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ORIGINAL ARTICLE

Retrospective reports of socioeconomic disadvantage in childhood and mortality risk: are associations consistent across measures and sex?

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Abstract Although prior research has established associations between childhood socioeconomic disadvantage and all-cause mortality, there is still limited research investigating (1) the consistency between subjective and objective reports of childhood socioeconomic status, (2) sex differences in the associations between childhood socioeconomic disadvantage and all-cause mortality, and (3) potential mediators within these associations. Drawing on data from the Midlife in the United States (MIDUS) cohort (N = 7425), we examined the associations between three distinct indicators of childhood socioeconomic disadvantage and all-cause mortality risk, and whether these associations differ for males and females. Among males only, lower perceived relative childhood financial status, lower levels of parents' education, and receipt of welfare during childhood were associated with excess mortality risk, adjusted for age and minority status, with adjusted hazard ratios ranging from 1.24 (95% confidence interval (CI): 1.02, 1.51) for perceived childhood financial status to 1.28 (95% CI: 1.11, 1.47) for welfare in childhood. When additionally adjusted for education, substance use, depression, and underlying health conditions, only childhood welfare status maintained an association with mortality (AHR, 1.17; 95% CI, 1.02–1.35). Mediation analyses among males revealed that education, substance use, depression, and underlying health conditions accounted for substantial proportions of these associations, ranging from 31.03 to 57.63%, across indicators of childhood socioeconomic disadvantage. Future research is needed to clarify the developmental mechanisms that lead to sex differences and identify effective strategies to intervene on the relation between childhood socioeconomic position and excess mortality risk among males.

Keywords Child SES · Mortality · Mediation · Survival analysis

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Introduction

Population-based research in the USA has consistently shown the detrimental impacts of

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socioeconomic disadvantage in childhood on long-term health and mortality, with consistent results across different study designs and analytic techniques [1, 2]. Over the last two decades, studies have documented associations between childhood socioeconomic disadvantage and an elevated risk for many negative health outcomes decades later, including functional limitations [3–5], heightened allostatic load [6, 7], chronic diseases such as cancer, diabetes, and hypertension [8–11], and all-cause mortality [4, 12]. However, within this extensive literature, few studies have evaluated whether objective and subjective retrospective reports of childhood socioeconomic disadvantage display similar relationships with mortality in mid- to late life, and there are many open questions with regard to potential sex differences and pathways. In the present study, we advance research on childhood socioeconomic disadvantage and mortality by (1) examining the consistency of associations across three retrospective reports of childhood socioeconomic position; (2) testing for potential differences in these associations for men and women; and (3) quantifying the contributions of social, behavioral, and health mechanisms for any observed associations.

Retrospective measures of childhood socioeconomic disadvantage

In studies of childhood socioeconomic status in relation to adult health, it is common for researchers to operationalize childhood socioeconomic disadvantage using a single metric of family socioeconomic position, such as paternal occupation [13] or highest parental education [14], or to create a composite variable that combines multiple measures [7, 15–17]. However, in a study involving several large cohorts, Braveman and colleagues demonstrated that reliance on a single metric of socioeconomic status (SES) may not allow researchers to investigate how specific aspects of socioeconomic status impact health [18]. Furthermore, while studies on this topic have commonly relied on non-subjective reports of childhood SES (e.g., reported parental education or receipt of welfare as a child), researchers have also studied subjective reports of childhood SES (e.g., perceptions of relative socioeconomic position) in relation to mortality [19, 20]. To date, limited research has examined whether objective and subjective reports of childhood SES display similar associations with adult mortality. A recent meta-analysis examining the association between socioeconomic status and subjective well-being suggests that concordance between objective (income and educational attainment) and subjective measures (the MacArthur Ladder, perceived relative socioeconomic status) is moderate at best ($r = 0.32$) [21]. Multiple meta-analyses have also found that subjective measures of SES are more strongly associated with health outcomes (e.g., hypertension, mortality, self-rated health) than objective measures [21, 22], suggesting that subjective and objective reports may provide unique information.

