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Effects of exposure to violence with a weapon during adolescence on adult hypertension

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Abstract

Objectives—Examine the longitudinal associations between exposure to violence with a weapon during the past year among adolescents and hypertension during adulthood, including the extent to which adult cardiovascular risk factors mediated the association.

Methods—Secondary analysis of the National Longitudinal Study of Adolescent Health, 1994–2008. The sample included 3555 male and 4416 female adults who were aged 11 to 17 years at wave 1 (1994–1995). Participants were categorized as hypertensive if they had a mean systolic blood pressure ≥ 140 mmHg or a mean diastolic pressure ≥ 90 mmHg at wave 4 (2008). Witnessed violence with a weapon was defined as having seen a shooting or stabbing during the year prior to wave 1 while victim of violence with a weapon was defined as having been shot, cut or stabbed, or had a gun or knife drawn on them during the year prior to wave 1. Potential mediators of adult cardiovascular risk (wave-4) included body mass index, daily smoking, alcohol abuse, and depression.

Results—Males who witnessed violence and females who were victims of violence in the year prior to wave 1 had an increased odds of hypertension at wave 4 compared to their unexposed peers (AOR=1.45, 95% CI=1.003, 2.10; AOR=1.72, 95% CI=1.04, 2.84, respectively). The hypothesized adult cardiovascular risk mediators did not significantly attenuate the associations for either the male or female samples.

Conclusions—Interventions addressing prior violence exposure are needed to promote adult cardiovascular health.

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Keywords

exposure to violence; hypertension; adverse childhood experiences; witnessed violence; victimization

The proportion of U.S. youth exposed to serious acts of physical violence in their family and/or community is substantial and continues to be a significant public health concern. [1] The most recent national survey in 2011 found that 22% of children and adolescents had witnessed some form of violence during the previous year with the rates of reported exposure increasing significantly with age. [2] Specifically, nearly 43% of adolescents aged 14–17 years had witnessed violence during the previous year and of these, 10% witnessed an assault in their family, 36% an assault in the community, and 8% either heard or witnessed a shooting occur. [2] The survey also found high rates of direct victimization in which 43% of children and youth reported that had been physically assaulted during the prior year. Exposure to serious physical violence was highest among adolescents aged 14 to 17 years as 15% of adolescents in this age-group reported they had been physically assaulted with a weapon during the previous year. [2]

A host of studies [3–11] has indicated significant psychosocial and behavioral complications (e.g. post-traumatic stress disorder [PTSD], depression, substance use, externalizing behaviors) occur among adolescents who have been witnesses or victims of violence. However, research on the effects of violence exposure on physical health outcomes is more limited, though cross-sectional findings suggest a cardiovascular link. [12–13] Specifically, Wilson et al. found that black/African American adolescents who were victims or witnesses of violence during the previous year were less likely than their unexposed peers to experience a decrease in nighttime blood pressure as is expected with the normative diurnal variation. [12] The lack of a nocturnal decline in blood pressure, also known as non-dipping, is a recognized risk factor for cardiovascular disease. [14] In subsequent study that examined gender differences among black/African American adolescents, the researchers found that both male and female victims of violence were more likely than those who had not been victimized to be non-dippers. [13] However, no significant difference in nighttime dipping status were found between adolescents who witnessed serious violence and those who were unexposed, but males who had *heard* about serious violence were more likely than their female counterparts to be non-dippers. [13] Although the sample size was small (N=56), the findings suggest that males and females may have different responses to more indirect violence exposure.

The findings of these studies support the need for longitudinal research to examine the associations between exposure to violence during adolescence and cardiovascular health in adulthood. Life course models posit that exposure to adverse events, particularly during childhood and adolescence can have a deleterious effect on adult health through either the accumulation of adversity over time or through an exposure that occurs during a critical or sensitive developmental period. [15–16] Prior research related to direct victimization supports the theory as adult women who were sexually abused or severely abused physically during childhood were found to have an increased likelihood of hypertension [17] and

serious cardiovascular events (e.g. myocardial infarction, stroke). [18] Furthermore, others found that exposure to a greater number of adverse life events before aged 18 years (e.g. physical, sexual and emotional abuse; neglect, witnessed domestic violence, parental divorce, mental illness/substance use in household, incarcerated household member) was associated with an increased likelihood of cardiovascular disease in adulthood. [19–20] Thus, the purpose of this study is to examine the longitudinal associations between exposure to serious physical violence with a weapon (witnessed and victimization) during the past year among male and female adolescents aged 11 to 17 years and hypertension during adulthood. Furthermore, because prior research [21–25] found that exposure to adverse life events during childhood or adolescence was associated with cardiovascular risk factors during adulthood (e.g. smoking, alcohol abuse, obesity, and psychosocial distress), we also examined the extent to which these risk factors mediated the associations between exposure to violence and adult hypertension.

