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Violence and Cardiovascular Health:

A Systematic Review

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Abstract

Context—Violence, experienced in either childhood or adulthood, has been associated with physical health outcomes including cardiovascular disease. However, the consistency of the existing literature has not been evaluated.

Evidence acquisition—In 2013**,** the authors conducted a PubMed and Web of Science review of peer reviewed articles published prior to August 2013 on the relation between violence exposure, experienced in either childhood or adulthood, and cardiovascular outcomes. To meet inclusion criteria, articles had to present estimates for the relation between violence exposure and cardiovascular outcomes (hypertension, blood pressure, stroke, coronary disease, or myocardial infarction) adjusted for demographic factors. Articles focusing on violence from TV, video games, natural disasters, terrorism, or war were excluded.

Evidence synthesis—The initial search yielded 2,273 articles; after removing duplicates and applying inclusion and exclusion criteria, 30 articles were selected for review. A consistent positive relation was noted on the association between violence experienced during childhood and cardiovascular outcomes in adulthood (i.e., hypertension, coronary heart disease, and myocardial infarction). Associations across genders with varying types of violence exposure were also noted. By contrast, findings were mixed on the relation between adult violence exposure and cardiovascular outcome.

Conclusions—Despite varying definitions of violence exposure and cardiovascular endpoints, a consistent relation exists between childhood violence exposure, largely assessed retrospectively, and cardiovascular endpoints. Findings are mixed for the adult violence–cardiovascular health relation. The cross-sectional nature of most adult studies and the reliance of self-reported outcomes can potentially be attributed to the lack of findings among adult violence exposure studies.

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Introduction

Heart disease remains the leading cause of death in the U.S., and prevention of cardiac disease is a major public health goal.[1] A growing body of research suggests that experiencing violence in either childhood or adulthood is associated with cardiovascular disease (CVD). National estimates show that the prevalence of experiencing violence during childhood is high, with 42% experiencing a physical assault in the U.S.[2] Furthermore, estimates of family violence against women and children indicate widespread exposure to violence in the home.[3] The U.S. state and local child protective services estimate that 681,000 children were victims of some form of maltreatment (i.e., physical abuse, sexual abuse, or neglect) in 2011.[4] In addition to being highly prevalent, exposure to violence has been recognized as a significant public health problem.[5–7] Children exposed to violence either at home or in the community have been found to express higher levels of negative emotions (anxiety, depressive mood, anger, and hostility) and adverse stress reactivity.[8,9]

The effects of violence may differ by life course stage. Healthy development of the brain and other organ systems can be derailed under chronic exposure to stress, making children particularly vulnerable to the effects of violence exposure.[10] These developmental effects can have long-term consequences on the development of chronic disease including CVD. Violence exposure in childhood has been associated with the development of cardiovascular risk factors in childhood,[11] which persist into adulthood.[12] Coping by modifying lifestyle factors and engaging in substance use behaviors, during childhood or adulthood, may increase an individual's CVD risk. However, in adulthood, the cumulative effects of lifestyle and substance use behaviors are relatively less compared to childhood, as the number of years in which risky behaviors are engaged is fewer. Furthermore, given the long developmental process of CVD, adult exposures to violence may operate under different biological mechanisms compared to violence experienced decades earlier. Therefore, the existing literature of violence exposure and CVD is evaluated separately by timing of violence exposure occurring either in childhood or adulthood while recognizing that individuals often experience violence during both periods.

WHO has developed a typology of violence where it is characterized as three different types: self-directed (e.g., suicidal behavior), interpersonal (e.g., family and community), and collective (e.g., political). Rather than including all three typologies, the authors chose to conduct a systematic review of interpersonal violence exposure over the life course and CVD to synthesize extant research. Interpersonal violence, defined as "the intentional use of physical force or power against another person that can result in injury, death, psychological harm, maldevelopment, or deprivation,"[13] is considered a proximal and often chronic form of violence that threatens the security and stability of both children and adults and is recognized as a public health problem. This systematic review aims to provide an integrated and unbiased summary of extant research, evaluate the consistency of findings around this topic, and outline next steps for future research. Among relevant studies, vast heterogeneity exists regarding exposure and outcome measures, sample populations, and study designs; thus, a meta-analysis was not conducted at this point.

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Methods

Inclusion Criteria

The inclusion criteria for this systematic review required that studies examine the association between violence (experienced at any point in the life course) and one of the outcomes of interest (described below). The manuscript had to be an original report of the association between violence and cardiovascular mortality, morbidity, or cardiovascular indices. Further criteria required that the analyses of violence and the outcome of interest be central to the aims of the study and analyses. The following outcomes were included: coronary heart disease (CHD), myocardial infarction (MI), stroke, hypertension, and blood pressure (BP). Several types of violence exposure were included: intimate partner violence (IPV), child abuse, sexual assault, and physical assault where the perpetrator was a stranger or non-stranger.

Exclusion Criteria

Because the focus was on experiences of interpersonal violence, exposures to natural or man-made disasters, such as earthquakes, terrorist attacks, or combat/war were excluded. Papers that focused on violence in video games, TV, or print media were also excluded. Studies that did not explicitly test the relationship between violence and cardiovascular outcomes, adjusting for sociodemographic factors (at least one of the following: age, gender, or SES), were excluded. Studies that considered aggregate measures of the home environment, but did not examine the association between violence and the outcome of interest separately, were excluded. Studies that did not evaluate CVD as a separate outcome or only assessed inflammatory markers were also excluded.

