INTIMATE PARTNER VIOLENCE AND INCIDENCE OF HYPERTENSION IN WOMEN

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Abstract

Purpose—Intimate partner violence, a prevalent stressor for women, may influence cardiovascular disease risk. We estimated the association between intimate partner violence and development of hypertension, an important risk factor for cardiovascular disease, using data on intimate partner violence in the Nurses' Health Study II cohort.

Methods—Intimate partner violence measures included adult lifetime physical and sexual partner violence and the Women's Experiences with Battering Scale, which ascertained women's subjective experience of recent emotional abuse. Physician-diagnosed hypertension was self-reported on biennial questionnaires. We used Cox proportional hazards models to estimate the association between report of intimate partner violence in 2001 and incidence of hypertension from 2001 through 2007.

Results—Of 51,434 included respondents, 22% reported being physically hurt and 10% reported being forced into sexual activities at some point in adulthood by an intimate partner. After adjustment for confounders, physical and sexual abuse were not associated with hypertension. However, women reporting the most severe emotional abuse had a 24% increased rate of hypertension (hazard ratio=1.24; 95% confidence interval: 1.02, 1.53) when compared to women unexposed to emotional abuse.

Conclusion—Hypertension risk appears to be elevated in the small number of women recently exposed to severe emotional abuse.

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Keywords

Domestic violence; spouse abuse; battered women; cardiovascular diseases; hypertension

Introduction

Cardiovascular disease is the leading cause of death for women in the United States (1). Behavioral risk factors for cardiovascular disease (CVD), such as smoking, have been extensively investigated (2–3), but the role of psychosocial factors is less well understood. A growing body of literature suggests that psychosocial stress, depression, and social isolation contribute importantly to CVD risk (4–9). However, few studies have investigated the role of interpersonal violence, a prevalent psychosocial stressor for American women, on the risk of CVD. In the 2010 National Intimate Partner and Sexual Violence Survey (10), 24% of women reported physical intimate partner violence; 40% of women reported childhood physical abuse by a caretaker in The National Violence Against Women Survey (11). Child abuse has been linked to poor adult mental health in numerous studies (12–17). A small number of studies have examined child abuse associations with adult physical health outcomes, generally finding women who were abused in childhood to have poorer adult health (18–21), including higher body mass index (22), and higher rates of hypertension (23) and Type 2 diabetes (24). Exposure to abuse in adulthood has received little attention in the epidemiologic literature. A handful of studies have linked intimate partner violence (IPV) in adulthood with women's risk of depression (25–27), suicide and suicidal ideation (17), post-traumatic stress disorder and traumatic symptoms (28–29), and poor self-rated health (25–26, 30). Only a small number of studies, all cross-sectional, have investigated associations of intimate partner violence with hypertension (31–33). Thus, little is known about how IPV is related to women's risk of CVD. To address these gaps in the literature, we estimate the influence of IPV on incidence of hypertension, an important marker of CVD risk, in the longitudinal Nurses' Health Study II.

Methods

Data sources

The Nurses' Health Study II (NHSII) follows a cohort of 116,430 female registered nurses recruited in 1989 when they were between the ages of 25 and 42. Participants are sent biennial questionnaires that gather sociodemographic, behavioral, and medical data. In 2001, 91,297 NHSII participants were mailed a supplemental questionnaire asking about their experiences of interpersonal violence in childhood, adolescence, and adulthood. NHSII participants who requested only short form questionnaires or who had not responded to previous NHSII questionnaires within three mailings were not included in this mailing. Questionnaires were returned by 68,376 (75%) of the Violence Questionnaire recipients. We compared the incidence of hypertension in the six years following the return of the Violence Questionnaire (2001–2007) in women with and without 2001 reports of adult IPV. We excluded 12,674 women who reported a hypertension diagnosis in or before 2001, when the Violence Questionnaires were returned, and an additional 4,261 women who reported taking antihypertensive medications in or before 2001. We also excluded 7 women who completed the supplemental Violence Questionnaire but died before completing the biennial questionnaire on which baseline hypertension status was ascertained. Our analysis included 51,434 women free from hypertension and antihypertensives at baseline.