Methods

Study Design and Sample

We analyzed secondary data from the National Longitudinal Study of Adolescent Health (Add Health) – a school-based longitudinal study designed to examine the multiple contexts of health and well-being from adolescence to adulthood. [26–27] Add Health incorporated a multistage, stratified, and clustered sampling design to ensure a nationally representative sample of US schools with respect to region of country, urbanicity, school size, school type, and ethnicity. The first wave of data was collected in 1994–1995 when participants were in the 7th–12th grade. The participants were then re-interviewed in 1996 (wave-2), 2001–2002 (wave-3) and 2007–2008 (wave-4). [27] The overall unweighted response rate was 80.3%; analyses from Add Health indicated the bias from non-response was negligible and that participants in wave-4 were representative of those from wave-1. [28]

The sample for this study was comprised of those respondents who participated in all 4 waves of the Add Health data collection (N= 9421). Inclusion criteria required participants to be aged less than 17 years at wave-1 to capture adverse childhood experiences and to have complete data for the second and third blood pressure readings at wave-4 (N=8467). The sample was gender-stratified for analysis (male N=3797; female N=4670) due to prior research suggesting gender differences in physiological responses to violence. [13] Participants missing data on measures of interest were listwise deleted (male N=242 or 6.4%; female N=254 or 5.4%). Analyses found no significant differences in hypertension or violence exposures between those who were excluded due to missing data and those included in the analyses for either sample. The final samples were comprised of 3555 males and 4416 females.

Measures

Dependent Variable

Hypertension: Trained field interviewers measured the respondent's arm circumference to determine the appropriate blood pressure cuff size. [29] An adult cuff was selected for respondents whose arm circumference was <13 cm and a large adult cuff for those 13–16

cm. Adults whose arm circumference was >16 cm were measured with the large adult cuff when possible, and the record was flagged (n=111). Field interviewers measured respondents' resting, seated systolic and diastolic blood pressures three times with 30-second intervals between measures using the factory calibrated, Microlife BP3MC1-PC-IB oscillometric blood pressure monitor (MicroLife USA, Inc.; Dunedin, FL) approved by the British Hypertension Society. [29] The second and third blood pressure measurements were averaged to create a single measure for this study. Participants were categorized as having hypertension if their measured mean systolic blood pressure was 140 mmHg or higher or their diastolic pressure was 90 mmHg or higher.

Primary Independent Variables of Interest

Witness of Violence with a Weapon during Past 12 Months, Wave 1: During the in-home interview, participants were asked one question about witnessing physical violence – “how often during the past 12 months did the following things happen”... “you saw someone stab or shoot another person.” Response options included never, once, or more than once. The measure for witnessed violence was dichotomized for this study due to the small proportion of adolescents who responded more than once (see Table 1).

Victim of Violence with a Weapon during Past 12 Months, Wave 1: During the in-home interview, participants were asked 3 separate questions about victimization with a gun or knife during the past 12 months. Specifically, “how often during the past 12 months did the following things happen...” – “someone pulled a knife or gun on you”, “someone shot you” or “someone cut or stabbed you?” Response options included never, once, or more than once. Consistent with the rationale for the measurement of witnessed violence (see Table 1), adolescents who responded they were victimized to any of the items one or more times during the past 12 months were categorized as “yes” to being a victim of violence with a weapon.