Search Strategy and Data Extraction

In 2013, using the established exposure and outcome definitions, a literature search was conducted using two electronic databases: Web of Science and PubMed (National Library of Medicine, Bethesda MD). PubMed and Web of Science were searched for the following parameters: Medical Subject Heading (MeSH) terms of either *violence*, *trauma*, or *abuse*, and a second MeSH term including *cardiovascular disease*, *stroke*, *hypertension*, *ischemic heart disease*, *myocardial infarction*, *blood pressure*, or *cardiovascular* in PubMed and using the Topics option in Web of Science with the same parameters. The search was limited to English studies of humans. The search, through August 2013, yielded 2,273 articles, including duplicates. The titles of these articles were screened and the exclusion criteria were applied. Published systematic reviews and meta-analyses were utilized solely for investigation of references and not otherwise included in the analysis. This stage yielded 122 articles (Figure 1). Abstracts of these articles were screened to discard duplicates of articles, commentaries, and letters or editorials. After review of the abstracts, 35 articles were retained. An additional manual search consisted of screening reference lists of selected relevant articles in order to identify other articles not captured by Web of Science or PubMed searches. This secondary screening yielded an additional four articles of interest, for a total of 39 articles. These articles were read in their entirety to ensure that exposures and outcomes met the inclusion and exclusion criteria. In total, 30 articles merited inclusion in the final review, 15 examining childhood violence exposure and 15 with adulthood

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violence exposure. Nine articles were excluded at this stage because they did not meet the inclusion/exclusion criteria. Information on developmental period of exposure, sample size and demographics, exposure and outcome assessment, variables used for stratification and adjustment, and findings both of the main association of interest as well as gender-stratified results were extracted when available.

Evidence Grade Criteria

A method for evaluating the quality of the reviewed studies was developed to establish an evidence grade for each study. One point each was assigned for the following four criteria: sample size >500 subjects, prospective follow-up for cardiovascular outcomes, a validated exposure measure (e.g., Revised Conflicts Tactics Scale), and a validated outcome measure (e.g., medical chart review) or an objectively measured outcome (e.g., BP taken by study staff). A higher score indicated higher quality study.

Results

Tables 1 and 2 summarize the 30 publications, organized by whether the violence exposure under evaluation occurred in childhood or adulthood.

Childhood Exposures

Fifteen manuscripts, from 13 studies, examined the relation between childhood violence exposure and cardiovascular health outcomes (Appendix Table 1). Twelve studies employed a cross-sectional study design and three used a prospective study design. The majority of the studies' sample populations were based in the U.S. (12 of 15 studies).[15–26] Of the 15 studies exploring childhood exposures selected for review, 12 explored the effects of childhood abuse on cardiovascular outcomes in adulthood[15–17,19,22–29] and only three examined the effects of experiencing violence in the community during childhood/adolescence.[18,20,21] The 12 studies that focused on child abuse all assessed child abuse exposure retrospectively during adulthood (Table 1). Among these 12 studies, six assessed childhood abuse with validated scales, mainly the Childhood Trauma Questionnaire or Conflict Tactic Scales.[15–17,24,25,29] Positive associations were noted among studies using validated scales as well as those using non-validated questions.

A positive relation between child abuse and hypertension in adulthood was found in all five studies evaluating hypertension as an endpoint, with all studies using self-reported hypertension.[17,22,25,26,28] Gender differences in the association between abuse and hypertension were only examined in one study. Using data from the National Comorbidity Survey, experiencing physical abuse during childhood was associated with self-reported hypertension among adult men but not women; however, sexual abuse was associated with self-reported hypertension among women but not men.[22]

Eight studies examined CVD as an endpoint, all noting significant positive associations between child abuse and CVD.[15–17,19,22,24,26,27] CVD was generally defined as experiencing any one of a series of potential endpoints, such as stroke, MI, or angina; however, definitions varied across studies. Using data from the Adverse Childhood Events study, Dong and colleagues[15] noted a relationship between emotional, physical, and sexual

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abuse and ischemic heart disease, which was defined as ever experiencing a heart attack, pain, or heavy pressure in chest with exertion or use of nitroglycerine. Only two studies, both from the National Comorbidity Survey, examined gender differences in the childhood abuse and CVD association, noting positive associations among women but not men.[19,22] Of the seven studies that examined CVD as an endpoint, all used self-reported CVD measures and noted positive associations. Two studies used medical record reviews to validate self-reported cardiovascular outcomes.[16,24] A positive association between forced sex and definite CVD events, defined as MI or stroke confirmed by medical record review, was noted in the Nurses Health Study.[24] Interestingly, patients with a history of abuse were less likely to allow access to medical records and were thus less likely to have self-reported CVD outcomes confirmed by medical records. The strength of the association between forced sex and cardiovascular events was also attenuated in the confirmed event cases compared to the self-reported cases. Roy and colleagues[16] used discharge diagnosis of CVD (MI, stroke, or CHD) to confirm self-reported CVD and also noted positive associations with childhood abuse and neglect. Number of childhood traumas as measured by the Childhood Trauma Questionnaire was associated with 6-year incidence of CVD based on discharge diagnosis.

One study assessed the relation between childhood sexual abuse and self-reported physician-diagnosed MI, noting a significant association among men but not women.[23] In the Nurses Health Study,[36] forced sex in childhood was associated with a non-significant increase in confirmed or probable MI among women. Severe physical abuse and forced sex were significantly associated with increased risk of confirmed or probable stroke. No other study examined cardiovascular endpoints independently.

Only three studies examined the impact of experiencing violence in the community on cardiovascular risk among adolescents or children.[18,20,21] Wilson and colleagues[21] noted that adolescents who experienced violence victimization were more likely to be classified as non-dippers, where the typical nocturnal decrease in blood pressure is absent or blunted, which has been associated with stroke and left ventricular hypertrophy. Murali and Chen[20] examined the effects of violence on laboratory assessments of cardiovascular and neuroendocrine measures, both at baseline and in response to an interpersonal laboratory stressor (a debate or puzzle task) in 115 urban high school students aged 16–19 years. Increased frequency of lifetime violence exposure was associated with higher basal diastolic BP and heart rate. Higher levels of violence exposure also predicted decreased cardiovascular reactivity to the acute laboratory stressor based on the physiologic indicators (i.e., BP, heart rate, and heart rate variability).