Sex differences and potential mechanisms

There is an increasing interest in studying sex differences in childhood socioeconomic disadvantage and health outcomes [23–25], and existing studies present conflicting findings. Some studies suggest that associations between childhood socioeconomic disadvantage and health are stronger in women compared to men, including outcomes of high blood pressure [26], depression [27], and mortality [4, 28]. In contrast, other research has suggested similar associations may be stronger in men compared to women, including poor immunological performance [29], inflammation [30], lung function [31], and mortality [12]. Additional research is needed to clarify the nature of these relationships, as well as the social, behavioral, and health mechanisms that may underlie these associations.

Previous research has suggested that stressful experiences during childhood, including childhood socioeconomic disadvantage, may contribute to the adaptation of unhealthy lifestyle behaviors, such as cigarette smoking and alcohol consumption, that may in turn contribute to the development of poor health [32]. Educational attainment is well established as one mediator between childhood socioeconomic disadvantage and mortality [6, 14]. A recent study using the Midlife in the United States (MIDUS) cohort found that smoking, sedentary behavior, obesity/BMI, and cardiovascular disease displayed significant indirect effects in the association between psychosocial stress and all-cause mortality [33]. However, additional research is necessary to examine additional potential mediators in the association between childhood socioeconomic disadvantage and mortality [34].

The present study

Drawing on data from the Midlife in the United States (MIDUS) study, a large national prospective cohort, the present study examined associations between individual aspects of childhood socioeconomic disadvantage and all-cause mortality risk and tested whether these associations differ based on sex. For observed associations, we investigated potential social, behavioral, and health mechanisms using mediation analyses. We hypothesized that each of the three retrospective reports of childhood socioeconomic disadvantage would be associated with a higher likelihood of all-cause mortality, and that associations would be stronger in women than men. In addition, we hypothesized that education, substance use, depression, and diagnoses of underlying health conditions would mediate the observed associations.

Methods

Study sample

We used data from MIDUS, a national cohort study of noninstitutionalized English-speaking adults between the ages of 25 and 74 at baseline, recruited through random-digit dialing [35]. The original participants (MIDUS 1, $N = 7108$) were recruited between January 1995 and September 1996 and included siblings or twins for a subset of respondents. A follow-up of 4963 MIDUS 1 participants occurred between January 2004 and August 2005 (70% response rate; referred to as MIDUS 2). Simultaneously, researchers recruited a supplement sample of 592 African Americans from Milwaukee, WI, to increase the participation of African Americans in MIDUS. Investigators collected data via a phone interview and, for the main sample only, self-administered questionnaires (SAQ) were mailed to the participant's residence.

For MIDUS 1, the response rate for data collection was 70% for the phone interview, and 89% of participants completed the SAQ. For MIDUS 2, the response rate was 71% for the Milwaukee sample, 70% for the main sample, and 80% of participants in the main sample completed the SAQ. All participants with complete data on all exposure, outcome, and confounding variables were included in our analyses. For participants with missing information on confounding or mediating variables as part of MIDUS 1 (e.g., sociodemographic characteristics, smoking, drinking, diagnoses of heart disease or cancer), we used data on the same variables from MIDUS 2 if available to maximize our analytic sample ($N = 638$, 8.5% of the total sample). All data on the Milwaukee sample was collected as part of MIDUS 2. Following this approach, our study sample included all complete cases from MIDUS 1. After excluding individuals with missing data on any covariate, 7425 participants were included in our main analytic sample (6871 participants from the original MIDUS sample and 554 participants from the Milwaukee sample; see Fig. 1); see Appendix Table 4 for a comparison of those included and excluded. Mortality data up until June 2018 was obtained from the National Death Index.