Potential Mediating Variables—Cardiovascular risk factors known to be associated with exposure to violence and hypertension were examined as potential mediators of the associations between having violence exposure and hypertension. [21–25] These measures included *body mass index* (BMI= weight (kg)/height (m²) with BMI categories as underweight [16.5 to <18.5], normal weight [18.5 to <25], overweight [25 to <30] and obese [30 and higher]); *daily cigarette smoker*; *alcohol abuse* (continuous measure of DSM IV alcohol abuse symptoms, range 0–4) and *depression* (continuous measure of the Center for Epidemiologic Studies Depression Scale on how often the following 5 items occurred in the past week – “bothered by things”, “can’t shake off the blues”, depressed, trouble focusing, “felt sad”, range 0–15).

Control Variables—Sociodemographic and health-related factors known to be associated with violence exposure and/or hypertension were included in the analysis as control variables. Measures were self-reported and created using items from the wave-1 in-home interview, wave-1 parent questionnaire and the wave-4 in-home interview. Wave-1 measures included: *race-ethnicity* (black/African American, Hispanic, Asian/Pacific Islander, multiracial, ‘other’ or white); *foreign birth*; *age in years*; *lived in a two parent*

household; parental public assistance (received food stamps, housing assistance or Aid to Families with Dependent Children in the past year); *parental education* (college degree or more); *level of general health* (range from poor=1 to excellent=5); and *violence perpetration* (respondent pulled a knife or gun, shot or stabbed someone in the prior 12 months). Wave-4 measures included: *currently married*; two measures of *economic hardship* – (1) public assistance (on public assistance, welfare payments, or food stamps between waves 3 and 4) and (2) trouble paying bills in prior year (respondent/household had trouble paying rent/mortgage, trouble paying gas/electric/oil bills, no phone service due to inability to pay, or worried about running out of money for food); *college degree* (bachelor degree or higher); *blood pressure cuff too small* (interviewer reported); *resting heart rate*; and *currently pregnant* (for female respondents only). In addition, a measure of *current antihypertensive medication use* was included in the analysis. Add Health interviewers visually inspected and entered all the prescription medications participants used during the previous 4 weeks into Lexicon Plus™ (Lexi-Comp®, Inc.; Hudson, OH) to categorize medication type. Consistent with prior research [30], participants who took beta blockers, thiazide diuretics, ace-inhibitors, anti-adrenergics (peripherally and centrally acting), calcium channel blockers, vasodilators, AT2 receptor blockers or a combination antihypertensive were categorized as currently on antihypertensive medication.

Analysis

Descriptive analyses were conducted to better understand the characteristics of the study samples. Multivariable logistic regression analyses examined the relationships between exposure to violence with a weapon (witnessed and victimization) during the past year among adolescents aged 11 to 17 years and hypertension during adulthood, including the extent to which adult cardiovascular risk factors mediated the association. All analyses were weighted and adjusted for the complex survey design using SAS survey procedures, version 9.2 (SAS Institute, Cary, NC). Analyses were gender-stratified because of known differences in hypertension awareness and treatment between men and women [31] and potential differences in response to violence exposure [13]. Multicollinearity was assessed prior to multivariable analyses; tolerance and variance inflation factors were within normal limits. Two models, adjusted for the control variables, were analyzed for each of the gender-stratified samples. In model 1, hypertension was regressed on the exposure to violence measures (victim and witness). In model 2, hypertension was regressed on the exposure to violence measures (victim and witness) and the potential mediating cardiovascular risk factors. Model 2 was then compared to model 1 to examine potential attenuation of the exposure to violence effects on hypertension.

Results

Sample characteristics are presented in Table 2. Approximately 12% of male and 9% of female adolescents aged 11 to 17 years at wave-1 reported they had witnessed at least one shooting or stabbing during the past year. With respect to victimization, nearly 19% of male and 8% of female adolescent aged 11 to 17 years at wave-1 had a gun or knife pulled on them, been cut or stabbed, and/or been shot during the past year. At wave-4, 25% of the

males and 10.5% of the females had hypertension. Proportions and means for the potential mediating and control measures are depicted in Table 2.

Table 3 presents the findings of the multivariable logistic regression analyses, stratified by gender, on the associations between violence exposure (witness and victim) during adolescence and hypertension during adulthood, including the mediating associations of the cardiovascular risk factors. For the male sample, in model 1 we found that male adolescents aged 11 to 17 years who had witnessed violence with a weapon in the year prior to wave-1 (1994–1995) had an increased odds of hypertension at wave-4 (2008) compared to their unexposed peers (AOR=1.43, 95% CI=1.002, 2.04). The inclusion of the cardiovascular factors in model 2 did not significantly attenuate the strength of the association between having witnessed violence at wave-1 and adult hypertension (AOR=1.44, 95% CI=1.01, 2.05). No significant associations in either model between violence victimization and hypertension were found among the male sample (AOR=1.01, 95% CI=0.72, 1.41; AOR=1.00, 95% CI=0.71, 1.41, respectively).