Adult Exposures

Fifteen manuscripts, from 12 studies, were selected for review of the relation between adult violence exposure and cardiovascular endpoints (Appendix Table 2).[30–44] Only two studies employed a prospective design,[33,34] and only three included both men and women in their sample.[35,36,45]

With the exception of four studies,[37,39,41,44] all focused on the effects of IPV, assessed retrospectively, and did not consider other forms of violence in adulthood (i.e., community). Hypertension was examined in 13 of 15 studies, with mixed findings. Eight studies noted no

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association between adult violence exposure and hypertension.[30,32,39–44] Using the Spanish National Health Survey, Vives-Casas and colleagues[44] examined the relation between IPV and self-reported hypertension among women but noted no significant associations. In contrast, a significant association was noted between IPV and self-reported hypertension among women but not men in the Behavioral Risk Factor Surveillance System Study (BRFSS).[35] Most studies relied on self-report of hypertension; only two used BP measurements or ICD-9 codes from medical records, noting no significant findings.[32,39] Sparrenberg and colleagues[39] observed no associations when examining the relation between physical violence in the past year and hypertension based on BP ≥140/90 mmHg or use of BP-lowering medications.

Ten studies examined violence exposure in adulthood and CVD as an endpoint. Nine studies used self-reported CVD measures defined as either heart/circulatory problems,[30,38] CHD,[35,40,44,46] cardiovascular signs or symptoms,[32] or a combination of hypertension, MI, stroke, chest pain, or congestive heart failure,[36,42] with mixed findings. Four of 9 studies noted positive associations between violence in adulthood and CVD.[30,35,42,44] Of the ten studies that examined adult violence and CVD endpoints, one study defined CVD as use of CVD medications ascertained through a national prescription database, noting no significant associations.[34]

Three studies assessed the relation between violence exposure in adulthood and MI, and all used a self-reported measure of MI. One noted a significant association among a representative sample of U.S. adults.[35] Another study using a sample of women utilizing the Veterans Affairs healthcare system, noted significant associations between histories of sexual assault in the military and MI in the past 12 months.[38] A third study based on the South African Stress and Health Study noted nearly significant associations between IPV and self-reported heart attack in the past 12 months.[40]

Three studies assessed the relation between violence exposure and stroke.[35,38,40] Using the BRFSS, Breiding and colleagues[35] noted significant associations between IPV and stroke, among both women and men. Two other studies noted no significant associations, though the number of stroke cases was small.[38,40]

Discussion

A consistent positive relation between child abuse and CVD in adulthood is noted, despite varying child abuse definitions as well as varying definitions of CVD. Adult violence exposure was not consistently associated with cardiovascular outcomes. Discrepancies in study findings may be attributed to methodologic limitations discussed below.

A relation was noted among childhood experiences of physical or sexual violence and various cardiovascular endpoints in adulthood. Over half of the child violence articles selected for review also assessed neglect, noting associations with various cardiovascular endpoints. Violence exposure may affect cardiovascular health directly through disruption of various physiologic mechanisms or indirectly by affecting mental health or modifying health behaviors. Violence exposure during childhood has been shown to disrupt normal

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physiologic development, particularly emerging brain architecture as well as cognitive and behavioral functioning.[10] Psychological stress has been associated with the activation of the sympathetic and adrenomedullary system and the hypothalamic-pituitary-adrenal axis.[47] Stress can lead to impairment of endothelial function; increases in circulating levels of inflammatory cytokines such as interleukin-6, C-reactive protein, and tumor necrosis factor-α; platelet activation; and prothrombotic changes in molecules involved in coagulation; factors that are involved in the atherosclerotic process.[48–50]

Violence exposure in childhood and adulthood may also affect cardiovascular health through indirect pathways. Long-term effects of violence exposure have been noted in relation to depression, aggression, substance use, and risk-taking behaviors.[35,51,52] Many, though not all, children and adults exposed to violence develop post-traumatic stress disorder (PTSD) and depression. Both PTSD and depression have been linked to obesity, hypertension, and adverse cardiac outcomes.[53,54] Although many children and adults exposed to violence may exhibit emotional disturbances (e.g., depression, PTSD, anxiety) as a result of their experiences, others experience adverse physical effects in the absence of adverse mental health effects. Children and adults employ different coping mechanisms to manage the stress associated with violence exposure, which may include changes in lifestyle factors (i.e., worsening diet and decreased physical activity) and engaging in substance use behaviors (i.e., smoking and alcohol use), which are known to affect heart disease risk.[55,56] Though not a focus of this review, various studies have documented associations among violence exposures and tobacco use, alcohol use, poor dietary habits, and sedentary lifestyle, potential mechanisms linking violence exposure and cardiovascular health. An extensive literature has shown that smoking, alcohol use, and decreased physical activity increase the risk of cardiovascular morbidity and mortality.[57] Smoking has been shown to be associated with more stressful violent environments,[52,58,59] and in conjunction with alcohol use, has also been proposed as a type of self-medication to cope with a stressful situation or environment.[60]

Limitations and Recommendations

First, there is a lack of uniformity on how violence is assessed and characterized. In general, existing studies have examined different types of violence exposure (i.e., physical, sexual, or emotional) separately in relation to CVD but have not accounted for the chronicity or severity of these exposures.[22] Furthermore, often only one question was used to assess exposure to a specific form of violence. Most of the studies focused on adult IPV characterized IPV with a single yes/no and did not consider frequency of abuse, severity, or whether the abuse occurred with multiple partners. Although most studies relied on a yes/no categorization of violence exposure that did not account for the type or the severity of the abuse, using data from the Nurses Health Study, Mason and colleagues[33] created IPV categories based on type and created three levels of severity when considering emotional abuse. The authors noted a significant association between emotional abuse and hypertension, particularly at the highest levels of abuse. It is plausible that differential characterization of exposure across studies is contributing to the mixed findings.