Measures

Childhood socioeconomic disadvantage was operationalized using three self-report measures and collected at MIDUS 1: (1) perceived relative financial status, (2) parents' highest educational attainment, and (3) welfare receipt. Participants rated their *perceived relative childhood financial status* by responding to one item that asked them to rate their childhood financial status relative to others on a scale from (1) a lot worse off than others to (7) a lot better off than others (Adler, Epel, Castellazzo, and Ickovics 2000). A scale point of (4) represented that participants felt their financial situation was about the same as others. Consistent with prior studies [7, 15], we created a three-category variable: (0) better off than others, (1) about the same as others, and (2) worse off than others. We constructed a measure of *parents' highest education* using two items that asked participants to report the highest level of education that their mother and father had each completed. Each item had 12 response options, and we created a single categorical variable to reflect the highest education attained, categorized into (0) bachelor's degree or higher, (1) high school diploma/GED, and (2) less than high school education, to represent important cut-offs in earning ability [7, 15, 16]. Finally, participants reported on receipt of *welfare* during childhood using one binary item that asked the participant to indicate whether they had ever been on welfare during childhood (yes/no).

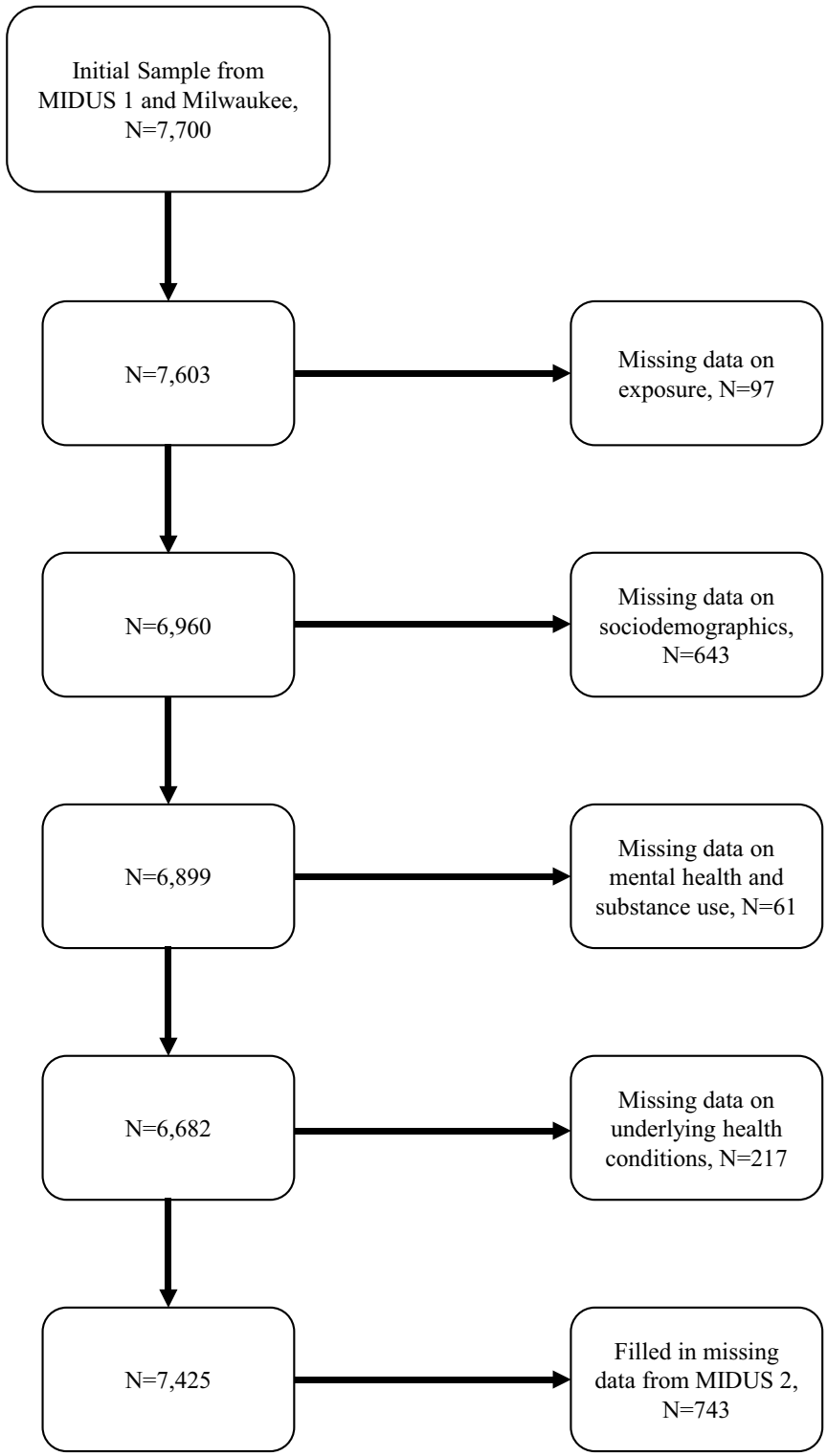

Fig. 1 Sample selection flowchart

The outcome, *all-cause mortality*, was obtained via linked records through June 2018 from the National Death Index.

Potential mediators

We examined the following variables as mediators: (1) educational attainment (bachelor's degree or more, high school diploma/GED, less than high school education); (2) substance use, which included regular smoking, measured via a binary item asking whether the participant smokes regularly now, and drinking, measured by asking the participant to report their alcohol consumption during the year they drank the most from never to every day on a 6-point scale (modeled as a continuous score); (3) depression, defined based on self-reported depressed affect or anhedonia, classified as scoring a four or greater on either 7-point scale [36]; and (4) history of heart problems, cancer, hypertension, or diabetes, assessed by items asking whether the participant had "ever had heart trouble suspected or confirmed by a doctor," "ever had cancer," "experienced or had been treated for hypertension," or reported use of medication for hypertension in the past 30 days, and "experienced or had been treated for diabetes or high blood sugar" or reported use of medication for diabetes in the past 30 days.

