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Associations between childhood maltreatment and risk of myocardial infarction in adulthood: Results from the National Epidemiologic Survey on alcohol and Related Conditions

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ABSTRACT

Objective: Although childhood maltreatment has been reported to be associated with the incidence of cardiovascular diseases, its association with specific major cardiovascular events remains unclear. This study aimed to examine the relationship between different types of childhood maltreatment (CM) and myocardial infarction (MI) occurrence in a nationally representative sample.

Methods: We used data from the National Epidemiologic Survey of Alcohol and Related Conditions, a nationally representative US sample of adults aged 20 years and older (N = 34, 653). Logistic regression models were constructed to investigate the associations between five types of CMs including physical abuse, physical neglect, emotional abuse, emotional neglect, and sexual abuse and the risk of MI adjusting for sociodemographic variables.

Results: After adjusting for sociodemographic variables, childhood sexual abuse was significantly associated with increased odds of MI occurrence (adjusted odds ratio [aOR] = 1.85, 95%CI = 1.24–2.76, p = 0.003). Additionally, childhood physical abuse was significantly associated with increased odds of MI occurrence in men (aOR = 2.45, 95%CI = 1.35–4.44, p = 0.004) but this association was not observed in women (aOR = 0.72, 95%CI = 0.32–1.66, p = 0.440). Compared to those who did not experience CM, those who experienced more than three types of CMs showed increased odds of MI occurrence (adjusted OR = 2.08–3.05, all $p < 0.05$).

Conclusions: Using data from a nationally representative US sample of adults, we found significant positive associations between CM and odds of MI occurrence in adulthood. Future longitudinal prospective studies are needed to confirm our findings.

1. Introduction

In the United States, it is estimated that about 790,000 individuals experience a heart attack, including 580,000 cases of a first heart attack and 210,000 cases of recurrent heart attacks each year (Benjamin et al., 2017). The total direct medical costs of cardiovascular diseases (CVDs) between 2012 and 2030 are projected to increase from $396 billion to $918 billion (Benjamin et al., 2017). Because of the high prevalence and high cost of CVDs, it is of public health importance to explore the risk factors of CVDs. Several risk factors have been identified, such as cigarette smoking, poor dietary habits, physical inactivity, dyslipidemia, hypertension, and diabetes (Mozaffarian et al., 2008).

In recent decades, there is growing interest in the impacts of adverse experiences in childhood and adolescence on physical illness over the life course (Shonkoff et al., 2012). Much of the existing literature has focused on the associations of childhood maltreatment (CM), including physical, sexual, and emotional abuse and neglect, with CVDs (Basu et al., 2017). Specifically, studies have reported significant associations between various types of CM and the risk of CVDs (Batten et al., 2004; Dong et al., 2004b; Felitti et al., 1998; Fuller-Thomson et al., 2012; Gilbert et al., 2015; Morton et al., 2014; Roy et al., 2010; Scott et al., 2011). In a WHO World Mental Health Survey conducted in 10 countries, childhood physical abuse (CPA) and childhood sexual abuse (CSA) were found to be significantly associated with the risk of heart diseases in adulthood (Scott et al., 2011). Moreover, several studies have reported a dose-response relationship between the number of different types of CM experienced and the risks of heart diseases (Dong et al., 2004b; Felitti et al., 1998; Roy et al., 2010; Scott et al., 2011). However, prior studies have not consistently controlled for social determinants such as socioeconomic status, or household dysfunction. Moreover, some studies on CM have focused on a single type of maltreatment (such as sexual abuse or physical abuse) despite the ample evidence demonstrating that these exposures frequently co-occur (Dong et al., 2004a; Green et al., 2010). Some studies also used a composite score for maltreatment, such that the relationship of specific types of maltreatment remains unclear (Batten et al., 2004). Additionally, sex differences

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have been observed in the exposure to CM and in cardiometabolic outcomes. However, recent reviews have demonstrated that investigation into whether sex modifies the relationship between CM and cardiometabolic outcomes has been limited (Suglia et al., 2018).

Most importantly, to the best of our knowledge, no study has investigated the relationship between different types of CM and a specific CVD like myocardial infarction (MI), as there are many types of CVDs, such as coronary heart diseases, strokes, peripheral arterial diseases and aortic diseases, and each type of CVD is different in severity and clinical outcome. A study by Fuller-Thomson et al. (2012) demonstrated that CSA was associated with the risk of MI in men, but no such association was observed in women. However, they did not evaluate the possible relationship of other coexisting CMs in individuals at risk of MI occurrence. As previous studies have shown the associations between specific types of CM (e.g., physical and sexual abuse) and cardiometabolic disease risk (Afifi et al., 2013; Suglia et al., 2018), the independent relationships between different types of CMs and MI need to be elucidated.