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These issues are not exclusive to studies that explore IPV exposures in adulthood. Studies that examined child abuse also had limitations associated with the use of limited exposure assessments. Violence during childhood was often also limited to only one question. A simplified, yes/no classification of child abuse assumes that all forms of abuse have the same effect on health outcomes. Furthermore, it ignores when in the life course the exposure occurred. If, as recent research suggests, only the most severe experiences have an impact on CVD, using a maltreatment classification that ignores chronicity or severity of exposure will obscure true effect estimates. Despite this limitation, most studies that explored child abuse noted positive associations.

There is also a heavy reliance on self-reported outcomes. The vast majority of reviewed studies relied on self-reported measures of CVD, which could introduce misclassification of the outcome that may or may not be differential with respect to violence exposure.[22,28] For example, National Health and Nutrition Examination Survey data have demonstrated that only 83% of hypertensive adults aged >18 years are aware of their hypertension,[61] thus, use of self-reported hypertension would underestimate the true prevalence of hypertension and potentially bias results toward the null, assuming non-differential misclassification. Alternatively, differential misclassification may result; in the Nurses Health Study,[24] a stronger association was noted between non-verified cardiovascular outcomes and violence exposure compared to associations that relied on verified cardiovascular outcomes. In addition, several studies combined cardiovascular outcomes such as hypertension, MI, and stroke into a single CVD category, making it difficult to distinguish effects that may be associated with only some cardiovascular outcomes.

Positive findings on the relation of child abuse and cardiovascular outcomes in spite of the potential for misclassification of both the exposure and outcome may be attributed to a large causal effect of child abuse on cardiovascular outcomes compared to the effect of adult violence exposure on cardiovascular outcomes. For both childhood and adulthood violence, it is possible that the observed effects are an underestimate of the true association, given the potential misclassification of exposure and outcome.

The studies had a wide range of sample sizes, ranging from studies with less than 100 participants to national studies with tens of thousands of participants. Sample size was not a factor among studies that examined childhood exposures, as all noted significant associations with CVD outcomes regardless of sample size. Among adult studies, where findings were mixed, no discernible trend appeared, in that both large and small studies failed to see an association. This suggests that the population under the study and the exposure and outcome assessments may be more important considerations with regard to the significance of the findings.

Sex differences in the relation between violence exposure and cardiovascular outcomes need to be explored further. Sex differences were examined in only a handful of studies, potentially obscuring associations that may exist in only one gender. Of the 15 reviewed papers that focused on violence exposure in adulthood, only two included both men and women in their samples.[35,39] Although women are more likely to experience IPV compared to men, men are also at risk. In the National Violence Against Women Survey that included

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men and women aged 18–65 years, 29% of women and 23% of men reported experiencing IPV in their lifetime. The prevalence of cardiovascular outcomes also differs by gender, with men having increased prevalence of hypertension, stroke, and MI compared to women.

All but one of the reviewed studies considered the childhood period, often defined as age <18 years, as one developmental period without consideration for sensitive periods that may exist within childhood. Research suggests that exposure to child abuse in early childhood, which is a critical period of brain development, is more detrimental to behavioral and cognitive development than exposure to child abuse at later stages of child development.[10] Whether childhood critical periods of exposure exist for the development of CVD remains unknown.

Few studies examined the relation between violence exposure and cardiovascular endpoints in childhood/adolescence. Those that did noted a positive association, suggesting a possible trajectory of health risk that starts in adolescence. Most studies focused on adult populations and only three examined adolescents prior to the onset of CVD.[18,20,21] Identifying those most at risk for development of CVD earlier in life would have a greater impact in prevention efforts. Violence exposure in childhood may be particularly important, as biological mechanisms used to compensate for chronic stress exposure may be detrimental to health, setting the stage for the early development of CVD.[62] Furthermore, unhealthy habits used to cope with stress exposure are formed during these early years and could contribute to greater cardiovascular risk.[63]

The cross-sectional nature of most adult violence exposure studies limits the ability of observing associations with adult violence exposures. Given the long developmental nature of CVD, the interval between adult exposure to violence and CVD assessment may not be sufficiently long. This may be particularly true for studies that examined past-year experiences of violence in adulthood.

Conclusions

In this systematic review, a consistent positive association across studies that examined the relation between child abuse and CVD endpoints is noted. In contrast, mixed findings are noted across studies examining the relation between adult violence exposure and cardiovascular outcomes. Inconsistencies in the manner in which violence exposure is characterized as well as the cross-sectional nature of most adult violence exposure studies make it difficult to draw definitive conclusions from these studies. Alternatively, sensitive or vulnerable time periods may exist in relation to violence exposure and cardiovascular health. Further research that captures the chronicity and severity of violence exposure across the life course is needed to further elucidate the relation between violence exposure and cardiovascular outcomes. Additionally, sufficient time should elapse between the exposure and query of the outcome, particularly for adulthood exposure to violence. Studies that examine the mechanisms through which violence is associated with cardiovascular endpoints as well as identify protective factors of the effects of violence would be fruitful areas of research that could effectively inform interventions. Given the high prevalence of experiencing and witnessing serious and lethal violence among youth,[4] the number of

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children at risk for developing adverse emotional and behavioral outcomes as well as increased risk of obesity, diabetes, and CVD makes this a significant public health problem.[5,6,64]