For the female sample, in model 1 we found no significant association among female adolescents aged 11 to 17 years who had witnessed violence with a weapon in the year prior to wave-1 and adult hypertension at wave 4 (AOR 0.67, 95% CI=0.39, 1.15). In contrast, adolescent females aged 11 to 17 years who had been victimized in the year prior to wave-1 had a significantly increased odds of hypertension during adulthood (AOR=1.75, 1.07, 2.86). Consistent with the male sample, the inclusion of the cardiovascular factors in model 2 did not significantly attenuate the strength of the association between victimization at wave-1 and adult hypertension (AOR=1.73, 95% CI=1.04, 2.85).

Discussion

The results of this study suggest that exposure to violence with a weapon at least once during adolescence increases the likelihood of hypertension during adulthood for both males and females. Specifically, male adolescents who had witnessed violence with a weapon and female adolescents who were victims of violence with a weapon during the year prior to the wave-1 Add Health interview were found to have an increased odds of hypertension during adulthood. The findings are in accordance with previous cross-sectional research on the relationships between exposure to serious physical violence and blood pressure irregularities among adolescents [12,13] as well as the growing body of literature on the deleterious effects of earlier life adversity on adult cardiovascular health. [15–25] However, the adult cardiovascular risk factors – smoking, alcohol abuse, obesity and depression that we examined as potential mediators in the analysis did not attenuate the effects of short-term violence exposure (prior year) during adolescence on the likelihood of adult hypertension. Measurement error due to under-reporting of risk behaviors could account for these findings, but they also suggest other mechanisms may play a role. For example, prior research found that PTSD increased the likelihood of hypertension among adult war veterans [32–33] and non-veterans who experienced a traumatic event (e.g. 9/11). [34–35] The disorder is thought to contribute to hypertension through the dysregulation of the neuroendocrine pathway, particularly when symptoms are prolonged or recurrent. [36–37] The repeated release of catecholamines in response to the associated chronic stress suppresses the beta-adrenergic

receptors in the heart and the peripheral vasculature, which consequently increases peripheral vascular resistance and blood pressure. [36–37] Further research exploring the biopsychosocial pathways through which exposure to violence contributes to future hypertension is needed, including genetic, psychosocial (e.g. social support) and environmental factors that could moderate the deleterious effects of violence exposure on the cardiovascular system, and serve as potential targets for intervention.

Our study also found that the effects of violence exposure during adolescence on adult hypertension differed for the male and female samples as males were more likely to experience hypertension after witnessing violence and females after direct victimization. Although Wilson et al. [13] found that both male and female black/African American adolescents who were victims of violence were more likely to experience non-dipping of nighttime blood pressure, they also found that the male adolescents who had heard about violence occurring in their community had higher daytime levels of epinephrine as well as non-dipping of nighttime blood pressure compared to their female counterparts. Further research exploring the reasons underlying these findings is needed, including potential gender differences in the context of the violence. For example, gender differences in adolescents' emotional proximity to the perpetrator of the violence or the victim of witnessed violence (e.g., family member, close friend, stranger, or acquaintance) may affect threat appraisals and fear of repeated violence in the future as well as coping responses [4]. According to prior research, female adolescents were more likely than male adolescents to report PTSD or depression symptoms in response to having witnessed parental or community violence [3, 39] as well as PTSD after violent victimization. [39] However, these gender differences in symptom prevalence may be due to male underreporting as others have found that male adolescents were more likely to deny traumatic symptoms after experiencing a violent crime compared to their female counterparts. [38] Boys may be less likely to communicate about experiences of witnessing violence (vs. violent victimization), in particular, if they are not felt to warrant a traumatic response – potentially leading to long-term impact.

