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ORIGINAL ARTICLE

Arthritis in adults, socioeconomic factors, and the moderating role of childhood maltreatment: cross-sectional data from the National Epidemiological Survey on Alcohol and Related Conditions

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Abstract

Summary These data present associations between socioeconomic status (SES), different types of childhood maltreatment (CM) history and family dysfunction, and arthritis in men and women across a wide age range. Arthritis was less likely among those with higher SES, regardless of CM history.

Introduction CM has been associated with increased risk of adult-onset arthritis; however, little is known about whether socioeconomic status moderates arthritis risk in those with CM history. We investigated arthritis across education, income, and race/ethnicity and whether CM moderated associations between SES and arthritis.

Methods Data were drawn from Wave 2 (2004–2005) of the nationally representative (USA) National Epidemiological Survey on Alcohol and Related Conditions (NESARC, $n = 34{,}563$; aged ≥ 20 years). Self-reported CM history included physical abuse, sexual abuse, emotional abuse, emotional neglect, physical neglect, and exposure to intimate partner violence (IPV). We used descriptive statistics and logistic regression to determine relationships between SES, CM, and arthritis. Interaction terms were used to test if CM moderated relationships between SES and arthritis.

Results Arthritis prevalence was 21.1% ($n = 3093$) among men and 30.1% ($n = 6167$) among women. In unadjusted analyses, women ($p \leq 0.001$) and older age (both sexes, $p \leq 0.01$) were associated with increased odds of arthritis. All CM types were associated with increased odds of arthritis, except exposure to IPV among women. In sex-stratified, age-adjusted analyses, lower education and income, family dysfunction, being Hispanic or Asian/Native Hawaiian/Pacific Islander, and ≥ 1 physical comorbidity were associated with increased odds of arthritis among those with and without CM: trends were similar for both sexes. In age-adjusted two-way interaction terms, CM did not moderate associations between SES and arthritis.

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Conclusions Although CM was associated with arthritis, associations between SES and arthritis were not amplified. Arthritis was less likely among those with higher SES, regardless of CM history.

Keywords Adults · Arthritis · Childhood maltreatment · NESARC · Socioeconomic factors

Arthritis is well-documented to be among the most common, debilitating, and costly of all chronic physical conditions [1]. By 2040, it is estimated that 78.4 million adults in the United States (US) will have physician-diagnosed arthritis [1, 2]. The personal, social, and economic costs associated with arthritis are vast and encompass lost productivity, increased healthcare costs, loss of quality of life, and premature death [1]. In financial terms, the US Centers for Disease Control and Prevention (CDC) identified annual direct medical costs in 2016 to be $81billion [1].

Although there is a paucity of data, the available literature suggests that arthritis is no exception to the social gradient of chronic health conditions [3–7]. Except for a few studies that investigated family dysfunction in terms of drug or alcohol addiction, parental unemployment, and parental divorce [8, 9], or being sent away from home, and being scared "so much you thought about it for years after" [9], there is little known about the relationship between arthritis and a history of family dysfunction. A wider literature base exists regarding the role of childhood maltreatment (CM), including abuse (physical and sexual) and neglect, on increasing the risk of many chronic non-communicable diseases, including arthritis [8–14], although data regarding other types of CM, such as exposure to intimate partner violence (IPV) and emotional abuse, are limited. It has been suggested that those with a CM history may be more likely to adopt unhealthy or risk-taking behaviors to cope with their childhood experiences [8], which may subsequently increase their risk for arthritis.

In addition to the non-modifiable genetic predisposition, such as sex and familial risk, many explanations are biologically plausible as to why CM might increase arthritis risk. Apart from high hormonal reactivity having been observed in children that have experienced abuse [15, 16], CM increases the secretion of stress hormones; a mechanism underpinning the onset of many chronic diseases [15]. Indeed, exposure to CM may not only affect the hypothalamus-pituitary adrenal (HPA) axis, thereby increasing cortisol secretion, but actual changes to the brain may occur [17]. Given the intimate relationship between the neuroendocrine stress response and the immune system, physiological responses to chronic stress also result in heightened immune dysfunction. A recent review showed systematic inflammation to be heightened in children exposed to CM [18]. Furthermore, the sympathetic nervous system, in response to stressors, may increase proinflammatory cytokines via the actions of adrenalin and/or noradrenalin [19]. Although social experiences do not alter the genetic code per se, they bring about changes in the various molecules that interact with DNA, determining which genes are switched on or off. It is now widely accepted that DNA methylation is influenced by environmental factors [20] and plays an important role in chronic disease onset [21]. Furthermore, epigenome-mediated interactions between genetic and environmental factors likely play a major role in the pathogenesis of common disorders [22]. Longitudinal data show that epigenetic variation of DNA methylation follows stressor events [23, 24], indicating that the induced stress reactions and other responses could modify DNA methylation patterns and consequently influence inflammation and thus arthritis risk. Indeed, the well-documented social gradient of chronic health conditions is suggested to be primarily due to cumulative assaults on the body, secondary to chronically stressful conditions [25].