Control variables

Informed by prior literature [37], we included relevant demographic characteristics and personality characteristics that could influence retrospective reporting as potential confounders. Demographic characteristics included age (continuous, median split for interaction tests), sex (male vs. female), and minority status (non-White vs. White). Personality traits of conscientiousness (α = 0.58) and neuroticism (α = 0.74) were each measured using the average of four items [38], asking participants to self-describe themselves through a series of adjectives. Each personality trait score was separated into tertiles for analyses.

Statistical analyses

All analyses were conducted using SAS 9.4. First, we examined descriptive statistics for the sample overall and stratified by sex. Second, using a basic model without any confounders or mediators, we tested for effect modification by sex using interaction terms; based on these initial findings, we proceeded with sex-stratified models. Third, we conducted separate Cox proportional hazards regression models [39] for each measure of childhood socioeconomic disadvantage, with covariates added sequentially in blocks. Our first model adjusted only for demographic variables (age and minority status). Next, we sequentially added variables for our potential mediators, including educational attainment (model 2), substance use (smoking, alcohol consumption) and depression (model 3), and underlying health conditions (cancer, heart disease, hypertension, diabetes; model 4). All models were adjusted for familial clustering, given that our sample included $N = 871$ siblings or twins.

Finally, we estimated indirect associations for the potential mediators in our sequence of models. We used VanderWeele's difference method [40] to calculate the change in the association beta estimate when including each potential mediator. Beta estimates were generated using the Cox proportional hazards modeling. For our mediation analysis, beta estimates can be directly used to calculate percentages mediated; the percentage mediated is calculated as the indirect effect beta estimate divided by the total effect beta estimate. Note that positive beta estimates indicate a positive association (i.e., corresponding to hazard ratios greater than 1), while negative beta estimates indicate a negative association (i.e., corresponding to hazard ratios less than 1). We used bootstrapping with 1000 repetitions to generate 95% confidence intervals (CIs) for each indirect association.