Considering the limitations of previous studies mentioned above, the present study aimed to expand on previous studies by using a nationally representative population-based dataset to investigate the associations between different types of CMs and the risk of MI occurrence. Based on the results of previous studies, we hypothesized that CM is associated with odds of MI occurrence. Moreover, we hypothesized that there is a dose-dependent relationship between the number of CMs experienced and odds of MI occurrence.

2. Materials and methods

2.1. Database

The present data were extracted from the National Epidemiologic Study of Alcohol and Related Conditions (NESARC), which was conducted in 2001. The NESARC employed a multi-stage sampling design that yields a representative sample of the civilian, non-institutionalized population aged 18 years and older residing in the USA (Grant et al., 2009; Ruan et al., 2008). A total of 43,093 noninstitutionalized civilian respondents, aged 18 years and older, completed face-to-face computer-assisted personal interviews. Hispanics, Blacks, and adults aged 18–24 years were oversampled. The current study used data from Wave 1 and 2 of the NESARC. Wave 1 of this survey was conducted between 2001 and 2002, with 43,093 participants and an overall response rate of 81.2%. Wave 2 was conducted between 2004 and 2005, and it attempted to re-interview the original Wave 1 sample. After excluding respondents who were ineligible for Wave 2 (e.g., who were dead), 86.7% of the respondents (n = 34,653) were interviewed, and sample weights were developed to additionally adjust for Wave 2 nonresponse. The weighted data were then adjusted to represent the US civilian population based on the 2000 census (Goldstein et al., 2015). To test whether this nonresponse adjustment was successful, a previous study compared Wave 2 respondents with the target population (comprising Wave 2 respondents and eligible nonrespondents) with reference to several baseline sociodemographic and diagnostic measures. The results indicated that there were no significant differences between the Wave 2 respondents and the target population in terms of age, race-ethnicity, sex, and socioeconomic status or the presence of any lifetime substance, mood, anxiety or personality disorder (Grant et al., 2009). The cumulative response rate was 70.2%. All interviews were conducted face-to-face within the respondents' household by trained lay United States Census Bureau Field Representatives. Additional detailed information regarding the NESARC could be found in other related articles (Grant et al., 2009; Ruan et al., 2008).

2.2. Measurements

Participants' experiences of a variety of adverse childhood events (events occurring before the age of 18 years) were assessed using questions adopted from the Adverse Childhood Experiences (ACE) study (Dong et al., 2003; Dube et al., 2003). These questions were a subset of the items from the Conflict Tactics Scale Straus (1979) and the Childhood Trauma Questionnaire (Bernstein et al., 1994). Respondents were asked to respond to all questions pertaining to abuse, neglect (except emotional neglect) on a five-point scale (never, almost never, sometimes, fairly often, or very often). Emotional neglect questions employed an alternative five-point scale of never true, rarely true, sometimes true, often true, or very often true. In the present study, the following five types of CM were identified: physical neglect, physical abuse, emotional neglect, emotional abuse and sexual abuse (Keyes et al., 2012).

2.3. Childhood maltreatments

We dichotomized the five CM scales for two reasons, their skewed distribution and the need to summarize them in an easily interpretable manner. The scales were classified as positive, as follows. (1) *Physical neglect*: Respondents were classified as having experienced childhood physical neglect if the respondents reported at least "sometimes" to either of the following questions: "How often were you made to do chores that were too difficult or dangerous for someone your age?", "How often were you left alone or unsupervised when you were too young to be alone, that is, before you were 10 years old?", "How often did you go without things you needed like clothes, shoes or school supplies because a parent or other adult living in your home spent the money on themselves?", "How often did a parent or other adult living in your home make you go hungry or not prepare regular meals?", or "How often did a parent or other adult living in your home ignore or fail to get you medical treatment when you were sick or hurt?" (Fenton et al., 2013). (2) *Physical abuse*: The following two questions were used to assess childhood physical abuse: how often a parent or other adult living in the respondent's home [1] pushed, grabbed, shoved, slapped, or hit the respondent; or [2] hit the respondent so hard that it left marks or bruises, or caused an injury. A respondent was defined as being physically abused if the response was either often or very often to the first question, or sometimes, often, or very often to the second (Dong et al., 2003; Dube et al., 2003). (3) *Emotional neglect:* It was defined by five questions regarding whether the respondent felt a part of a close-knit family or whether anyone in the respondent's family of origin made the respondent feel special, wanted the respondent to succeed, believed in the respondent, or provided strength and support. Consistent with previous research all five items were reverse-scored and summed. Scores of 15 or greater were indicative of having experienced emotional neglect (Dong et al., 2003; Dube et al., 2003). (4) *Emotional abuse*: Caregivers verbally abused or threatened respondents at least fairly often, or respondents feared their caregiver would injure them at least sometimes (Fenton et al., 2013). (5) *Sexual abuse*: The questions examined the occurrence of sexual touching or fondling, attempted intercourse, or actual intercourse by any adult or other person when the respondent did not want the act to occur or was too young to understand what was happening. Any response other than "never" on any of the questions was regarded as indicative of having experienced sexual abuse (Wyatt, 1985).