In addition, little is known about whether different types of CM, including exposure to IPV and emotional abuse, moderate the association between social disadvantage and arthritis, despite the well-documented association between low social status and childhood maltreatment [26–29]. Thus, the objectives of this study are to investigate whether (i) the sex-stratified prevalence of self-reported arthritis differed across different sociodemographic variables, (ii) the sex-stratified prevalence and odds of arthritis differed across different types of CM, and (iii) the sex-stratified relationship between sociodemographic variables and arthritis is moderated by a history of any CM.

Methods

Patients and methods

We analyzed cross-sectional data from Wave 2 (2004–2005) of the National Epidemiological Survey on Alcohol and Related Conditions (NESARC), a nationally representative sample of 34,653 community-dwelling adults (≥ 20 years of age) residing in the US including Districts of Columbia, Alaska, and Hawaii.

As previously reported, Wave 2 of the NESARC cohort excludes deceased, deported, or institutionalized adults, or those on active military duty [30]. Face-to-face interviews were based on a structured questionnaire and conducted by trained lay interviewers from the US Census Bureau who had

Table 1 Prevalence and odds (95%CI) of arthritis across parameters of socioeconomic status (SES), stratified by sex, $N = 34{,}653$

	Men $n = 14{,}564$		Women $n = 20{,}089$	
SES	% (*n*)	OR (95% CI)	% (*n*)	OR (95% CI)
Sex	21.06 (3093)	1.00	30.10 (6167)	*1.61 (1.5–1.7)****
Age	*n* = 14,564		*n* = 20,089	
20–39 years	6.10 (259)	1.00	6.87 (476)	1.00
40 to 49 years	14.84 (444)	*2.68 (2.2–3.3)****	18.91 (793)	*3.16 (2.7–3.7)****
50 to 59 years	27.82 (707)	*5.93 (4.8–7.3)****	39.54 (1382)	*8.87 (7.7–10.3)****
60 to 69 years	39.04 (720)	*9.85 (8.2–11.9)****	54.15 (1304)	*16.01 (13.8–18.5)****
70 to 79 years	47.86 (604)	*14.12 (11.6–17.2)****	64.70 (1298)	*24.84 (21.3–29.0)****
≥ 80 years	54.31 (359)	*18.28 (13.9–24.0)****	69.74 (914)	*31.23 (26.2–37.3)****
Race/ethnicity	*n* = 14,564		*n* = 20,089	
White	23.61 (2121)	1.00	32.46 (3802)	1.00
Black	18.40 (529)	*0.73 (0.6–0.8)****	29.33 (1398)	*0.86 (0.8–0.9)***
AI/AN	30.66 (69)	*1.43 (1.0–2.0)**	35.84 (123)	1.16 (0.9–1.5)
A/NH/PI	12.30 (49)	*0.45 (0.3–0.7)****	18.44 (97)	*0.47 (0.4–0.6)****
Hispanic	9.95 (325)	*0.36 (0.3–0.4)****	18.95 (747)	*0.49 (0.4–0.6)****
Education	*n* = 14,564		*n* = 20,089	
Completed college degree	16.44 (899)	1.00	22.80 (1601)	1.00
Completed some college	19.04 (566)	*1.20 (1.0–1.4)**	25.60 (1135)	*1.17 (1.0–1.3)***
Completed secondary/high school	24.83 (935)	*1.68 (1.5–1.9)****	36.46 (1996)	*1.94 (1.8–2.2)****
Did not complete secondary/high school	29.15 (693)	*2.09 (1.8–2.4)****	43.60 (1435)	*2.62 (2.3–3.0)****
Past-year household income US$	*n* = 14,564		*n* = 20,089	
≥ $70,000	15.46 (656)	1.00	20.49 (880)	1.00
$40,000 to $69,000	20.47 (766)	*1.41 (1.2–1.6)****	25.10 (1155)	*1.30 (1.2–1.5)****
$20,000 to $39,000	24.89 (865)	*1.81 (1.6–2.1)****	34.07 (1675)	*2.00 (1.8–2.3)****
≤ $19,999	29.14 (806)	*2.25 (2.0–2.6)****	43.00 (2457)	*2.93 (2.6–3.3)****
Family history of dysfunction	*n* = 14,409		*n* = 19,872	
No	19.99 (2199)	1.00	30.12 (4417)	1.00
Yes	24.11 (878)	*1.27 (1.1–1.4)****	29.92 (1716)	0.99 (0.9–1.1)
Number of other chronic physical health conditions	*n* = 14,236		*n* = 19,707	
None	10.70 (810)	1.00	14.45 (1407)	1.00
One	26.04 (833)	*2.94 (2.6–3.3)****	35.85 (1642)	*3.31 (3.0–3.7)****
Two	34.39 (618)	*4.4 (3.7–5.1)****	49.06 (1318)	*5.70 (5.1–6.4)****
≥ Three	52.14 (764)	*9.09 (7.9–10.5)****	67.27 (1679)	*12.17 (10.6–14.0)****