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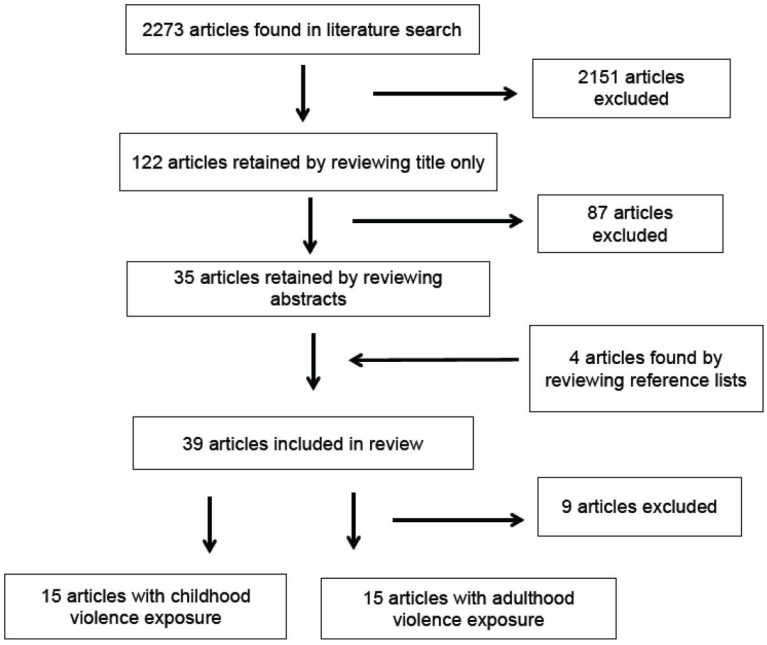

Figure 1.
Itemization of articles included in systematic review

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Appendix Table 1

Childhood violence exposure and cardiovascular outcomes, by study design and sample size

Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Objective Outcome Assessment	Outcome Measure	Results	Evidence Grade
Prospective Studies									
24	Rich-Edwards JW (2012)	66,798 F Mean age: 35	Prospective cohort of female nurses in the US	Retrospective assessment of physical and sexual abuse	R-CTS assessment of physical abuse prior to age 18 categorized into none/ mild/moderate/severe; sexual abuse prior to age 18 categorized as none, unwanted sexual touching, forced sexual activity	Self-reported CV events with attempted confirmation by medical record review or additional information	CV events defined as MI and stroke (3 levels of case ascertainment: self-reported only, probable/definite by additional information, and definite confirmed by medical record review) with 14 years of retrospective outcome assessment and 4 years of prospective assessment	Severe physical abuse was associated with all CV events (AHR: 1.5, 95% CI: 1.1, 1.9). Forced sex was associated with CV events (AHR: 1.6, 95% CI: 1.2, 2.0), prospective cases (AHR: 1.7, 95% CI: 1.1, 2.6), and definite cases (AHR: 1.4, 95% CI: 1.1, 2.0).	++++
25	Riley EH (2010)	64,733 F Mean age: 35	Prospective cohort of female nurses in the US	Retrospective assessment of physical/sexual abuse in childhood and adolescence	Childhood (up to age 11) and adolescence (ages 11–17): PA assessed with R-CTS (no abuse, mild to moderate, severe as child or teen, severe as both), SA with Gallup survey (no abuse, touched, forced sex as child or teen, forced sex as both)	Self-reported HTN	Physician-diagnosed HTN with 12 years of retrospective assessment and 2 years of prospective assessment	Forced sex as both child and teen was associated with HTN (AOR: 1.2, 95% CI: 1.1, 1.3). Severe physical abuse as both child and teen (AOR: 1.1, 95% CI: 1.1, 1.2) and child or teen (AOR: 1.2, 95% CI: 1.1, 1.3) was associated with increased risk for HTN.	+++
16	Roy A (2010)	444 M/F 60% F Mean age: 29	Prospective study of Type 1 diabetics in NJ, USA	Retrospective assessment of childhood emotional, physical, sexual abuse and physical and emotional neglect	CTQ scales assessing childhood emotional, physical, sexual abuse, and physical and emotional neglect; positive responses summed	Medical record review for CVD	Discharge diagnosis of angina pectoris, MI, or stroke within 6 years of follow-up	Number of childhood traumas was significantly associated with the 6-year incidence of any CVD (AOR: 1.2, 95% CI: 1.0, 1.5).	+++
Cross-sectional Studies									
26	Afifi TO (2013)	34,226 M/F Age >20 years	Cross-sectional representative survey of adults in the US	Retrospective assessment of physical, sexual, and emotional abuse and neglect	Frequency of experiences used to define experiences of physical abuse, emotional abuse and harsh physical punishment. Sexual abuse and neglect defined as any positive response.	Self-reported HTN or CVD	Physician-diagnosed HTN or CVD (angina pectoris, MI, tachycardia)	Childhood maltreatment was associated with HTN (AOR: 1.2, 95% CI: 1.1, 1.3) and CVD (AOR: 1.6, 95% CI: 1.1, 1.8). Harsh physical punishment was associated with CVD (AOR: 1.4, 95% CI: 1.1, 1.8).	+
28	Stein DJ (2010)	18,600 M/F 53% F 53% 21–44 yo	Cross-sectional, representative survey of adults in 10 countries	Retrospective assessment of childhood physical and sexual abuse, neglect, and family violence	Assessment of any physical and at least 3 instance of sexual abuse, neglect, and family violence	Self-reported HTN	Adult onset (age >20), physician-diagnosed HTN	Physical abuse (HR: 1.2, 95% CI: 1.0, 1.5) and family violence (HR: 1.2, 95% CI: 1.0, 1.3) were associated with HTN. No significant association of HTN with sexual abuse or neglect.	+