Several limitations to this study warrant further discussion. First, the measured hypertension rates of the young adults in the Add Health study are considerably higher than those found in young adults in the 2007–2008 National Health and Nutrition Examination survey (19% vs 4.6%) [30, 40]. In investigations of the disparate findings, the differences were not explained by low validity or reliability of the blood pressure data or significant variation in participant selection, measurement or interview context. However, the researchers hypothesize that the different methodologies to collect the blood pressure data (e.g. automatic oscillometric monitor versus sphygmomanometry) and their different sampling frames and composition (e.g. school-based longitudinal sample of adolescents versus community-based cross-sectional sample of adults) may account for the disparate results. Second, Add Health collected blood pressure data at wave-4 only, thus blood pressure change could not be assessed. In addition, violence exposure measures were limited to those occurring only in the prior year, thus cumulative measures of exposure to violence during childhood and adolescence could not be captured and the effects of violence exposure on hypertension may be underestimated. Although many of the Add Health participants were 17 years of age or younger at wave-2 of the data collection, less than a year had passed

between waves for the majority precluding reliable measurement of repeated exposures. Third, Add Health is a school-based study, thus adolescents who were not enrolled in school at wave-1 and potentially of greater risk to be exposed to violence were not included in the study. However, future waves did include adolescents who dropped out of school in between waves.

Despite these limitations, this study is among the first to find an increased likelihood of hypertension during adulthood among males and females who were exposed to violence with a weapon at least once during adolescence. The findings support the need for further research to better understand the mechanisms underlying this relationship, including social, environmental and biological factors that could buffer or amplify the effect. More imperatively, the findings illustrate that exposure to serious violence can have a lasting deleterious effect on cardiovascular health and potentially lead to greater morbidity and mortality earlier in the life course. Screening adolescents at preventive visits about prior violence exposure should be considered, including appropriate referrals and follow-up for identified youth. Furthermore, public health research and practice targeting violence prevention is needed for the promotion of cardiovascular health across the life course.

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Abbreviations

Add Health	National Longitudinal Study of Adolescent Health
BMI	Body mass index
PTSD	Post traumatic stress disorder
SE	Standard error
AOR	Adjusted odds ratio
CI	Confidence interval

References

1. U.S. Department of Health and Human Services. [Accessed March 31, 2013] Healthy People 2020: Injury and Violence Prevention. Available at: <http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=24>
2. Finkelhor D, Turner HA, Shattuck A, Hamby SL. Violence, crime, and abuse exposure in a national sample of children and youth: an update. *JAMA Pediatr.* 2013; 167:614–21. [PubMed: 23700186]