2.4. Household dysfunction variables

Respondents were asked if they experienced any of the following prior to the age of 18 years: *Battered mother*: to characterize the experience of having a battered caregiver, respondents were asked whether the respondent's father, stepfather, foster/adoptive father, or mother's boyfriend had ever done any of the following to the respondent's mother, stepmother, foster/adoptive mother, or father's girlfriend: (1) pushed, grabbed, slapped, or threw something at her; (2) kicked, bit, hit with a fist, or hit her with something hard; (3) repeatedly hit her for at

Table 1
Weighted prevalence of demographic characteristics and five types of childhood maltreatment in the total sample.

	Total sample (n = 34,653)		Sexual abuse (n = 3854)		Physical abuse (n = 3108)		Emotional abuse (n = 4754)		Physical neglect (5,980)		Emotional neglect (3,383)	
	N	W%[d]	N	W%	N	W%	N	W%	N	W%	N	W%
Sex												
Male	14,564	47.9	845	2.5	1249	3.8	1863	5.9	2521	8.1	1230	3.9
Female	20,089	52.1	3009	7.8	1859	4.5	2861	7.1	3459	8.4	2153	5.3
Race												
White	20,161	70.9	2155	7.2	1630	5.4	2719	9.2	3119	10.7	1994	6.4
Black	6587	11.0	818	1.4	731	1.2	922	1.5	1142	1.8	505	0.8
Native	578	2.2	110	0.4	103	0.4	138	0.5	155	2.2	90	0.3
Asian	968	4.3	64	0.2	56	0.2	105	0.4	173	4.2	81	0.3
Hispanic	6359	11.6	707	1.1	588	1.0	840	1.4	1391	11.6	713	1.4
Age												
20–29	4913	16.3	506	1.5	353	1.0	619	1.9	736	2.3	333	1.1
30–39	6621	18.7	844	2.2	622	1.7	1003	2.7	1183	3.2	626	1.6
40–49	7539	21.5	998	2.7	768	2.0	1148	3.2	1311	3.6	808	2.2
50–59	6117	17.8	773	2.0	705	1.8	1026	2.8	1166	3.2	703	2.0
≥60	9463	25.7	733	1.9	660	1.7	928	2.4	1584	4.2	913	2.4
MI[a]	327	0.9	49	0.1	46	0.1	59	0.1	84	0.2	38	0.1
Gov. funding[b]	5153	13.2	1077	2.6	884	2.2	1235	3.2	1448	3.7	753	1.9
Household Dysfunction[c]	12,674	38.8	2364	6.7	2072	6.0	3170	9.4	3495	10.4	1954	5.7

[a] MI, myocardial infarction.
[b] Before age 18, the respondents' family ever received money from government assistance programs.
[c] Household dysfunction: at least one of: battered caregiver, caregiver substance use problem, caregiver was incarcerated, caregiver attempted or committed suicide, caregiver with mental illness, and caregiver divorced or separated.
[d] Weighed prevalence.

least a few minutes; or (4) threatened to use or actually used a knife or gun on her. Any response of "sometimes" or greater for Question 1 or 2, or any response except "never" for Question 3 or 4, was defined as having a battered mother.

Parental substance abuse was assessed with two questions regarding whether a parent or other adult living in the home had a problem with alcohol or drugs. A response of "yes" to either of these questions was defined as parental substance abuse. To characterize the remaining household dysfunction variables, respondents were asked to answer with either "yes" or "no" as to whether a parent or other adult in the household (1) went to jail or prison; (2) was treated or hospitalized for a mental illness; (3) attempted suicide; and/or (4) actually committed suicide; or whether the (5) respondent's parents were divorced or had died. Responses of "yes" for any of these questions defined the corresponding general household dysfunction variable.