Italic indicates statistical significance (*$p \le 0.05$; **$p \le 0.01$; ***$p \le 0.001$)

AI/AN American Indian/Alaska Native, *A/NH/PI* Asian/Native Hawaiian/Pacific Islander

at least 5 years of experience. The methods and sampling procedures of the NESARC has been comprehensively detailed elsewhere [31–33].

Sociodemographic factors and socioeconomic status

Age was categorized as 20–39 years, 40–49 years, 50–59 years, 60–69 years, 70–79 years, and ≥ 80 years. Self-reported educational attainment was categorized into four groupings of (i) did not complete secondary/high school, (ii) completed secondary/high school, (iii) completed some college, or (iv) completed a college degree. Self-reported household income (US$) for the previous year was reported as being in $5000 increments and was categorized into one of the following groups, as previously employed [34]: (i) ≤ $19,999, (ii) $20,000–$34,999, (iii) $35,000–$59,999, and (iv) ≥ $60,000. Self-reported race/ethnicity was categorized as (i) White, (ii) Black, (iii) American Indian/Alaska Native, (iv) Asian/Native Hawaiian/Other Pacific Islander, and (v) Hispanic.

Table 2 Cross tabulation presenting the number of individuals and the proportion of men and women with arthritis who also experienced childhood maltreatment (CM)

Type of CM	Men		Women	
	% (*n*)	OR (95% CI)	% (*n*)	OR (95% CI)
Physical abuse	26.86 (727)	*1.49 (1.3–1.7)****	34.41 (1237)	*1.27 (1.2–1.4)****
Sexual abuse	26.61 (214)	*1.39 (1.1–1.7)****	33.05 (1015)	*1.18 (1.1–1.3)***
Exposure to IPV	28.25 (346)	*1.54 (1.3–1.8)****	31.68 (810)	1.09 (0.96–1.2)
Emotional abuse	29.92 (314)	*1.67 (1.4–2.0)****	37.83 (688)	*1.47 (1.2–1.7)****
Emotional neglect	26.55 (325)	*1.40 (1.2–1.7)****	38.04 (795)	*1.49 (1.3–1.7)****
Physical neglect	22.69 (910)	*1.14 (1.0–1.3)**	33.18 (1569)	*1.21 (1.1–1.3)****
Any CM	24.11 (1525)	*1.37 (1.2–1.5)****	32.80 (2867)	*1.25 (1.2–1.3)****

Missing values on individual types of CM ranged from 0.95% (physical abuse) to 1.26% (any CM) among men and from 0.97% (physical abuse) to 1.43% (any CM) among women. Italic indicates statistical significance (*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$)