3. Zinzow HM, Ruggiero KJ, Resnick H, et al. Prevalence and mental health correlates of witnessed parental and community violence in a national sample of adolescents. *J Child Psychol Psychiatry*. 2009; 50:441–50. [PubMed: 19220624]
4. Lambert SF, Boyd RC, Cammack NL, Ialongo NS. Relationship proximity to victims of witnessed community violence: associations with adolescent internalizing and externalizing behaviors. *Am J Orthopsychiatry*. 2012; 82:1–9. [PubMed: 22239388]
5. Buka SL, Stichick TL, Birdthistle I, Earls FJ. Youth exposure to violence: prevalence, risks, and consequences. *Am J Orthopsychiatry*. 2001; 71:298–310. [PubMed: 11495332]
6. Mrug S, Windle M. Prospective effects of violence exposure across multiple contexts on early adolescents' internalizing and externalizing problems. *J Child Psychol Psychiatry*. 2010; 51:953–61. [PubMed: 20331489]
7. Mrug S, Windle M. Initiation of alcohol use in early adolescence: links with exposure to community violence across time. *Addict Behav*. 2009; 34:779–81. [PubMed: 19442452]
8. Ramirez M, Wu Y, Kataoka S, et al. Youth violence across multiple dimensions: a study of violence, absenteeism, and suspensions among middle school children. *J Pediatr*. 2012; 161:542–546. [PubMed: 22521110]
9. Ruchkin V, Vermeiren R, Schwab-Stone M, Deboutte D, Leckman PE. Violence exposure and substance use in adolescents: Findings from three countries. *Pediatrics*. 2003; 111:535–540. [PubMed: 12612233]
10. Boynton-Jarrett R, Hair E, Zuckerman B. Turbulent times: Effects of turbulence and violence exposure in adolescence on high school completion, health risk behavior, and mental health in young adulthood. *Soc Sci Med*. Epub ahead of print.
11. Patchin JW, Huebner BM, McCluskey JD, Varano SP, Bynum TS. Exposure to community violence and childhood delinquency. *Crime & Delinquency*. 2006; 52:307–332.
12. Wilson DK, Kliwer W, Teasley N, et al. Violence exposure and ambulatory blood pressure in African-American adolescents. *Int J Rehabil Health*. 1998; 4:223–232.
13. Wilson DK, Kliwer W, Teasley N, Plybon L, Sica DA. Violence exposure, catecholamine excretion, and blood pressure nondipping status in African American male versus female adolescents. *Psychosom Med*. 2002; 64:906–15. [PubMed: 12461196]
14. Yano Y, Kario K. Nocturnal blood pressure and cardiovascular disease: a review of recent advances. *Hypertens Res*. 2012; 35:695–701. [PubMed: 22378470]
15. Elder, GH.; Johnson, MK.; Crosnoe, R. The emergence and development of life course theory. In: Mortimer, J.; Shanahan, MJ., editors. *Handbook of the Life Course*. New York: Kluwer; 2003. p. 3-19.
16. Shonkoff JP, Garner AS. Committee on Psychosocial Aspects of Child and Family Health; Committee on Early Childhood, Adoption, and Dependent Care; Section on Developmental and Behavioral Pediatrics. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*. 2012; 129:e232–46. [PubMed: 22201156]
17. Riley EH, Wright RJ, Jun HJ, Hibert EN, Rich-Edwards JW. Hypertension in adult survivors of child abuse: observations from the Nurses' Health Study II. *J Epidemiol Community Health*. 2010; 64:413–8. [PubMed: 20445210]
18. Rich-Edwards JW, Mason S, Rexrode K, et al. J. Physical and sexual abuse in childhood as predictors of early-onset cardiovascular events in women. *Circulation*. 2012; 126:920–7. [PubMed: 22787111]
19. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: the adverse childhood experiences (ACE) study. *Am J Prev Med*. 1998; 14:245–258. [PubMed: 9635069]
20. Dong M, Giles WH, Felitti VJ, et al. Insights into causal pathways for ischemic heart disease: Adverse Childhood Experiences Study. *Circulation*. 2004; 110:1761–1766. [PubMed: 15381652]
21. Ford ES, Anda RF, Edwards VJ, et al. Adverse childhood experiences and smoking status in five states. *Prev Med*. 2011; 53:188–93. [PubMed: 21726575]
22. Anda RF, Croft JB, Felitti VJ, et al. Adverse childhood experiences and smoking during adolescence and adulthood. *JAMA*. 1999; 282:1652–1658. [PubMed: 10553792]