Variable definitions

Exposures—We examined three IPV exposure variables: physical IPV in adulthood (age 18+), sexual IPV in adulthood, and the Women's Experience with Battering Scale (34) for intimate relationships that were ongoing in 2001. Women were considered to have been physically abused in adulthood if they answered "Yes, this happened once" or "Yes, this happened more than once" to the question "Have you ever been hit, slapped, kicked, or otherwise physically hurt by your spouse/significant other?" Likewise, women who answered "Yes, this happened once" or "Yes, this happened more than once" to the question "Has your spouse/significant other ever forced you to have sexual activities?" were defined as having been sexually abused in adulthood. Women were instructed to consider only relationships at age 18 or older when answering these questions. Preliminary analyses indicated that abuse experienced once and abuse experienced more than once did not differ importantly in their associations with hypertension, so these categories were combined into a single exposure level.

To assess emotional IPV, the Violence Questionnaire included the Women's Experiences with Battering (WEB) Scale, which assesses the extent to which women experience disempowerment, entrapment, loss of identity, and threat in their intimate relationships (34). We examined WEB scores reported for intimate relationships that were ongoing at the time of the 2001 Violence Questionnaire. This scale ranges from 10 to 60, with 60 corresponding to the most severely abusive relationships. For the main analyses we categorized women into three levels of the WEB: 10–19, 20–39, and 40–60. We also assessed the linearity of the WEB–hypertension association using likelihood ratio tests to compare a model with a linear WEB term to a model with the linear term plus cubic splines (35).

Physical IPV and sexual IPV were missing for 1,038 and 1,044 women, respectively, leaving 50,396 women for physical IPV analyses and 50,390 for sexual IPV analyses. For WEB analyses, we included those women in a relationship at the time of the 2001 Violence Questionnaire, a total of 42,602 women with non-missing 2001 WEB scores.

Outcome—Physician diagnosis of hypertension was self-reported by the NHSII participants on each biennial questionnaire. A recent validation of this variable in a random sample of NHSII participants indicated good agreement with medical records data (sensitivity=94% and specificity=85%) (36).

Interactions—We had previously observed an association of child abuse (abuse prior to age 18) with adult hypertension in this cohort (23). Stressful early life experiences may lead to life-long stress response impairments (37–39), making abused populations uniquely susceptible to later stress. We investigated the hypothesis that a history of child abuse influences the health impact of adult abuse by examining interaction terms between adult and child abuse. The ascertainment of child physical and sexual abuse in the NHSII is described in detail elsewhere (23–24). Briefly, respondents reported physical child abuse by indicating the frequency with which an adult caregiver pushed, grabbed or shoved them; kicked, bit, or punched them; hit them with an object; choked or burned them; or otherwise physically attacked them. Regarding sexual abuse, respondents were asked the frequency with which an adult or older child touched them in a sexual way or forced/attempted to force them into sexual activities.

We tested interaction terms between a dichotomized child abuse variable (no child physical or sexual abuse versus any child physical or sexual abuse) and physical, sexual, and emotional adult IPV exposure variables. In addition, a previous analysis indicated that hypertension risk became significantly elevated among women with a history of severe sexual abuse or severe physical abuse prior to age 18 (23). We therefore investigated the

possibility that IPV effects differ depending on exposure specifically to severe child abuse, using interaction terms between IPV exposures and child abuse dichotomized into "severe" (forced sexual activities or kicked, bitten, punched, choked, burned, or physically attacked (23)) versus none, mild, or moderate abuse.

Covariates—We considered as potential confounders those risk factors for hypertension not thought to be on the pathway between IPV and hypertension incidence. Main adjusted models included age in months, race (indicators for Caucasian, African-American, Hispanic, Asian, and "other"), mother's and father's educational attainment (indicators for <9 years, 9–11 years, 12 years, 13–15 years, and 16+ years), continuous somatogram score at age five (the participant could choose one of nine female figures ranging from very lean, a score of 1, to very obese, a score of 9, that best represented her body type at age five years), and continuous BMI at age 18. Covariates were missing for fewer than 2% of observations, with the exception of mother's education and father's education, which were missing for 11% and 12% of observations, respectively. Missing variables were handled with missing indicators; a complete case analysis produced similar results. The following potential confounders were not included in final models, because their inclusion had little influence on the abuse–hypertension effect estimates: parental occupations; parental home ownership; parental history of early (<age 60) myocardial infarction or stroke; spouse's educational attainment; and 2001 self-rated health, smoking status, alcohol intake, physical activity, and BMI.