IPV intimate partner violence

Childhood maltreatment and family history of dysfunction

CM and family history of dysfunction variables were adapted from those used in the Adverse Childhood Experiences Study [35, 36] and included items from psychometrically established measures including the Childhood Trauma Questionnaire [37] and the Conflict Tactics Scales [38]. Self-reported experiences of CM (that occurred before the age of 18 years) included physical abuse, sexual abuse, emotional abuse, emotional neglect, physical neglect, and exposure to IPV [39]. All child maltreatment items were measured on a 5-point ordinal scale (*never*, *almost never*, *sometimes*, *fairly often*, and *very often*) and were based on experiences that occurred before the age of 18 years. Similar to other research, recommended cut-offs (vs. psychometrically established) provided dichotomous coding which was used to identify the presence of child maltreatment [39–41]. Physical abuse was defined as having ever (i.e., any response other than *never*) being hit so hard that it left marks, bruises, or caused an injury (i.e., any response, other than *never*) or as having been pushed, grabbed, shoved, slapped, or hit (*sometimes, fairly often*, or *very often*) by parents or any adult living in the respondent's home. Sexual abuse was defined as having ever (i.e., any response other than *never*) experienced any unwanted sexual touching or fondling, or any attempted or actual intercourse by an adult or another person that was unwanted or occurred when the respondent was too young to understand what was happening. Exposure to IPV in childhood was determined by asking respondents whether their mother's partner had pushed, grabbed, slapped, or thrown something at their mother (*sometimes*, *fairly often*, or *very often*); kicked, bit, or hit their mother with a fist or something hard (*sometimes*, *fairly often*, or *very often*); ever repeatedly hit their mother for at least a few minutes (i.e., any response other than *never*); or had ever threatened her with a knife or gun, or use a knife or gun to hurt her (i.e., any response other than *never*). Physical neglect was defined as having ever (i.e., any response other than *never*) been left alone or unsupervised before the age of 10 years; gone without needed things such as clothes, shoes, or school supplies because a parent or other adult living in the home spent the money on themselves; been made to go hungry or did not have regular meals prepared; and/or had a parent or other adult living in the home ignore or fail to get the respondent medical treatment. Emotional abuse was defined as having *fairly often* or *very often* experienced a parent or other adult living in the home: swear at or insult the respondent; threaten to hit or throw something at the respondent, but did not do it; and/or act in any other way that made the respondent feel afraid. The emotional neglect items were assessed on a similar 5-point ordinal scale (*never true*, *rarely true*, *sometimes true*, *often true*, and *very often true*). Emotional neglect in childhood was assessed with the following five items: (i) the respondent felt there was someone in the family who wanted them to be a success; (ii) someone in the respondent's family made them feel special or important; (iii) the respondent's family was a source of strength or support; (iv) the respondent felt part of a close-knit family; and (v) someone in the respondent's family believed in them. Similar as other research, these items were reverse-coded and summed with scores of 15 or greater indicative of having experienced emotional neglect in childhood [35, 36, 41].

Family history of dysfunction was defined as having had a parent or other adult living in the home who had a problem with alcohol or drugs, went to jail, was hospitalized or treated for mental illness, or who had attempted or completed suicide.

Arthritis and other chronic physical health conditions

Past-year prevalence of arthritis (any) was identified if the participant self-reported a diagnosis from a physician or other

Table 3 Univariable associations between parameters of SES and arthritis, in men with and without childhood maltreatment (CM) history

SES indicators	No CM	CM	SES×CM
	n = 8084	*n* = 6296	*p* value
	OR (95% CI)	OR (95% CI)	
Age	*n* = 8084	*n* = 6296	
20–39 years	1.00	1.00	REF
40 to 49 years	*2.67 (2.0–3.5)***	*2.63 (2.0–3.5)***	NS
50 to 59 years	*6.06 (4.5–8.2)***	*5.60 (4.2–7.4)***	NS
60 to 69 years	*11.20 (8.6–14.6)***	*8.52 (6.4–11.2)***	NS
70 to 79 years	*15.35 (11.8–20.0)***	*12.70 (9.6–16.7)***	NS
≥ 80 years	*24.62 (17.6–34.4)***	*12.54 (8.7–18.0)***	*< 0.01*
Race/ethnicity	*n* = 8084	*n* = 6296	
White	1.00	1.00	REF
Black	*0.73 (0.6–0.9)***	*0.70 (0.6–0.8)***	NS
AI/AN	1.36 (0.8–2.4)	1.34 (0.8–2.2)	NS
A/NH/PI	*0.40 (0.2–0.7)***	*0.51 (0.3–0.8)***	NS
Hispanic	*0.34 (0.3–0.4)***	*0.34 (0.3–0.4)***	NS
Education	*n* = 8084	*n* = 6296	
Did not complete secondary/high school	*2.31 (1.9–2.8)***	*1.76 (1.4–2.2)***	NS
Completed secondary/high school	*1.80 (1.5–2.1)***	*1.50 (1.2–1.8)***	NS
Completed some college	1.15 (0.9–1.4)	*1.21 (1.0–1.5)**	NS
Completed a college degree	1.00	1.00	REF
Past-year household income US$	*n* = 8084	*n* = 6296	
≤ $19,999	*2.50 (2.0–3.1)***	*1.90 (1.5–2.4)***	NS
$20,000 to $39,999	*2.23 (1.8–2.7)***	*1.39 (1.1–1.7)***	*0.001*
$40,000 to $69,000	*1.50 (1.2–1.8)***	*1.32 (1.1–1.6)***	NS
≥ $70,000	1.00	1.00	REF
Family history of dysfunction	*n* = 8078	*n* = 6264	
No	1.00	1.00	REF
Yes	1.05 (0.9–1.3)	*1.28 (1.1–1.5)***	NS
Any other chronic physical health condition	*n* = 7993	*n* = 6170	
None	1.00	1.00	REF
One	*3.10 (2.6–3.7)***	*2.65 (2.2–3.2)***	NS
Two	*4.61 (3.8–5.7)***	*4.01 (3.1–5.1)***	NS
≥ Three	*9.86 (8.1–12.0)***	*7.67 (6.1–9.6)***	NS