23. Dube SR, Anda RF, Felitti VJ, Edwards VJ, Croft JB. Adverse childhood experiences and personal alcohol abuse as an adult. *Addict Behav.* 2002; 27:713–725. [PubMed: 12201379]
24. Williamson DF, Thompson TJ, Anda RF, Dietz WH, Felitti VJ. Body weight, obesity, and self-reported abuse in childhood. *Int J Obes.* 2002; 26:1075–1082.
25. Chapman DP, Anda RF, Felitti VJ, Dube SR, Edwards VJ, Whitfield CL. Adverse childhood experiences and the risk of depressive disorders in adulthood. *J Affect Disord.* 2004; 82:217–225. [PubMed: 15488250]
26. Harris, KM. The National Longitudinal Study of Adolescent Health (Add Health), Waves I & II, 1994–1996; Wave III, 2001–2002; Wave IV, 2007–2009 [machine-readable data file and documentation]. Chapel Hill, NC: Carolina Population Center, University of North Carolina at Chapel Hill; 2009.
27. Harris, KM.; Halpern, CT.; Whitsel, E., et al. [Accessed March 15, 2013] The National Longitudinal Study of Adolescent Health: Research Design. Available at: <http://www.cpc.unc.edu/projects/addhealth/design>
28. Brownstein, N.; Kalsbeek, WD.; Tabor, J.; Entzel, P.; Daza, E.; Harris, KM. [Accessed March 15, 2013] Non-Response in Wave IV of the National Longitudinal Study of Adolescent Health. Available at: <http://www.cpc.unc.edu/projects/addhealth/data/guides/>
29. Entzel, P.; Whitsel, EA.; Richardson, A.; Tabor, J.; Hallquist, S.; Hussey, J.; Halpern, CT.; Harris, KM. [Accessed March 15, 2013] Add Health Wave IV Documentation Report - Cardiovascular and Anthropometric Measures. Available at: <http://www.cpc.unc.edu/projects/addhealth/data/guides/>
30. Nguyen QC, Tabor JW, Entzel PP, Lau Y, Suchindran C, Hussey JM, Halpern CT, Harris KM, Whitsel EA. Discordance in national estimates of hypertension among young adults. *Epidemiology.* 2011; 22:532–541. [PubMed: 21610501]
31. Yoon SS, Burt V, Louis T, Carroll MD. Hypertension among adults in the United States, 2009–2010. *NCHS Data Brief.* 2012; 107:1–8. [PubMed: 23102115]
32. Abouzeid M, Kelsall HL, Forbes AB, Sim MR, Creamer MC. Posttraumatic stress disorder and hypertension in Australian veterans of the 1991 Gulf War. *J Psychosom Res.* 2012; 72:33–8. [PubMed: 22200520]
33. Paulus EJ, Argo TR, Egge JA. The impact of posttraumatic stress disorder on blood pressure and heart rate in a veteran population. *J Trauma Stress.* 2013; 26:169–72. [PubMed: 23371434]
34. Holman EA, Silver RC, Poulin M, Andersen J, Gil-Rivas V, McIntosh DN. Terrorism, acute stress, and cardiovascular health: a 3-year national study following the September 11th attacks. *Arch Gen Psychiatry.* 2008; 65:73–80. [PubMed: 18180431]
35. Gerin W, Chaplin W, Schwartz JE, et al. Sustained blood pressure increase after an acute stressor: the effects of the 11 September 2001 attack on the New York City World Trade Center. *J Hypertens.* 2005; 23:279–84. [PubMed: 15662215]
36. Bedi US, Arora R. Cardiovascular manifestations of posttraumatic stress disorder. *J Natl Med Assoc.* 2007; 99:642–9. [PubMed: 17595933]
37. Coughlin SS. Post-traumatic stress disorder and cardiovascular disease. *Open Cardiovasc Med J.* 2011; 5:164–70. [PubMed: 21792377]
38. McCart MR, Davies WH, Harris R, Wincek J, Calhoun AD, Melzer-Lange MD. Assessment of trauma symptoms among adolescent assault victims. *J Adolesc Health.* 2005; 36:70 e7–13. [PubMed: 15661600]
39. McGee ZT, Davis BL, Brisbane T, et al. Urban stress and mental health among African-American youth: assessing the link between exposure to violence, problem behavior, and coping strategies. *J Cult Divers.* 2001; 8:94–104. [PubMed: 11855219]
40. Chyu L, McDade TW, Adam EK. Measured blood pressure and hypertension among young adults: A comparison between two nationally representative samples. *Biodemography Soc Bio.* 2011; 57:184–199. [PubMed: 22329087]

Table 1

Proportion of adolescents aged 11 to 17 years exposed to violence with a weapon during the year prior to wave 1, The National Longitudinal Study of Adolescent Health, 1994–2008

	Male sample % (n)	Female sample % (n)
Witness of Violence with a Weapon		
Adolescent witnessed shooting or stabbing past year, W1		
Never	88.0 (3081)	91.2 (4001)
Once	8.6 (330)	6.7 (318)
More than once	3.4 (144)	2.1 (97)
Victim of Violence with a Weapon		
Someone pulled a knife or gun on adolescent past year, W1		
Never	83.5 (2941)	93.9 (4145)
Once	12.4 (470)	5.4 (234)
More than once	4.1 (144)	0.7 (37)
Someone shot adolescent past year, W1		
Never	98.2 (3493)	99.7 (4400)
Once	1.6 (47)	0.3 (14)
More than once	0.2 (15)	0.1 (2)
Someone cut or stabbed adolescent past year, W1		
Never	94.2 (3336)	97.0 (4277)
Once	5.3 (195)	2.7 (125)
More than once	0.5 (24)	0.3 (14)