2.5. Socioeconomic status in childhood/adolescent

In Wave 2 of the NESARC, respondents were asked, "before the age of 18 years, did your family receive money from government assistance programs?" Respondents' families were categorized as having poor economic status if they responded "yes."

2.6. Definition of myocardial infarction

Past year physical health condition categories were assessed based on Wave 2 of the NESARC asking if the respondent had experienced a heart attack or MI in the past year. Respondents who reported that the diagnosis had been made by a physician or other health professional were defined as having MI.

3. Statistical analysis

All analyses were conducted using the weight and stratification variables supplied with the NESARC Wave 2 data file. To account for the complex sampling design of the NESARC, the Taylor series linearization was used as the variance estimation technique using STATA (Pacek et al., 2013). Odds ratios estimated by a multiple logistic regression were used to assess the associations between CM and MI, adjusting for sociodemographic variables and other adverse childhood experiences. Whether sex modifies the associations between CMs and the odds of MI occurrence were also examined by including the interaction term (sex*maltreatment) in the regression model. In addition, a logistic regression was used to investigate the dose-response relationship between the number of different types of CM experiences and the risk of MI occurrence adjusting for sociodemographic variables and other adverse childhood experiences. Moreover, to avoid an over-adjustment bias (Schisterman et al., 2009), intermediate variables such as substance abuse; lifestyle; mental illness; and CVD risk factors such as obesity, hypertension, and diabetes on the causal path from CM to MI were not adjusted in the logistic regression model (Suglia et al., 2018).

4. Sensitivity analyses

To identify if there were significant associations between any types of maltreatment and risk of MI occurrence, we further conducted a sensitivity analysis to investigate if there is a dose-response relationship between the severity of the specific types of maltreatment and the risk of MI occurrence, adjusting for the number of other maltreatments (Dong et al., 2003). All analyses were conducted using STATA version 15.1.

5. Results

5.1. Prevalence of childhood maltreatment

The characteristics of study participants have been presented in Table 1. The prevalence of physical neglect was similar among males (8.1%) and females (8.4%). However, the prevalence of other types of CM, including sexual abuse (7.8% vs 2.5%), physical abuse (4.5% vs 3.8%), emotional abuse (7.1% vs 5.9%), and emotional neglect (5.3% v. s. 3.9%) was higher in females than in males.

Table 2
Results of logistic regression for the associations between childhood maltreatment and presence of diagnosis of myocardial infarction in the past year.

Maltreatment type	Model 1 Crude OR	95% CI	p-value	Model 2 Adjusted OR	95% CI	p-value	Model 3 Adjusted OR	95% CI	p-value
Sexual abuse	**2.27**	**1.50–3.45**	**< 0.001**	**2.26**	**1.47–3.49**	**< 0.001**	**1.85**	**1.24–2.76**	**0.003**
Physical abuse	**1.92**	**1.24–2.96**	**0.004**	**2.06**	**1.30–3.26**	**0.002**	**1.89**	**1.06–3.38**	**0.031**
Emotional abuse	**1.65**	**1.12–2.43**	**0.012**	**1.75**	**1.17–2.62**	**0.007**	1.14	0.72–1.83	0.561
Physical neglect	1.33	0.96–1.84	0.083	1.18	0.84–1.68	0.335	0.97	0.66–1.43	0.883
Emotional neglect	1.40	0.94–2.09	0.096	1.37	0.87–2.14	0.166	1.21	0.74–1.99	0.441

Model 1: adjusted for age and gender.
Model 2: adjusted for age, gender, race, economic status, and any household dysfunction.
Model 3: adjusted for age, gender, race, economic status, any household dysfunction, interaction terms, and other coexisting maltreatments.

5.2. Associations between childhood maltreatment and odds of MI occurrence

The results of the multivariate logistic regression investigating the associations between different types of CM and MI have been presented in Table 2. The findings indicated that childhood sexual abuse (CSA) (adjusted OR (aOR) = 1.85; 95%CI = 1.24–2.76, p = 0.003) and physical abuse (aOR = 1.89; 95%CI = 1.06–3.38, p = 0.031) was significantly associated with higher odds of MI occurrence. In addition, we found interactions by sex in the associations between physical abuse and odds of MI occurrence (p = 0.036). Specifically, when using gender-specific analysis to determine the relationship between physical abuse and odds of MI occurrence in male (n = 14,564) and female (n = 20,089) respondents, we found that physical abuse was significantly associated with increased odds of MI occurrence in males alone (aOR = 2.45; 95%CI = 1.35–4.44, p = 0.004) (Table 3).