Sensitivity analyses

We conducted three sensitivity analyses. First, we included personality factors of conscientiousness, neuroticism as potential confounders. Of note, this model had a slightly reduced sample size due to missing data on these variables (n = 6107). Second, we estimated our models with all measures of childhood socioeconomic disadvantage within the same model, in order to determine whether they were independently associated with mortality. Third, considering the large age range of the sample at baseline (25–74 years), we also tested for interactions between age

and each measure of childhood socioeconomic disadvantage in sex-stratified models.

Results

Descriptive statistics from our analytic sample are displayed in Table 1. The mean age of the sample was 46.64 years old at baseline (SD = 12.96), 41.12% perceived their relative childhood financial status as worse off than others, and 31.42% had parents with less than a high school diploma or GED. Approximately 9% of the sample reported being on welfare at some time during their childhood. By June 2018, a total of 19.08% (N = 1417) of our analytic sample participants were confirmed as deceased. Females tended to have greater personality trait scores, higher rates of depression, and higher prevalence of cancer and hypertension history than males. All three measures of childhood socioeconomic disadvantage were correlated with one another (range: 0.140 to 0.256; $p < 0.0001$, Supplemental Table 1).

Cox proportional hazards regression models

Using multiplicative interaction tests for each measure of childhood socioeconomic disadvantage, we identified sex as an effect modifier of the association between childhood welfare status and mortality (interaction hazard ratio (IHR), 1.31; 95% CI: 1.07–1.60; $p < 0.05$); the p-values for interactions between sex and childhood financial status (IHR, 1.25; 95% CI: 0.95–1.66; $p = 0.12$) and sex and highest level of parents' education (IHR, 1.13; 95% CI: 0.87–1.48; $p = 0.37$) were not significant at $p < 0.05$, yet were in the same direction as the interaction observed for welfare status. Accordingly, we conducted sex-stratified analyses for the remainder of the analyses.

Table 1 Sample characteristics (N = 7425)

Variable	Full sample (N = 7425)	Males (N = 3524)	Females (N = 3901)	p-value
Perceived childhood financial status, %				
Better off than others	24.18	25.65	22.84	0.008
About the same as others	34.71	33.34	35.94	
Worse off than others	41.12	41.00	41.22	
Highest level of parents' education,%				<0.0001
Bachelor's degree or higher	33.67	34.68	32.76	
High school diploma/GED	34.91	37.15	32.89	
Less than high school	31.42	28.18	34.35	
Childhood welfare status, %	8.57	7.78	9.28	0.021
Deceased, %	19.08	21.08	17.28	<0.0001
Age at baseline, M (SD)	46.64 (12.96)	46.27 (12.83)	46.97 (13.07)	0.019
Minority status, %	26.30	25.68	26.86	0.247
Highest level of education, %				
Bachelor's degree or higher	57.29	61.41	53.58	<0.0001
High school diploma/GED	26.75	24.69	28.61	
Less than high school	15.96	13.90	17.82	
Conscientiousness (range 0–4), M (SD)	3.42 (0.44)	3.37 (0.44)	3.47 (0.43)	<0.0001
Neuroticism (range 0–4), M (SD)	2.23 (0.66)	2.16 (0.65)	2.30 (0.67)	<0.0001
Regular smoking, %	23.07	23.92	22.30	0.098
Alcohol consumption (range 1–6), M (SD)	3.17 (1.53)	3.67 (1.53)	2.72 (1.38)	<0.0001
Clinical depression, %	13.01	9.93	15.79	<0.0001
History of heart problems, %	18.13	18.39	17.89	0.580
History of cancer, %	7.03	5.33	8.56	<0.0001
History of hypertension, %	18.96	17.76	20.05	0.012
History of diabetes, %	5.02	5.39	4.69	0.168

Perceived relative childhood financial status was significantly associated with all-cause mortality among males when adjusting for demographic factors (adjusted hazard ratio (AHR), 1.24; 95% CI, 1.02–1.51), but became null when adjusting for education (see Table 2, model 2).