Significant odds ratios are indicated in italic by *p* values: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

AOR age-adjusted odds ratio, *CM* childhood maltreatment, *NS* not significant, *OR* odds ratio, *SES* socioeconomic status, *AI/AN* American Indian/Alaska Native, *A/NH/PI* Asian/Native Hawaiian/Pacific Islander, *SES×CM* socioeconomic status × childhood maltreatment interaction term

health professional. The survey also assessed physical conditions by first having respondents indicate if they had at least one of the following physical conditions in the past year: hardening of the arteries/arteriosclerosis, high blood pressure/hypertension, diabetes/sugar diabetes, cirrhosis of liver, any other form of liver disease, chest pain/angina pectoris, rapid heartbeat/tachycardia, heart attack/myocardial infarction, high cholesterol, other form of heart disease, stomach ulcer, human immunodeficiency virus (HIV), autoimmune deficiency syndrome (AIDS), sexually transmitted disease/venereal disease, gastritis, or stroke. Chronic physical health conditions, other than arthritis, were grouped as none, one, two, or three or more.

Ethics

Written informed consent was obtained from all participants. The US Census Bureau and the US Office of Management and Budget reviewed the research protocol and provided full ethical approval: this study was performed in accordance with the ethical standards identified in the 1964 Declaration of Helsinki and later amendments.

Table 4 Univariable associations between parameters of SES and arthritis, in women with and without childhood maltreatment (CM) history

	No CM *n* = 11,226 OR (95% CI)	CM *n* = 8575 OR (95% CI)	SES×CM *p* value
Age	*n* = 11,226	*n* = 8575	
20–39 years	1.00	1.00	REF
40 to 49 years	*3.37 (2.7–4.2)***	*2.98 (2.4–3.7)***	NS
50 to 59 years	*10.21 (8.1–12.8)***	*7.94 (6.6–9.6)***	NS
60 to 69 years	*20.10 (15.9–25.4)***	*13.94 (11.2–17.3)***	*< 0.05*
70 to 79 years	*34.47 (27.6–43.1)***	*19.49 (15.4–24.7)***	*0.001*
≥ 80 years	*47.43 (36.6–61.5)***	*21.35 (15.5–29.5)***	*< 0.001*
Race/ethnicity	*n* = 11,226	*n* = 8575	
White	1.00	1.00	REF
Black	0.90 (0.8–1.0)	*0.80 (0.7–0.9)**	NS
AI/AN	1.13 (0.7–1.8)	1.13 (0.8–1.6)	NS
A/NH/PI	*0.45 (0.3–0.7)***	*0.50 (0.3–0.7)***	NS
Hispanic	*0.50 (0.4–0.6)***	*0.47 (0.4–0.6)***	NS
Education	*n* = 11,226	*n* = 8575	
Did not complete secondary/high school	*2.83 (2.4–3.4)***	*2.27 (1.9–2.8)***	*< 0.05*
Completed secondary/high school	*2.19 (1.9–2.5)***	*1.63 (1.4–1.9)***	*< 0.01*
Completed some college	1.14 (0.98–1.3)	1.14 (0.98–1.3)	NS
Completed a college degree	1.00	1.00	REF
Past-year household income US$	*n* = 11,226	*n* = 8575	
≤ $19,999	*3.60 (3.1–4.2)***	*2.16 (1.8–2.5)***	*< 0.001*
$20,000 to $39,999	*2.47 (2.1–2.9)***	*1.51 (1.3–1.8)***	*< 0.001*
$40,000 to $69,000	*1.44 (1.2–1.7)***	1.11 (0.9–1.3)	*< 0.05*
≥ $70,000	1.00	1.00	REF
Family history of dysfunction	*n* = 11,216	*n* = 8548	
No	1.00	1.00	REF
Yes	*0.84 (0.7–0.97)**	0.96 (0.9–1.1)	NS
Any other chronic physical health condition	*n* = 11,127	*n* = 8455	
None	1.00	1.00	REF
One	*3.82 (3.3–4.4)***	*2.67 (2.3–3.1)***	*< 0.01*
Two	*6.13 (5.2–7.3)***	*5.03 (4.2–6.0)***	NS
≥ Three	*14.23 (11.7–17.3)***	*9.85 (8.1–12.0)***	*0.01*

