggesting that associations may become more apparent under specific conditions, such as reduced variability of IL-6 across pregnancy (Robertson Blackmore et al., 2016) and lower PHA-stimulated IL-6 (Newton et al., 2011) with IPV. Finally, the studies testing CD4 and CD8 cell counts in HIV + populations provide important insight into how experiences of IPV can have an impact on biological processes directly implicated in disease progression.

Psychological studies have larger sample sizes allowing for the use of more nuanced statistical models. Overall, these studies suggest that IPV is associated with heightened perceived stress, and increases in prevalence and intensity in the presence of chronic strain or other stressful life events. Still, not all studies yielded the expected associations between IPV and stress. Studies not yielding significance were more likely to have samples characterized by high stress or severe IPV, such as migrant farmworkers (Duke and Cunradi, 2011; Kim-Godwin et al., 2014), African American suicide survivors (Kaslow et al., 2000) or women seeking protective orders (most of whom were Latina; Jose and Novaco, 2016). Null results in these samples may be the result of an amalgamation of unique and severe stressors which are not all accounted for in analyses, and understandably so, as it may not be feasible to include multiple measures of stress in studies including special or vulnerable populations. Still, results are counterintuitive, as it seems there is an element of exceptional stress or stress culmination in these studies that is maybe not as prevalent in the other studies and is not being captured in relation to IPV. Alternatively, in samples composed of minority or immigrant participants, victims may have barriers to disclosure due to cultural norms, stigma, limited language proficiency, and/or immigration status (Rizo and Macy, 2011; Stockman et al., 2014). These studies highlight a heterogeneity to IPV, to stress, and to any mediational or moderational third variables impacting the relationship between the two, which should be more carefully addressed in future studies.

While the biological studies have almost exclusively conceptualized IPV as a predictor of biological outcomes, psychological studies highlight the potential bidirectionality of the association between IPV and stress—IPV can predict stress, but stress can also increase risk for the emergence or continuation of IPV. With few exceptions, the majority of studies tested this link cross-sectionally, and thus temporal sequence cannot be established. One exception is a study showing, albeit retrospectively, that IPV increased from before to after Hurricane Katrina, and that these increases were associated with the number of Katrina-related stressful events (Schumacher et al., 2010). Similarly, Arriaga

and Schkeryantz's (2015) prospective study suggests that new instances of partner violence precede psychological stress. That study also suggests that psychological aggression is particularly deleterious in this sequence, as it can be an "invisible", unacknowledged form of violence that can make the effects of psychological IPV particularly insidious in terms of their consequences for health.

Some of the broader issues are shared by both the biological and psychological literatures, with the most apparent one being that most studies are cross-sectional and retrospective, with few examples of well-controlled longitudinal studies. It is these studies, however, which give particularly meaningful insight into the effects of IPV. Besides gaining valuable information on how stressful life events can increase IPV (Schumacher et al., 2010) and how new instances of IPV can precede distress in couples (Arriaga and Schkeryantz, 2015), studies showed the absence of expected decreases in parenting stress over the first year post partum (Agrawal et al., 2014), and accelerated HIV progression among IPV victims (Jewkes et al., 2015). Prospective, longitudinal studies are particularly important for furthering our understanding of how IPV may be causally implicated in disease processes by altering stress-related biological and psychological variables.

We started out this review by arguing that IPV is a unique and complex stressor that is distinct from others, and highlighted several differences between IPV and other types of chronic stressors, including the cycle of violence, the intensity and duration of IPV, the history of other abuse experiences, the co-occurrence of other stressors, whether IPV resulted in trauma, and whether or not the victim is still in an intimate relationship with the abuser. The current literature has not carefully addressed these intricacies of the IPV experience. We were unable to locate relevant studies addressing the cycle of violence. To this end, it may be difficult and, depending on the study, potentially dangerous for victims to participate in research on the topic in the presence of the abuser. Also absent from the literature, perhaps for similar reasons, are studies that differentiate clearly between the different phases of IPV. It is likely that individuals still living in an abusive relationship would show patterns, both in terms of biological parameters and psychological stress that differ from those in the process of leaving and those having left the abusive relationship a long time ago.

Few studies have carefully considered IPV victims' history of abuse (e.g., child abuse, non-IPV abuse), and their exposure to trauma (IPV-related or other) or disaster (e.g., war, mass violence, natural disaster). This distinction is important for establishing the unique contribution of IPV on stress-related biological and psychological measures associated with health outcomes. One notable exceptions is the study by Woods et al. (2005) who showed in a structural path model direct paths from IPV to PTSD symptoms and from PTSD symptoms to immune status, but no comparable associations for child abuse (even though child abuse and IPV were strongly correlated). Other studies variably point toward the presence (Griffin et al., 2005; Johnson et al., 2008a, 2008b) or absence (Seedat et al., 2003) of an effect of traumatic experiences and PTSD in this context, and several studies controlled for the effects of PTSD (Newton et al., 2011; Pinto et al., 2016) or non-IPV trauma (Jewkes et al., 2015; Robertson Blackmore et al., 2016) in their analyses. Nonetheless, there is a need for additional rigorous work parsing out the unique effects of IPV with and without IPV-related trauma, and for considering possible additive or multiplicative effects of IPV occurring in the context of previous or ongoing other trauma (see Fragkaki et al., 2016).

Notably, a substantial proportion of studies included in this review focused on women during the perinatal period. Pregnancy is a particularly interesting time to study IPV because of its documented effects on maternal – infant health. On average, IPV victims are more likely to deliver preterm or low birth weight infants (Alhusen et al., 2015), both significant risk factors for the offspring's lifelong health (Barker et al., 1989), and to develop postpartum depressive symptoms following delivery (Yim et al., 2015). Moreover, pregnancy provides researchers with a conceptual framework to study, prospectively and over a relatively short period of time, the effects of stress on disease, and the biopsychosocial pathways linking the two. However, few studies provided data speaking to this issue (Agrawal et al., 2014; Robertson Blackmore et al., 2016).

In sum, there are two lines of research, one biological and one psychological, which evolved separately and remain distinct. The biological literature, while limited by small samples and by its focus on only a few biomarkers, provides emerging evidence of dysregulations in stress-related endocrine and immune-inflammatory markers that are in line with patterns observed in chronically stressed individuals. The psychological literature provides strong evidence that IPV is associated with psychological stress, and the few longitudinal studies further suggest that psychological stress follows new instances of IPV. What is needed are larger-scale, integrative studies using prospective study designs that more carefully map out how IPV influences victims both biologically and psychologically, and how these biopsychological changes, in turn, affect the health of victims over time. Longitudinal studies of pregnant women may be one opportunity to take such an approach. Studies identifying risk and protective intermediary factors and how those might play into the IPV – stress link to influence health outcomes are needed. Studies addressing these questions promise to provide much needed empirical evidence that can ultimately guide the development of targeted and timely interventions, and improve the care for IPV survivors.

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Conflicts of Interest

None.

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