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Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Objective Outcome Assessment	Outcome Measure	Results	Evidence Grade
15	Dong M (2004)	17,337 M/F 54% F Mean age: 56	Cohort of adults in a health care plan in San Diego, CA, USA	Retrospective childhood abuse and neglect assessment	Childhood emotional and physical abuse (CTS), emotional and physical neglect (CTQ), and sexual abuse prior to age 18	Self-reported IHD	MI, pain or heavy pressure in chest with exertion, or use of nitroglycerine	Childhood emotional (AOR: 1.7, 95% CI: 1.5–1.9), physical (AOR: 1.5, 95% CI: 1.4–1.9) and sexual (AOR: 1.4, 95% CI: 1.3–1.6) abuse and emotional (AOR: 1.3, 95% CI: 1.1–1.6) and physical (AOR: 1.4, 95% CI: 1.2–1.8) neglect were all associated with IHD.	++
27	Fuller-Thomson E (2010)	13,093 M/F 52% female 60% <50 yo	Cross-sectional, representative survey of individuals ≥12 yo in Manitoba & Saskatchewan, Canada	Retrospective childhood physical abuse assessment	Positive response to query on physical abuse prior to age 18	Self-reported heart disease	Physician-diagnosed heart disease	Childhood physical abuse was associated with self-reported heart disease (AOR: 1.5, 95% CI: 1.0–2.1).	+
23	Fuller-Thomson E (2012)	12,863 M/F 60% F 56% <50 yo	Cross-sectional representative survey of adults in 5 US states	Retrospective assessment of childhood forced sex	Positive response to query on penetrative forced sex prior to age 18	Self-reported MI	Physician-diagnosed MI	Forced sex was associated with MI in males (AOR: 3.0, 95% CI: 1.1, 7.9) but not females (AOR: 0.9, 95% CI: 0.3, 2.8).	+
22	Goodwin RD (2004)	5,877 M/F 50% F Mean age: 33	Cross-sectional, representative survey of individuals 15–54 yo in the US	Retrospective assessment of childhood sexual and physical abuse and serious neglect	Positive response to query on sexual abuse (rape or molestation), physical abuse or serious neglect prior to age 18	Self-reported HTN or cardiac disease	HTN or cardiac disease (heart attack or other serious heart trouble) experienced in the past 12 months	Physical abuse associated with HTN among males (AOR: 1.6, 95% CI: 1.2–2.3). Neglect associated with cardiac disease among females (AOR: 5.7, 95% CI: 2.2, 14.5). Sexual abuse associated with cardiac disease (AOR: 8.5, 95% CI: 2.3, 31.7) and HTN (AOR: 1.6, 95% CI: 1.0, 2.6) among females.	+
19	Batten SV (2004)	5,395 M/F 50% F Mean age: 33	Cross-sectional, representative survey of adults 15–54 in the US	Retrospective child sexual/physical abuse and neglect assessment	Questions on rape, molestation, physical abuse, and serious neglect	Self-reported CVD	HTN, MI, or stroke	Childhood maltreatment was associated with increased CVD among women (AOR: 8.8, p<.001) but not men (AOR: 0.9, NS).	+
29	van Reedt Dortland AK (2011)	2,755 M/F 66% F Mean age: 42	Cross-sectional baseline data from a prospective cohort of adults using health care in the Netherlands	Retrospective assessment of emotional neglect, physical, psychological and sexual abuse	Frequency of emotional neglect, psychological, physical, and sexual abuse prior to age 16 assessed by Childhood Trauma Interview	Measured BP and metabolic risk factors	DBP, SBP, HDL, triglycerides, waist circumference, and glucose. Metabolic risk factors were summed to create a metabolic risk score	Emotional neglect was inversely associated with SBP (beta= −0.05, p=.03). History of sexual abuse (beta=0.5, p=.004), physical abuse (beta=0.05, p=.001), and psychological abuse (beta=0.05, p=.001) were associated with metabolic risk score.	+++
17	Springer KW (2007)	2,051 M/F 52% F Mean age: 55	Cross-sectional data from a prospective, population-based cohort in WI, USA	Retrospective assessment of child physical abuse	CTS with childhood physical abuse defined as “some” or “a lot” of abuse	Self-reported CV problems	CV problems defined as physician-diagnosed circulation problems, heart trouble, high BP, and high cholesterol	Childhood physical abuse was significantly associated with circulation problems (AOR: 1.5 95% CI: 1.0, 2.2), heart troubles (AOR: 1.5 95% CI: 1.0, 2.2) and high BP (AOR: 1.4, 95% CI: 1.1, 1.9).	++
18	Clark R (2006)	172 M/F 50% F Mean age: 12	Cross-sectional study of healthy African-American teenagers in	Retrospective assessment of	Violence that was heard, seen or experienced in the home or neighborhood was	Measured BP and heart rate	BP and heart rate before and after a stressor (reactivity)	Violence exposure was inversely related to SBP reactivity (Beta −0.05	+

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Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Objective Outcome Assessment	Outcome Measure	Results	Evidence Grade
			a Midwestern city in the US	Violence in the home	assessed by Screen for Adolescent Violence Exposure scale			SE 0.02) and DBP reactivity (Beta −0.04 SE 0.01).	
20	Murali R (2005)	115 M/F 62% F Mean age: 17	Cross-sectional study of adolescents in St. Louis, MO, USA	Retrospective assessment of observed, experienced, and subjective perceptions of violence	Lifetime experiences, observations, and subjective perceptions of violence were summed. Frequency, proximity and severity to violence were evaluated using the Exposure to Violence scale	Measured CV vital signs	HRt, HRV, SBP, DBP measured at baseline and in response to stressor (reactivity)	Total experiences of violence was correlated (r=.22, p<.05) with higher baseline DBP. Higher frequency of experienced violence was correlated with elevated baseline DBP (r=.31, p<.05) and HRt (r=.30, p<.05). Subjective violence score was correlated with baseline SBP (r= −.24, p<.01). Total experiences of violence was associated with decreased SBP (beta= −.14, p<.05) and HR (beta= −.21, p<.001) reactivity. Total observed violence was associated with decreased SBP reactivity (beta=−.14, p<.05).	++
21	Wilson DK (2002)	56 M/F 52% F Mean age: 13	Cross-sectional study of healthy African-American adolescents in Richmond, VA	Retrospective assessment of experiencing, seeing, or hearing about violence in the community	Frequency of experiencing, seeing, or hearing about violence in the community in the past year using RSSECV	Measured BP dipping status	BP readings every 15 min over a 24-hour period; nondipping status based on <10% or difference in mean BP between waking and sleeping	Mean BP nondipping status was positively associated with victimization (beta 0.32, SE 0.15). Hearing about violence was associated with mean BP nondipping status among men (beta 2.29 SE 1.03).	+