Significant odds ratios are indicated in italic by *p* values: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

AOR age-adjusted odds ratio, *CM* childhood maltreatment, *NS* not significant, *OR* odds ratio, *SES* socioeconomic status, *AI/AN* American Indian/Alaska Native, *A/NH/PI* Asian/Native Hawaiian/Pacific Islander, *SES×CM* socioeconomic status × childhood maltreatment interaction term

Statistical analyses

Statistical weights were applied in all analyses to ensure that the NESARC data were representative of the general US population. As recommended by the NESARC Wave 2 documentation, Taylor series linearization was used as a variance estimation technique to account for the complex sampling design [32]. First, descriptive statistics using cross tabulations were computed to examine the distribution of self-reported arthritis by sociodemographic variables, family history of dysfunction, number of other physical health conditions, and CM types, stratified by sex. Second, sex-stratified logistic regression models were computed to examine the associations of each of these variables with self-reported arthritis. Third, logistic regression models were used to examine the association between sociodemographic variables, family history of dysfunction, and number of other physical health conditions, and self-reported arthritis. These models were stratified by CM history (yes/no) and sex (male/female). Both unadjusted and age-adjusted logistic regression models were computed. Finally, socioeconomic status (SES) by CM interaction terms were entered into logistic regression models (that included both CM and no CM groups) to examine whether the relationship between parameters of SES and arthritis for men and women

Table 5 Age-adjusted associations between parameters of SES and arthritis, in men with and without childhood maltreatment (CM) history

SES indicators	No CM *n* = 8084 AOR (95% CI)	CM *n* = 6296 AOR (95% CI)	SES×CM *p* value
Race/ethnicity	*n* = 8084	*n* = 6296	
White	1.00	1.00	REF
Black	0.89 (0.7–1.1)	0.86 (0.7–1.1)	NS
AI/AN	1.50 (0.8–2.9)	1.56 (0.9–2.7)	NS
A/NH/PI	*0.50 (0.3–0.9)**	*0.64 (0.4–0.96)**	NS
Hispanic	*0.53 (0.4–0.7)****	*0.52 (0.4–0.7)****	NS
Education	*n* = 8084	*n* = 6296	
Did not complete secondary/high school	*1.86 (1.5–2.3)****	*1.78 (1.4–2.3)****	NS
Completed secondary/high school	*1.66 (1.4–2.0)****	*1.67 (1.4–2.1)****	NS
Completed some college	*1.43 (1.1–1.8)***	*1.38 (1.1–1.7)***	NS
Completed a college degree	1.00	1.00	REF
Past-year household income US$	*n* = 8084	*n* = 6296	
≤ $19,999	*1.85 (1.5–2.3)****	*1.73 (1.3–2.3)****	NS
$20,000 to $39,999	*1.72 (1.4–2.1)****	*1.28 (1.0–1.6)**	*< 0.05*
$40,000 to $69,000	*1.36 (1.1–1.7)***	*1.37 (1.1–1.7)***	NS
≥ $70,000	1.00	1.00	REF
Family history of dysfunction	*n* = 8084	*n* = 6264	
No	1.00	1.00	REF
Yes	*1.26 (1.0–1.6)**	*1.54 (1.3–1.8)****	NS
Any other chronic physical health condition	*n* = 7993	*n* = 6170	
None	1.00	1.00	REF
One	*1.89 (1.6–2.3)****	*1.82 (1.5–2.2)****	NS
Two	*2.33 (1.9–2.9)****	*2.36 (1.8–3.1)****	NS
≥ Three	*4.40 (3.5–5.5)****	*4.01 (3.1–5.1)****	NS

Significant odds ratios are indicated in italic by *p* values: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

AOR age-adjusted odds ratio, *CM* childhood maltreatment, *NS* not significant, *OR* odds ratio, *SES* socioeconomic status, *AI/AN* American Indian/Alaska Native, *A/NH/PI* Asian/Native Hawaiian/Pacific Islander, *SES×CM* socioeconomic status × childhood maltreatment interaction term

separately was moderated by CM history. Results at $p \leq 0.05$ (and corresponding 95% confidence intervals) were considered statistically significant.