5.3. Dose-response relationships

As shown in Table 4, after adjusting for SES variables, we found a significant dose-response relationship between the number of different numbers of CMs experienced and the odds of MI occurrence. Compared to those without experiences of CM, subjects who had experienced more than 3 types of CM exhibited a significantly higher risk of MI occurrence, with OR = 2.04, 2.35, and 3.05 for those who had experienced three, four, and five different types of CM, respectively (all p < 0.05). The results of the sensitivity analysis showed that, severity of CSA was associated with increased risk of MI occurrence (aOR = 1.14, 95%CI = 1.08–1.20, p < 0.001).

6. Discussions

Using data from the NESARC, we found significant associations between CM and risk of MI occurrence. Specifically, there was a significant association between CSA and risk of MI occurrence and there was a significant association between physical abuse and risk of MI occurrence in males alone. Moreover, we found a significant dose-response relationship between the number of different types of CMs experienced and the risk of having an MI in adulthood.

Our findings are similar to most previous studies reporting significant associations between CM and CVDs (Batten et al., 2004; Dong et al., 2004b; Felitti et al., 1998; Fuller-Thomson et al., 2012; Gilbert et al., 2015; Roy et al., 2010; Scott et al., 2011). However, findings on sex differences in the relationship between CM and cardiovascular outcomes have been inconsistent. While one study found no sex-related differences in CVD outcomes (Afifi et al., 2013) two other studies reported increased odds of CVD occurrence for women alone (Batten et al., 2004; Hosang et al., 2013). Another American population-representative study found an association of childhood physical abuse with stroke in men, and an association of childhood neglect and sexual abuse with cardiac disease in women (Goodwin and Stein, 2004). However, due to differences in the methodology employed to measure or define CM and cardiovascular outcome. It is difficult for us to directly compare those studies with ours. On the other hand, with regard to the associations between CM and MI, our results were inconsistent with those reported in the study conducted by Fuller-Thomson et al. (2012). Using a population-based dataset in Canada, they found a significant association between childhood sexual abuse and heart attack in men but not in women. There are several possible explanations for these differences. First, Esme et al. evaluated exposure to childhood sexual abuse with one question “How often did anyone at least 5 years older than you, or an adult, force you to have sex?”, while the NESARC used four questions to evaluate such experiences, and it is conceivable that the definition of sexual abuse used in our study influenced these outcomes. Indeed, a looser definition of sexual abuse may have led to different results.

However, to understand better the relationship between abuse experiences and health, it will be important to survey as wide as possible an array of abuse experiences, as each of these (and their aggregate burden) may contribute to adverse health outcomes (Banyard et al., 2001; McNutt et al., 2002). Second, Fuller-Thomson et al. (2012) focused on sexual abuse but not on any other forms of CM. As results from a factor analysis showed that sexual abuse, physical abuse, emotional abuse, and emotional neglect are distinct yet correlated constructs representing different facets of CM (Bernstein et al., 1994), possible

Table 4
Associations between number of maltreatment and myocardial infarction.

Number of Maltreatment	Adjusted OR	95% CI	p-value
0	Reference	–	–
1	1.20	0.81–1.77	0.352
2	1.51	0.87–2.62	0.139
3	**2.04**	**1.05–3.96**	**0.035**
4	**2.35**	**1.13–4.88**	**0.023**
5	**3.05**	**1.10–8.48**	**0.032**

Model is adjusted for age, gender, race, economic status, and any household dysfunction.

Table 3
The associations between different types of childhood maltreatment and myocardial infarction stratified by sex.