Data Analysis

We used Cox proportional hazards regression to model the association between IPV and hypertension, with study time beginning with ascertainment of exposure (IPV) status in 2001 and ending at time of incident physician-diagnosed hypertension, at time of death, or at the end of June 2007. For each of the three adult IPV exposures (physical IPV, sexual IPV, and WEB scale), we ran two models. Model 1 included age in months; Model 2 added potential confounders (child/adolescent physical and sexual abuse, race, parental educational attainment, age 5 somatogram, and BMI at age 18). We assessed interactions between adult abuse exposures and child/adolescent physical and/or sexual abuse dichotomized in two ways (any versus no physical or sexual abuse prior to age 18 and severe versus none/mild/ moderate abuse prior to age 18), using likelihood ratio tests to compare models with adult and child abuse main effect parameters to models with main effect parameters plus interaction terms.

In our main analyses, women contributed study time starting in 2001, at the time of IPV ascertainment, to ensure that only incident cases of hypertension were included in the outcome. However, we were concerned that by excluding 16,935 women who reported hypertension diagnosis or anti-hypertensive medicines in 2001, when women were between the ages of 37 and 64, we might limit our ability to detect IPV impacts on early-onset hypertension. This was of particular concern for physical and sexual IPV, which were queried as adult lifetime variables, and may have occurred many years before our study baseline. We therefore re-ran adjusted models stratified by age in 2001, examining the impact of IPV separately in the 40% of women who were aged 45 years and younger when we assessed IPV history —women who were less likely to have been excluded for prevalent hypertension, and whose IPV exposures may have occurred more recently.

Results

Of the 51,434 Violence Questionnaire respondents free of hypertension and not using antihypertensives at baseline (2001), 22% reported being physically hurt and 10% reported

being forced into sexual activities in adulthood by an intimate partner (Table 1); of the women who reported forced sex in an intimate relationship, 62% also reported physical abuse. Around 1.5% of the women scored above 40 (out of 60) on the WEB scale, indicating the most serious abusive relationships (Table 1).

Of the covariates, child abuse was most strongly correlated with IPV; around 80% of women reporting physical or sexual abuse IPV also reported physical or sexual abuse in childhood or adolescence.

There was little evidence of an association between adult physical or sexual IPV and incidence of hypertension from 2001 through 2007 in age-adjusted or fully-adjusted estimates (Table 2). Results from a supplemental analysis of exposure to combinations of physical and sexual IPV were likewise null (data not shown). However, age-adjusted effect estimates for the WEB showed an increase in risk associated with more severely abusive relationships, and this elevation in risk remained after adjustment for other confounders. A 2001 WEB score of 40–60 was associated with a 24% increase in hypertension rate between 2001 and 2007 (HR=1.24; 95% CI: 1.02, 1.53). An assessment of linearity (likelihood ratio test of linear WEB plus cubic splines versus linear WEB alone) indicated a positive, linear dose-response relationship between the WEB and hypertension risk (p for non-linearity=0.95; p for linear trend = 0.05), with each 10-unit increase in the WEB associated with a hazard ratio of 1.04 (95% CI: 1.00–1.09). However, a qualitative look at the 3-category WEB results suggests that hypertension is influenced only by the most severe levels of the WEB (Table 2).

Of the included covariates, aside from age, child/adolescent abuse history was the most influential confounder of the adult abuse–hypertension associations. There was no evidence of interaction between any of the adult abuse exposures and child abuse dichotomized either as any versus none or as severe versus none/mild/moderate (all interaction p-values>0.2).