We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Results

Table 1 presents the prevalence, and unadjusted odds, of arthritis ($n = 9260$) across sex, age groups, parameters of SES, family history of dysfunction, and number of other physical health conditions. The odds of arthritis increased as age groups increased (all $p \leq 0.001$). For all age groups, odds of arthritis were larger for women compared to men, and the highest odds were observed for women and men aged ≥ 80 years (OR 31.2, 95%CI 26.2–37.3; OR 18.3, 95%CI 13.9–24.0, respectively). Compared to White persons, American Indian/Alaska Native men, but not women, were more likely to have arthritis (OR 1.4, 95%CI 1.0–2.0): other races/ethnicities had significantly lower odds of arthritis for both men and women compared to White persons. A dose-response trend was observed between income and education and arthritis, whereby decreasing income and education categories were related to increased odds of having arthritis, for both men and women. An increased likelihood of arthritis was associated with increasing numbers of chronic physical health conditions, with the highest odds being observed in women with three or more comorbidities (OR 12.2, 95%CI 10.6–14.0).

Table 2 presents the prevalence, and unadjusted odds, of associations between CM history and arthritis. Increased odds of arthritis were observed with each type of CM; this was observed for both sexes, except for women with exposure to IPV where no association was observed.

Tables 3 and 4 present the univariable, and Tables 5 and 6 present the age-adjusted associations between parameters of SES and arthritis in men and women with and without a

Table 6 Age-adjusted associations between parameters of SES and arthritis, in women with and without childhood maltreatment (CM) history

SES indicators	No CM *n* = 11,226 AOR (95% CI)	CM *n* = 8575 AOR (95% CI)	SES×CM *p* value
Race/ethnicity	*n* = 11,226	*n* = 8575	
White	1.00	1.00	REF
Black	*1.27 (1.1–1.5)***	1.07 (0.9–1.3)	NS
AI/AN	1.18 (0.7–2.0)	1.40 (1.0–2.0)	NS
A/NH/PI	*0.62 (0.4–0.9)**	*0.57 (0.4–0.9)***	NS
Hispanic	0.82 (0.6–1.0)	*0.73 (0.6–0.9)***	NS
Education	*n* = 11,226	*n* = 8575	
Did not complete secondary/high school	*1.37 (1.1–1.7)***	*1.71 (1.4–2.1)****	NS
Completed secondary/high school	*1.40 (1.2–1.7)****	*1.35 (1.2–1.6)****	NS
Completed some college	1.10 (0.9–1.3)	*1.25 (1.1–1.5)**	NS
Completed college degree	1.00	1.00	REF
Past-year household income US$	*n* = 11,226	*n* = 8575	
≤ $19,999	*1.82 (1.5–2.2)****	*1.69 (1.4–2.0)****	NS
$20,000 to $39,999	*1.67 (1.4–2.0)****	*1.37 (1.1–1.6)****	*< 0.05*
$40,000 to $69,000	*1.36 (1.1–1.6)***	1.08 (0.9–1.3)	NS
≥ $70,000	1.00	1.00	REF
Family history of dysfunction	*n* = 11,216	*n* = 8548	
No	1.00	1.00	REF
Yes	1.15 (1.0–1.4)	*1.17 (1.0–1.3)**	NS
Any other chronic physical health condition	*n* = 11,127	*n* = 8455	
None	1.00	1.00	REF
One	*1.94 (1.7–2.3)****	*1.69 (1.4–2.0)****	NS
Two	*2.34 (1.9–2.9)****	*2.57 (2.1–3.1)****	NS
≥ Three	*4.85 (3.9–6.0)****	*4.41 (3.5–5.5)****	NS

Significant odds ratios are indicated in italic by *p* values: *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$

AOR age-adjusted odds ratio, *CM* childhood maltreatment, *NS* not significant, *OR* odds ratio, *SES* socioeconomic status, *AI/AN* American Indian/Alaska Native, *A/NH/PI* Asian/Native Hawaiian/Pacific Islander, *SES×CM* socioeconomic status × childhood maltreatment interaction term

CM history. For men, the age-adjusted odds of arthritis were significantly lower for those who were Asian/Native Hawaiian/Pacific Islander or Hispanic compared to White men, and higher for those with lower educational attainment or income, a family history of dysfunction, and one or more chronic physical health conditions (Table 5). These associations were similar for those with and without a CM history. For women, greater age-adjusted odds of arthritis were seen in association with lower educational attainment, lower income, and with one or more chronic physical health conditions for those with and without CM history (Table 6). Compared to White women, greater odds of arthritis were observed for Black women without CM history, whilst significantly lower odds of arthritis were observed for Hispanic women with CM history and Asian/Native Hawaiian/Pacific Islander women with and without CM history (Table 6). In age-adjusted two-way interaction terms, CM did not moderate associations between arthritis and SES for men or women.