Abbreviations: AHR: Adjusted hazard ratio, AOR: Adjusted odds ratio, ARR: Adjusted risk ratio, BP: Blood pressure, CTI: Childhood Trauma Interview, CTS: Conflict Tactics Scales, CTQ: Childhood Trauma Questionnaire, CV: Cardiovascular, CVD: Cardiovascular disease, DBP: Diastolic bood pressure, HbA1C: Hemoglobin A1c, HDL: High density lipoprotein, HR: Hazard ratio, HRt: Heart rate, HRV: Heart rate variability, HTN: Hypertension, IHD: Ischemic heart disease, MI: Myocardial infarction (heart attack), OR: Odds ratio, R-CTS: Revised Conflict Tactics Scale, RSSECV: Richters and Saltazman's Survey of Exposure to Community Violence, SBP: Systolic blood pressure

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Appendix Table 2

Adult violence exposure and cardiovascular outcomes, by study design and sample size

Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Measured Outcome Assessment	Outcome Measure	Results	Evidence Grade
Prospective Studies									
33	Mason SM (2012)	51,434 F Mean age: 46	Prospective cohort of registered nurses in the US	Retrospective assessment of physical and sexual IPV and current assessment of emotional abuse	Any experience of physical or sexual IPV or emotional abuse in ongoing relationships (3 levels of severity)	Self-reported HTN	Physician-diagnosed HTN reported in 6 years of follow-up after exposure ascertainment	No significant association was noted between incident HTN and physical (AHR: 1.1, 95% CI: 1.0–1.1) or sexual IPV (AHR: 1.0, 95% CI: 0.9–1.1). Women with most severe emotional abuse had increased incidence of HTN (AHR: 1.2, 95% CI: 1.0–1.5) compared to women without emotional abuse.	++
34	Stene (2013)	5,593 F 31% 30 yo 45% 40,45 yo 24% 59,60 yo	Prospective population-based cohort of women aged 30–60 in Oslo, Norway	Retrospective assessment of IPV	Any experience of psychological IPV or physical and/or sexual IPV	CV drug use ascertained from national prescription database	Incident CV drug use ascertained from Norwegian Prescription Database including all CV drugs, anti-HTN drugs, and lipid-modifying drugs	Psychological IPV was not associated with any CV drug use. Physical/sexual IPV was associated with anti-HTN drug use (AIRR: 1.4, 95% CI: 1.1–1.7).	++
Cross-sectional Studies									
35	Breiding MJ (2008)	70,156 M/F 61% F Age >18	Cross-sectional, representative survey of adults in 16 states in the US	Retrospective assessment of IPV	Any experience of threatened, attempted or completed physical or sexual violence by current or former intimate partner	Self-reported CV events or signs	History of physician-diagnosed high BP, high cholesterol, MI, stroke, CHD	Among women, IPV was associated with high cholesterol (AOR: 1.3, 95% CI: 1.1–1.4), stroke (AOR: 1.8, 95% CI: 1.4–2.2), high BP (AOR: 1.1, 95% CI: 1.0–1.2), MI (AOR: 1.4, 95% CI: 1.1–1.8) and CHD (AOR: 1.8, 95% CI: 1.5–2.1). Among men, IPV was associated with stroke (AOR: 1.4, 95% CI: 1.0–2.1).	+
44	Vives-Cases C (2011)	13,094 F 40% >50 yo	Cross-sectional nationally representative survey in Spain	Retrospective assessment of IPV and VAW	IPV defined as violence in the past 12 months where the perpetrator was the woman's intimate partner; VAW defined as violence perpetrated by a unknown man or woman or known man who was not their partner	Self-reported HTN or CHD	Physician-diagnosed HTN or CHD	No association between HTN and IPV (AOR: 0.8, 95% CI: 0.5–1.5) or VAW (AOR: 1.0, 95% CI: 0.5–1.8) in past 12 months. Significant association noted between IPV and CHD (AOR 5.3 95% CI: 1.5, 19.3). Unable to estimate association between VAW and CHD due to small numbers.	+
38	Frayne SM (1999)	3,632 F Mean age: 47	Cross-sectional survey of women using VA health care	Retrospective assessment of sexual assault in the military	Any experience of sexual assault while in the military	Self-reported CVD events and symptoms	Reports of being bothered by angina or other heart problem; treatment for HTN, MI, TIA, or stroke in past 12 months	History of sexual assault in military was associated with angina (AOR: 1.6, 95% CI: 1.3–2.0), other heart problems (AOR: 1.6, 95% CI: 1.3–2.1), HTN (AOR: 1.3, 95% CI: 1.1–1.6), and MI (AOR: 2.3, 95% CI: 1.4–4.0) but not TIA (AOR: 1.2, 95% CI: 0.7–2.1) or stroke (AOR: 1.5, 95% CI: 0.8–2.9).	+