Covariate-adjusted results stratified by age in 2001 (45 years versus >45 years) are presented in Table 3. Physical IPV and WEB associations with hypertension appear to be stronger for younger than older women. Although the confidence intervals overlap considerably across strata, the general pattern suggests that our main estimates might be diluted by the exclusion of early-onset hypertension. To examine this possibility further, we ran Poisson models with a log link and robust variances (40) to estimate covariate-adjusted prevalence ratios (PRs) for pre-2001 hypertension comparing IPV-exposed women to IPV-unexposed women. Physical IPV, sexual IPV, and moderate WEB were all associated more strongly with prevalent (pre-2001) hypertension than with incident (2001–2007) hypertension; adjusted prevalence ratios were 1.12 (95% CI: 1.09, 1.16), 1.18 (95% CI: 1.13, 1.22), 1.13 (95% CI: 1.07, 1.19), and 1.25 (95% CI: 1.14, 1.38) for physical IPV, sexual IPV, moderate WEB, and severe WEB, respectively. These results should be interpreted with great caution, since we cannot establish the temporal sequence between exposure and outcome, and they are subject to recall bias (women were already diagnosed with hypertension at the time of exposure ascertainment). However, we present them here as part of a pattern of findings that suggest an influence of IPV on early-onset hypertension that we may have missed in our main analyses.

Discussion

Stress is increasingly implicated in cardiovascular disease pathogenesis (4, 6), but our results do not provide strong support for a relationship between lifetime adult intimate partner physical or sexual violence, presumably potent stressors, and hypertension. We did, however, observe an association between recent emotional abuse, as measured by the

Women's Experiences with Battering scale, and hypertension risk in women. Two previous retrospective studies of modest size that queried hypertension as part of a battery of self-reported health outcomes found no association of physical, sexual, or psychological intimate partner violence with the prevalence of hypertension, although both reported associations with chronic disease risk factors in the aggregate (31–32). A larger retrospective study recently reported a modest association between reported adult lifetime physical or sexual IPV and hypertension (33).

Earlier analyses in this population documented an association between childhood physical and sexual abuse and hypertension in adulthood, with hypertension rate increases on the order of 13% to 60%, depending on child abuse severity (23). We expected to see similar hypertension associations with adult physical and sexual violence, but we found limited evidence of adult abuse effects on hypertension. Stressful early life experiences may alter hypothalamic-pituitary-adrenal axis development (37–39), which may increase cardiovascular disease risk and overshadow subsequent stressors, such as adult abuse, in determining CVD risk. This may explain the lack of association we observe between adult physical and sexual abuse and hypertension once child abuse is taken into account. On the other hand, the WEB remained predictive of hypertension even after adjusting for child abuse, suggesting that recent severe abuse in adulthood may exert an effect on health above and beyond the effect of early abuse.

The associations we report for physical and sexual abuse in adulthood may be underestimates of the true abuse–hypertension relationship if questions about specific abusive events (e.g. being "physically hurt" by one's partner) do not capture the most relevant aspects of an abusive relationship. The psychological impact of the experience, rather than the experience itself, may trigger the physiologic stress response thought to lead to CVD. The stronger associations we observed for the WEB than for reports of physical and sexual abuse suggest that women's subjective experiences may better predict their health outcomes than more "objective" abuse measures. The stronger WEB association may also be due to the timing of physical and sexual IPV, which were ascertained as lifetime exposure variables, versus the WEB, which pertained to recent relationships. Our physical and sexual abuse questions asked if women had *ever* experienced these types of violence as adults, and we did not have data on the specific timing of physical and sexual abuse. Health insults from IPV may not persist indefinitely after the abusive relationship has ended, and our effect estimates may therefore have been diluted by the inclusion of women who left abusive relationships many years ago.

Our study follow-up began in 2001 with the return of the Violence Questionnaire, but adult physical and sexual abuse could have occurred as early as the mid-1960s. If severe physical or sexual abuse led to early hypertension onset, then women experiencing severe sexual and physical interpersonal violence may have been diagnosed with hypertension prior to baseline and excluded from our follow-up. Our estimates may therefore have missed the strongest abuse–hypertension associations. Analyses restricted to younger women in the cohort, for which IPV–hypertension associations were stronger, provide suggestive evidence that IPV may influence early hypertension onset. This is reinforced by the stronger associations we observed between 'ever' adult IPV and prevalent hypertension; while we cannot rule out the possibility of recall bias in this sub-analysis, it captures more early hypertension onset and more cases with a short latency between abuse exposure and hypertension, many of which would have been excluded in the main incident case analysis.