Maltreatment type	Female (n = 20,089) Adjusted OR	95% CI	p-value	Male (n = 14,564) Adjusted OR	95% CI	p-value
Physical abuse	0.72	0.32–1.66	0.440	**2.45**	**1.35–4.44**	**0.004**

Model is adjusted for age, race, economic status, any household dysfunction, and other maltreatments.

confounding effects of other coexisting maltreatment should be considered. On the other hand, similar to previous reports, we found a dose-response relationship between the number of different types of CMs experienced and the risk of CVDs (Dong et al., 2004b; Felitti et al., 1998; Gilbert et al., 2015; Scott et al., 2011). This type of dose-response relationship suggests that reducing the number of co-occurring CMs could help reduce the possibility of the downstream cardiometabolic consequences of such maltreatment (Suglia et al., 2018). Additionally, we also found that sex modifies the associations between physical abuse and odds of MI occurrence. Due to insufficient data in previous studies, we cannot draw any conclusions. One possible explanation is that there is a gender-specific vulnerability to psychosocial stress (Pedersen et al., 2016). Future studies are warranted to confirm our findings.

There are several pathways commonly identified to explain how CM may increase the risk of CVDs. First, previous studies suggested that CM is associated with adverse health behaviors such as cigarette smoking, overeating causing obesity, consumption of unhealthy food and sedentary lifestyle (Felitti et al., 1998; Hemmingsson et al., 2014; Sherwood and Jeffery, 2000; Suglia et al., 2018) and increasing evidence suggests that these behavioral risk factors, in part, mediate the childhood adversity–CVD relationship (Suglia et al., 2018). Second, the associations between childhood adversity and subsequent mental health problems in youth and adulthood is well known (McLaughlin, 2016). A recent systemic review has pointed that mental disorders were a partial mediator for the associations between CM and CVDs (Basu et al., 2017). CM has been found to increase the risk of anxiety including posttraumatic stress disorder and mood disorders (Green et al., 2010; McLaughlin et al., 2012) which are recognized risk factors for cardiovascular morbidity and mortality (Chou et al., 2012; Goldstein et al., 2015; Koenen et al., 2017). Third, exposure to CM might contribute to risk of CVDs by disrupting the regulatory systems in the body, including the immune, metabolic, neuroendocrine, and autonomic nervous systems (Basu et al., 2017). Studies have demonstrated that childhood adversity lead to chronic inflammation in victims, such as elevation of C-reactive protein, interleukin-6, fibrinogen, and other inflammatory markers related to cardiometabolic disease (Danese et al., 2007; Hostinar et al., 2015; Slopen et al., 2010). Fourth, preliminary data suggest that epigenetic changes may contribute to the associations between childhood adversity and cardiometabolic derangement (Bick et al., 2012; Demetriou et al., 2015; Houtepen et al., 2016; Tyrka et al., 2012). However, studies focusing on DNA methylation is still an emerging field of study. In future, more studies are warranted to clarify the role of epigenetics in the link between CM and CVD risk.

This study has several strengths. First, it was conducted using data from a nationally representative epidemiologic survey, and therefore, selection bias was minimized. Second, it addressed the limitations of preceding research by investigating specific physical outcomes (i.e., MI) of a wide range of CMs in a large general population sample spanning the entire adult age range. However, our study also has several limitations. First, the use of a cross-sectional design precludes causal inferences regarding the relationship between CM and MI. Second, data on CM and other childhood adverse experiences were collected retrospectively, which may involve recall and reporting biases. However, there is evidence that supports the validity of accurate recall of adverse childhood events (Hardt and Rutter, 2004). Third, although the NESARC included a wide range of adverse childhood events, this is not an exhaustive list. Other types of adverse childhood experiences such as peer victimization should be included in future research. Fourth, in the NESARC, the diagnosis of MI was documented by self-report without medical examination or review of health records. Although previous studies suggest that self-reported diagnoses of heart disease are relatively accurate (Barr et al., 2009; Bergmann et al., 1998), the possibility of overreporting remains and cannot be ruled out. In addition, the NESARC data set only includes information related to conditions, symptoms or events within the past year at Wave 2, and those with MI occurrence after Wave 1 but more than 1-year prior to Wave 2 were not included. Thus, the occurrence and risk of MI occurrence may be underestimated. Fifth, in the present study, we did not adjust for the presence of mental illness or substance abuse because we hypothesized that they are mediators in the causal path from CM to MI. However, we did not have data regarding the exact age of CM experiences. If the presence of mental illness or substance abuse have occurred before the experience of CM, they could be confounders. Sixth, we did not analyze the frequency and duration of maltreatment in childhood. Indeed, they may also influence the physical condition in abused children.

In conclusion, we found that CSA is significantly associated with risk of MI, and physical abuse is associated with risk of the MI occurrence in men alone. Therefore, assessment of a history of CM in both men and women with CVD is recommended. Future longitudinal prospective studies are needed to confirm our findings.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jpsychires.2018.12.001.

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