Table 2

Characteristics of the male and female samples via weighted proportions and means, National Longitudinal Study of Adolescent Health, 1994–2008

	Males (N=3555)	Females (N=4416)
	% (n)	% (n)
Outcome variable		
Hypertension, W4	25.0 (887)	10.5 (463)
Predictor variables of interest		
Adolescent 11–17 yrs witnessed violence past 12 months, W1	12.0 (474)	8.8 (415)
Adolescent 11–17 yrs victim of violence past 12 months, W1	18.8 (704)	8.0 (354)
Potential Mediators: Cardiovascular Risk Factors		
BMI categories, W4		
Underweight	1.0 (26)	2.2 (95)
Overweight	33.9 (1231)	24.9 (1148)
Obese	34.3 (1234)	36.5 (1604)
Normal weight	30.8 (1064)	36.4 (1569)
Daily smoking, W4	27.1 (847)	21.4 (817)
Number alcohol abuse symptoms, W4, mean (SE), range 0–4	0.6 (0.03)	0.3 (0.02)
Depression, W4 mean (SE), range 0–15	2.3 (0.06)	2.8 (0.06)
Control variables		
Race and ethnicity		
Black-African American	13.3 (601)	15.0 (924)
Hispanic	11.7 (548)	11.3 (631)
Asian-Pacific Islander	3.1 (215)	2.6 (207)
Multiracial	3.3 (134)	3.0 (176)
‘Other’	1.4 (45)	1.0 (50)
White	67.3 (2012)	67.1 (2428)
Foreign birth, W1	4.7 (234)	4.9 (267)
Age in years, W1, mean (SE), range 11–17 years	14.9 (0.11)	14.8 (0.10)
Two parent household, W1	58.0 (2059)	58.0 (2467)
Public assistance, W1	17.8 (566)	17.5 (789)
Parent college degree or more, W1	25.1 (977)	23.2 (1114)
Adolescent general health, W1, mean (SE), range 1–5	4.0 (0.02)	3.8 (0.02)
Adolescent perpetrator of violence past 12 months, W1	6.4 (227)	2.4 (114)
Currently married, W4	34.2 (1269)	41.9 (1853)
College degree or more, W4	30.1 (1127)	36.2 (1706)
Economic hardship, W4		
Public assistance	17.0 (548)	28.0 (1151)
Trouble paying bills	20.7 (694)	26.0 (1099)
Currently pregnant, W4	NA	6.8 (302)
Inappropriate cuff size, W4	1.0 (40)	0.6 (35)

	Males (N=3555)	Females (N=4416)
	% (n)	% (n)
Antihypertensive medication use, W4	2.2 (75)	2.4 (100)
Resting heart rate, W4, mean, (SE), range 40–143	72.2 (0.28)	75.9 (0.26)

Table 3

Multivariable weighted logistic regression of the associations between exposure to violence with a weapon in the prior year among adolescents aged 11–17 years and hypertension during adulthood, National Longitudinal Study of Adolescent Health, 1994–2008 ^a

Predictor variables of interest	Males (N=3555)			Females (N=4416)		
	Model 1		Model 2		Model 1	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
Adolescent witnessed violence past year, W1	1.43	(1.002, 2.04)*	1.44	(1.01, 2.05)*	0.67	(0.39, 1.15)
Adolescent victim of violence past year, W1	1.01	(0.72, 1.41)	1.00	(0.71, 1.41)	1.75	(1.07, 2.86)*
Cardiovascular Risk Mediators						
BMI category, W4						
Underweight			1.04	(0.40, 2.71)		0.03
Overweight			1.74	(1.29, 2.33)*		1.69
Obese			2.41	(1.80, 3.23)*		2.58
Normal weight (ref)			1.00			1.00
Daily smoker, W4			1.21	(0.94, 1.56)		1.21
Alcohol abuse symptoms, W4			1.14	(1.02, 1.27)*		1.05
Depression, W4			0.98	(0.93, 1.02)		0.99

^a All models adjusted for control variables – wave 1 race-ethnicity, foreign birth, age, lived with two parents, parental economic hardship, parental college education, adolescent overall general health and wave 4 blood pressure cuff size too small, heart rate, antihypertensive medication use, marital status, economic hardship and college degree.

AOR= adjusted odds-ratio CI=confidence interval

* p<.05