When examining the highest level of parents' education as our main predictor, we found a significant main effect between the highest level of parents' education and all-cause mortality when adjusting for demographic factors among males (AHR, 1.39; 95% CI, 1.13–1.70). This association remained significant when adjusting for the respondents' education (AHR, 1.29; 95% CI, 1.05–1.60). This association was attenuated after further adjustment for substance use and depression (see Table 2, model 3).

Analyses examining childhood welfare status revealed significant associations between childhood welfare status and all-cause mortality among males, adjusting for demographic factors (AHR, 1.28; 95% CI, 1.11–1.47). The association among males remained significant when adjusting for education (AHR, 1.26; 95% CI, 1.10–1.45) and substance use and depression (AHR, 1.17; 95% CI, 1.02–1.35). Further adjustment for underlying health conditions attenuated the association (Table 2, model 4).

All models to examine perceived relative childhood financial status, parents' education, and childhood welfare status in relation to mortality risk were null for females.

Sensitivity analyses

Results were marginally different across all measures with the inclusion of personality factors in our exploratory models. The adjusted hazard ratios for perceived childhood financial status, highest level of parents' education, and childhood welfare status only changed by 0.12, 0.01, and 0.01, respectively (see Table 2, model 5).

Analyses examining all three measures of childhood socioeconomic disadvantage within the same model revealed associations primarily between childhood welfare status and mortality (see Supplemental Table 2).

Within our sex-stratified models, we tested multiplicative interaction tests between each measure of childhood socioeconomic disadvantage and age, using a median age split. These tests revealed significant age interactions for perceived childhood financial status, highest level of parents' education, and childhood welfare status among males, and highest level of parents' education among females.

In general, these sensitivity analyses revealed that associations between childhood socioeconomic disadvantage and mortality were more pronounced among younger adults compared to older ones. Among males, perceived childhood financial status was the most significant predictor of all-cause mortality, in contrast to females, where highest level of parents' education was the most significant predictor (see Supplemental Tables 3 and 4).

Mediation analyses

We conducted mediation analyses to examine indirect effects via our proposed mediators in the models with male respondents that displayed a significant main effect. For perceived relative childhood financial status, a significant indirect effect was established only for most models (Table 3). Of the total association between perceived relative childhood financial status, 31.03% of the total association among males could be explained by education, substance use, depression, and underlying health conditions.

For highest level of parents' education, a significant indirect effect was established for education only (Table 3). Of the total association between the highest level of parents' education and all-cause mortality among males, a total of 44.67% of the association could be explained by education, substance use, depression, and underlying health conditions.

For childhood welfare status, our mediation analyses revealed significant indirect effects for all models (Table 3). Of the total association between childhood welfare status and all-cause mortality among males, 57.63% could be explained by education, substance use, depression, and underlying health conditions.

Discussion

Building upon previous research, this study investigated sex differences in the associations between three retrospective measures of childhood socioeconomic disadvantage and all-cause mortality. Men who grew up in families that received welfare at any point in childhood displayed an increased risk of mortality

Table 2 Cox regressions estimating the hazard of mortality among participants, stratified by sex [MIDUS 1 (1995–1996), Milwaukee sample (2012–2013)]