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Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Measured Outcome Assessment	Outcome Measure	Results	Evidence Grade
37	Frayne SM (2003)	3,632 F Mean age: 47	Cross-sectional survey of women using VA health care	Retrospective assessment of sexual assault in the military	Any experience of sexual assault while in the military	Self-reported HTN	Self-reported HTN	History of sexual assault in military was associated with HTN (AOR: 1.2, 95% CI: 1.0–1.5).	+
32	Bonomi AE (2009)	1,928 F 55% 45–64 yo	Cross-sectional study of healthcare plan members in Washington and Idaho, USA	Retrospective assessment of IPV	Any experience of physical, sexual or non-physical abuse by intimate partner in the past year compared with women with no history of IPV in adulthood	ICD-9 codes from health care visits	ICD-9 codes for CV signs and symptoms, disorders of lipid metabolism and HTN in the past year	No significant associations were noted between IPV in past year and CV s/s (AOR: 1.1, 95% CI: 0.7–1.7), disorders of lipid metabolism (AOR: 0.9, 95% CI: 0.5–1.6), or HTN (AOR: 1.3, 95% CI: 1.0–1.8).	++
41	Golding JM (1994)	1,610 F Mean age: 40	Cross-sectional representative survey of adults in Los Angeles, CA, US	Retrospective assessment of sexual assault	Lifetime experience of sexual assault including forced touching or intercourse	Self-reported heart disease or HTN	Lifetime history of heart disease and HTN	No significant associations between sexual assault and heart disease (AOR: 1.6, p–value=0.06) or HTN (AOR: 1.2, p–value=0.28).	+
39	Sparrenberger F (2008)	1,474 M/F 59% F Mean age: 49	Cross-sectional representative survey of adults in Porto Alegre, Brazil	Retrospective assessment of physical violence	Any type of physical violence experienced in the past year perpetrated by any person	Measured blood pressure	HTN was defined as blood pressure above 140/90 mmHg or use of blood pressure lowering medication	Adjusted analyses showed no significant associations between physical violence and HTN in either men (AOR: 0.3, 95% CI: 0.1–1.1) or women (AOR: 0.7, 95% CI: 0.2–3.0).	++
43	Ruiz-Perez, I (2007)	1,402 F Mean age: 39	Cross-sectional study of women attending family practices in Spain	Retrospective assessment of IPV	Current (past year) and past IPV (physical, psychological or sexual abuse by a partner) in 4 combinations of (psychological only, psychological and physical, psychological and sexual, all 3 types); duration of abuse recorded as no abuse, 1 month–1 year, >1 year	Self-reported HTN	Self-reported HTN	No association between any lifetime IPV and HTN (AOR: 1.0, 95% CI: 0.6–1.7) or between specific combinations of IPV and HTN.	+
40	Gass JD (2010)	1,229 F Age >18	Cross-sectional nationally-representative sample of adults in South Africa	Retrospective assessment of physical IPV	Physical IPV by current or most recent intimate partner	Self-reported stroke, MI, heart disease, and high BP	Stroke or MI in past 12 months; heart disease or high BP ever	IPV was not significantly associated with MI (AOR: 1.8, 95% CI: 1.0–3.3), stroke (AOR: 1.3, 95% CI: 0.6–2.8), high BP (AOR: 1.5, 95%CI: 1.0–2.2), or heart disease (AOR: 1.2, 95% CI: 0.7–2.2).	+
42	Lown EA (2001)	1,155 F Mean age: 32	Cross-sectional representative survey of Mexican Americans living in Fresno County, CA, USA	Retrospective assessment of IPV	Physical or sexual IPV by a current partner in past 12 months	Self-reported high BP, MI and other serious heart trouble	MI or serious heart trouble, or high BP in the past 12 months	Physical/sexual IPV was associated with MI (AOR: 17.0, 95% CI: 4.3–66.7) but not high BP (AOR: 0.9, 95% CI: 0.3–2.8).	+
30	Coker AL (2000)	1,152 F 44% 40 yo	Cross-sectional study of women attending family practice clinics in SC, USA	Retrospective assessment of IPV	Any experience of physical or sexual violence with or without psychological abuse by intimate partner; psychological abuse without any physical/sexual violence by intimate partner	Self-reported CV events or problems	Physician-diagnosed MI, stroke, HTN, angina, other heart or circulatory problems	Physical/sexual violence associated with angina (AOR: 2.0, 95% CI: 1.2–3.5) and other heart or circulatory problems (AOR: 1.5, 95% CI: 1.0–2.2) but not with HTN (AOR: 1.0, 95% CI: 0.8–1.3). Psychological abuse was not significantly associated with any CV outcome.	+

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Ref No.	First Author (Year)	Sample Size/ Gender/Age	Study Design/ Setting	Retrospective/ Prospective Exposure Assessment	Exposure Measurement	Self-report/ Measured Outcome Assessment	Outcome Measure	Results	Evidence Grade
36	Keyes KM (2013)	1,054 M/F 53% F Mean age: 44	Population-based cohort of adults in Detroit, MI, USA	Retrospective assessment of assaultive violence	Assaultive violence included any experience of rape, other sexual assault, being shot, stabbed, held captive, tortured, kidnapped, mugged, held up, threatened with a weapon, or badly beaten up	Self-reported CVD	CVD included physician-diagnosed HTN, MI, stroke, chest pain, congestive heart failure	Assaultive violence was not associated with CVD (OR: 1.0, 95% CI: 0.7–1.3).	+
31	Newton TL (2005)	39 F Mean age: 51	Cross-sectional study	Retrospective assessment of lifetime victimization	Lifetime victimization severity score includes robbery, child physical abuse, stalking or threatening behavior, adult sexual or physical assault as well as other crime victimization	Measured BP and heart rate	Ambulatory BP and heart rate over an average 18 hours	Lifetime victimization severity was associated with heart rate variability.	+

Abbreviations: AIRR: Adjusted incident rate ratio, AHR: Adjusted hazard ratio, AOR: Adjusted odds ratio, BP: Blood pressure, CAD: Coronary artery disease, CHD: Coronary heart disease, CTS: Conflict Tactics Scales, CV: Cardiovascular, CVD: Cardiovascular disease, DBP: Diastolic blood pressure, HbA1C: Hemoglobin A1c, HDL: High density lipoprotein, HR: Hazard ratio, HRT: Heart rate, HRV: Heart rate variability, HTN: Hypertension, IHD: Ischemic heart disease, IPV: Intimate partner violence, MI: Myocardial infarction (heart attack), OR: Odds ratio, R-CTS: Revised Conflict Tactics Scale, SBP: Systolic blood pressure, TIA: Transient ischemic attack, VA: Veteran's Administration, VAW: Violence against woman