Reliance on self-report of abuse is a limitation our study shares with most other studies of interpersonal violence, but the abuse questions included in the questionnaire have been used in other populations with good test-retest reliability (41). Women's subjective experiences,

such as those captured by the WEB scale, may be more important than abuse experiences that can be externally validated. Thus, validation of self-reports of abuse against police or court reports, while an important goal, may not represent a true gold standard for exposure measurement. Generalizability of our results is another potential concern. Assessments of generalizability suggest that results from our nurse population are similar to those in other white female samples (42). Additional studies in more ethnically diverse populations would enrich understanding of IPV effects on health.

Few previous studies have examined interpersonal violence in adulthood as a risk factor for CVD-related outcomes. Our study begins to fill this gap. The study had several strengths, including a large cohort with rich data on adult abuse, child abuse, and numerous covariates. Setting 2001 as the baseline for follow-up in main analyses avoided bias arising from differential recall of abuse by hypertension status, and hypertension self-report has been validated in this population.

Our study results indicate that having ever experienced adult physical or sexual abuse does not predict women's risk of hypertension, but that recent emotional abuse, as measured by the Women's Experiences with Battering Scale, is associated with hypertension, especially if the abuse is severe. The stronger associations we observe for the WEB suggest that subjective experiences of abuse may influence hypertension risk more than specific abuse incidents; alternatively, measures of lifetime adult physical and sexual abuse may fail to predict hypertension because they include past abuse that is no longer influencing health outcomes. Future studies may help to explain these findings by comparing abuse–hypertension associations using subjective measures, such as the WEB, with associations using more "objective" measures of abuse for the same time period. More detailed investigations into the timing and nature of abuse may also provide insights on the persistence of health effects after women end abusive relationships. Such insights may expand understanding of cardiovascular disease etiology and inform IPV prevention efforts.

Acknowledgments

List of Abbreviations

CVD	Cardiovascular Disease
IPV	Intimate Partner Violence
NHSII	Nurses' Health Study II
WEB	Women's Experiences with Battering Scale
BMI	Body Mass Index
HR	Hazard Ratio
CI	Confidence Interval

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Table 1

Distribution of sample across covariate levels, by exposure (physical, sexual, and emotional intimate partner violence) status: Nurses' Health Study II, 2001–2007.

Covariate means and percentages [*]	Exposures						
	Adult physical intimate partner violence		Adult sexual intimate partner violence		Emotional intimate partner violence score (WEB scale[†])		
	No (N=39,378)	Yes (N=11,018)	No (N=45,386)	Yes (N=5,004)	10–19 (N=38,669)	20–39 (N=3,297)	40–60 (N=636)
Mean							
Age in 2001	46.2	46.8	46.3	47.0	46.2	46.3	45.9
Mother's education (years)	12.4	12.3	12.4	12.3	12.4	12.4	12.3
Father's education (years)	12.6	12.4	12.6	12.5	12.6	12.6	12.4
Body mass index‡ at age 18	20.9	20.9	20.9	20.9	20.9	20.9	20.8
Somatotype§ at age 5	2.5	2.5	2.5	2.5	2.4	2.5	2.5
Percent							
Physical child abuse							
None	51.3	32.9	48.8	32.8	49.1	37.1	31.7
Mild	18.7	20.2	19.1	17.9	19.2	19.4	19.0
Moderate	24.0	32.3	25.0	32.5	25.0	30.8	29.8
Severe	6.1	14.7	7.0	16.8	6.7	12.7	19.5
Sexual child abuse							
None	70.2	58.1	69.2	52.9	69.1	59.1	54.5
Touch only	21.1	25.3	21.7	25.0	21.6	25.6	23.9
Forced sex once	4.8	8.5	5.1	10.1	5.2	7.8	9.3
Forced sex more than once	3.9	8.1	4.1	12.0	4.1	7.5	12.3
Race							
African-American	0.6	1.7	0.7	2.1	0.7	1.0	0.2
Hispanic	1.2	1.6	1.2	1.8	1.2	1.3	1.6
Asian	1.4	1.2	1.3	1.5	1.3	1.3	1.5
Caucasian	95.2	93.7	95.1	93.0	95.3	94.4	95.1
Other	1.6	1.8	1.6	1.6	1.5	2.1	1.7