Discussion

We provide data regarding the associations between SES, CM history and family dysfunction, and arthritis in men and women across a wide age range. We also provide evidence regarding six different types of CM, including exposure to IPV and experiencing emotional abuse, about which the association with arthritis has been, to date, little investigated. All six types of CM were associated with increased odds of arthritis. Experiencing CM did not moderate the association between SES and arthritis, although small moderation effects of CM on associations between SES and arthritis were observed, which were inconsistent across males and females. We report that lower education, lower income, family history of dysfunction, and the presence of more than one chronic physical comorbidity increased the likelihood of having arthritis in those with and without CM.

Data have shown increased odds for poorer mental health outcomes in men who have CM history [39]. However, some data also suggest that there are certain factors that may

determine whether a childhood traumatic event, such as CM, may result in vulnerability to, or in resilience against, the onset of chronic disease later in life. It is imperative that "resilience" be understood as the process of adaptation in the face of adversity whereby distress is overcome and positive outcomes optimized [25]; importantly, this concept does not suggest that distress is not experienced. One key factor in resilience of children is the degree of support experienced in their developmental environment [42]. For instance, data has shown that the deleterious impact of war-related adversities experienced during childhood can be moderated by positive bonds between the child and caregivers and also the receipt of school-based social support from teachers and friends [43]. Furthermore, there are data suggesting that the neural circuits involved in resilience can be modified for many years after adversity [44, 45], hinting at the possibility that social stressors and adversities experienced across the life course have the ability to increase vulnerability to the effects of CM history on physical health outcomes later in life.

The associations we report are between arthritis and social disadvantage, which represent the well-documented social gradient of disease [46, 47]. Whilst estimates of the proportions of people that experienced each type of CM have been published elsewhere [34]: our findings of robust associations between CM history and arthritis are analogous to those previously observed, including in a German study of 331 patients with rheumatoid arthritis [48] and in a Canadian study of 11,108 individuals (10.1% with osteoarthritis) [8, 15], among others [9, 14]. However, in the current study, CM history did not moderate the relationship between sociodemographic variables and arthritis.

We have previously argued that areas of higher SES have greater social capital [3], a complex construct that may influence differences in arthritis between lower and higher SES due to concomitant differences in mutual concern for others, the extent of social networks, and their normative environments. Greater social capital has the potential to reduce the focus on disease, potentially influencing a reduced likelihood of those from advantaged areas of SES to report their health as poor [49]. Furthermore, various psychosocial factors may reduce vulnerability to stress and be protective against physical comorbidities [25]. One such factor is health literacy, a term that encompasses an array of elements influencing the effective management of health, including abilities as well as social supports and the accessibility of healthcare systems [50]. Higher health literacy, which is associated with greater social advantage and younger age [51, 52], is also associated with increased uptake of preventive behaviors [53] and has previously been suggested as a mediator in the relationship between social advantage and better health outcomes [53, 54].

This study has some noteworthy strengths. Our study provides evidence for the association between SES, CM, and arthritis using data from a large and representative sample of adults from the US. Furthermore, we add to the evidence-base by presenting data for different types of CM, particularly in terms of being exposed to IPV and experiencing emotional abuse, and family dysfunction. We also report some limitations in this work. Our data are retrospective and cross-sectional, so inferences regarding causation cannot be made. The definition of arthritis used in the NESARC was non-specific, and as such, we are unable to comment on whether the observed relationships may hold true for types of arthritis, for instance rheumatoid arthritis or osteoarthritis, but not for others. However, as we have previously indicated [30], self-reported data has acceptable concordance with medical records of diagnosed physical conditions [55]. Despite this, it may be possible that both CM history and SES may result in recall bias, or differential reporting, of arthritis. Our analyses did not include adjustment for other potential confounders, such as body mass index, physical activity levels, or social support. Although the NESARC population is a nationally representative sample of community-dwelling adults residing in the US including Districts of Columbia, Alaska, and Hawaii, we caution against assuming generalizability of these results to other countries or populations.

In conclusion, CM did not show large moderation of the association between arthritis and lower SES, and indeed any of the small moderation was inconsistent between the sexes. This study confirms previous research findings and provides evidence that all types of CM were associated with increased odds of arthritis, and this encompasses being exposed to IPV and experiencing emotional abuse. This study also confirms previous findings regarding several SES factors being associated with the increased odds of arthritis, including the history CM. Reducing the burden of CM could be considered a means of primary prevention of arthritis. Further longitudinal research is warranted to investigate why associations between social disadvantage and arthritis remained despite CM history.

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Compliance with ethical standards

Conflicts of interest None.

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