[*] Means and percentages are age-adjusted for all covariates, except for age in 2001

[†] Women's Experiences with Battering Scale. Range 10–60; higher scores indicate more severe abuse

$\ddagger$kg/m^2

$\S$Participants chose the image of a female figure that best approximated their body type at age 5. Somatotypes ranged from 1 (very lean) to 9 (obese)

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Table 2

Hazard ratios for hypertension diagnosis following adult exposure to adult lifetime physical intimate partner violence, adult lifetime sexual intimate partner violence, and emotional intimate partner violence in 2001: Nurses' Health Study II, 2001–2007.

Exposure*	Person-years (Cases)	Model 1: Age-adjusted		Model 2: Child and adolescent confounder-adjusted†	
		HR	(95% CI)	HR	(95% CI)
Ever Adult Physical Abuse					
Never	209,329 (4,857)	1.00	REF	1.00	REF
Once or more than once	57,647 (1,520)	1.08	(1.02, 1.15)	1.06	(1.00, 1.12)
Ever Adult Sexual Abuse					
Never	240,704 (5711)	1.00	REF	1.00	REF
Once or more than once	26,211 (670)	1.02	(0.94, 1.11)	0.99	(0.91, 1.07)
WEB‡ Scale for Current Relationship in 2001					
WEB Scale = 10–19	205,736 (4,756)	1.00	REF	1.00	REF
WEB Scale = 20–39	17,282 (427)	1.05	(0.95, 1.16)	1.03	(0.93, 1.14)
WEB Scale = 40–60	3,266 (98)	1.28	(1.04, 1.57)	1.24	(1.02, 1.53)

*
Separate models were were run for each abuse exposure

†
Adjusted for child physical and sexual abuse, race, parental educational attainment, somatogram score at age 5, and BMI at age 18; when additionally adjusted for adult baseline (2001) BMI, physical activity, alcohol intake, and smoking, HRs were 1.04 (95% CI: 0.98, 1.10) and 1.00 (95% CI: 0.92, 1.08) for physical and sexual abuse, respectively, and 1.02 (95% CI: 0.92, 1.12) and 1.22 (95% CI: 1.00, 1.50) for WEB scores of 20–39 and 40–60, respectively.

Table 3

Adjusted[†] hazard ratios for hypertension diagnosis following adult exposure to adult lifetime physical intimate partner violence, adult lifetime sexual intimate partner violence, and emotional intimate partner violence among women ≤45 and >45 in 2001: Nurses' Health Study II, 2001–2007.

Exposure*	Age ≤45 years in 2001			Age >45 years in 2001		
	Person-years (Cases)	HR	(95% CI)	Person-years (Cases)	HR	(95% CI)
Ever Adult Physical Abuse						
Never	88,476 (1,508)	1.00	REF	120,854 (3,349)	1.00	REF
Once or more than once	20,979 (434)	1.16	(1.04, 1.30)	36,668 (1,086)	1.02	(0.95, 1.10)
Ever Adult Sexual Abuse						
Never	100,622 (1,777)	1.00	REF	140,083 (3,934)	1.00	REF
Once or more than once	8,874 (167)	1.01	(0.85, 1.18)	17,337 (503)	0.98	(0.89, 1.08)
WEB[‡] Scale for Current Relationship in 2001						
WEB Scale = 10–19	87,343 (1,511)	1.00	REF	118,393 (3245)	1.00	REF
WEB Scale = 20–39	7,080 (142)	1.12	(0.94, 1.33)	10,202 (285)	0.99	(0.88, 1.12)
WEB Scale = 40–60	1,486 (38)	1.45	(1.04, 2.01)	1,780 (60)	1.16	(0.89, 1.50)

*
Separate models were run for each abuse exposure

[†]
Adjusted for child physical and sexual abuse, race, parental educational attainment, somatogram score at age 5, and BMI at age 18