	Model 1		Model 2		Model 3		Model 4		Model 5 ($N = 2894$)	
	HR	95% CI	AHR	95% CI	AHR	95% CI	AHR	95% CI	AHR	95% CI
Males ($N = 3524$)										
Perceived childhood Financial status										
Better off than others	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
About the same as others	1.07	(0.88, 1.30)	1.03	(0.84, 1.26)	0.98	(0.80, 1.20)	0.94	(0.77, 1.15)	0.90	(0.73, 1.12)
Worse off than others	**1.24**	**(1.02, 1.51)**	1.20	(0.99, 1.47)	1.12	(0.92, 1.36)	1.11	(0.91, 1.36)	0.99	(0.80, 1.23)
Highest level of parents' education										
Bachelor's degree+	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
High school diploma/GED	1.32	(1.08, 1.62)	1.28	(1.04, 1.57)	1.15	(0.93, 1.42)	1.12	(0.91, 1.38)	1.06	(0.85, 1.33)
Less than high school	**1.39**	**(1.13, 1.70)**	**1.29**	**(1.05, 1.60)**	1.23	(0.99, 1.52)	1.20	(0.97, 1.48)	1.19	(0.95, 1.49)
Childhood welfare status										
No	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
Yes	**1.28**	**(1.11, 1.47)**	**1.26**	**(1.10, 1.45)**	**1.19**	**(1.03, 1.36)**	**1.17**	**(1.02, 1.35)**	1.16	(0.98, 1.36)
	Model 1		Model 2		Model 3		Model 4		Model 5 ($N = 3213$)	
	HR	95% CI	AHR	95% CI	AHR	95% CI	AHR	95% CI	AHR	95% CI
Females ($N = 3901$)										
Perceived childhood Financial status										
Better off than others	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
About the same as others	1.05	(0.87, 1.28)	1.03	(0.85, 1.26)	1.05	(0.86, 1.28)	0.99	(0.81, 1.20)	0.96	(0.77, 1.18)
Worse off than others	1.00	(0.81, 1.24)	0.96	(0.77, 1.20)	0.97	(0.77, 1.21)	0.97	(0.78, 1.21)	0.89	(0.70, 1.14)
Highest level of parents' education										
Bachelor's degree+	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
High school diploma/GED	1.20	(0.97, 1.50)	1.20	(0.96, 1.50)	1.15	(0.92, 1.44)	1.16	(0.92, 1.46)	1.12	(0.88, 1.44)
Less than high school	1.21	(0.99, 1.48)	1.18	(0.96, 1.46)	1.14	(0.92, 1.41)	1.12	(0.90, 1.39)	1.00	(0.79, 1.27)
Childhood welfare status										
No	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00	Ref	1.00
Yes	0.97	(0.84, 1.13)	0.96	(0.83, 1.11)	0.96	(0.83, 1.11)	0.98	(0.85, 1.13)	1.03	(0.88, 1.20)

Each childhood indicator is estimated in separate models. Survey weights have been applied to account for complex survey design

HR, hazard ratio; *AHR*, adjusted hazard ratio; *GED*, general education development or high school equivalency diploma

Model 1 displays the association between the selected childhood socioeconomic indicator and odds of mortality, adjusted for age, and minority status

Model 2 adds respondent socioeconomic status to the model, proxied by education level. Education level is broken into three categories by degree level (less than high school, high school diploma/GED, and college diploma)

Model 3 adds substance use and mental health conditions (smoking, alcohol consumption, depression)

Model 4 adds pre-existing health conditions (cancer, heart disease, hypertension, diabetes)

Model 5 adds personality factors (conscientiousness, neuroticism) in a reduced sample size due to missing data

Table 3 Mediation analyses describing the associations between childhood socioeconomic disadvantage and odds of all-cause mortality among males ($N = 3524$)

	Total effect estimate	Indirect effect estimate	95% CI	Percent mediated
Perceived childhood financial status: less than average vs. average/better off				
+Education	0.17	0.01	**(0.0004, 0.028)**	**7.58%**
+Alcohol consumption	0.15	0.02	(−0.002, 0.040)	**11.95%**
+Smoking	0.13	0.05	**(0.017, 0.080)**	**36.59%**
+Depression	0.13	0.05	**(0.016, 0.081)**	**37.07%**
+Heart disease	0.16	0.04	**(0.004, 0.075)**	**23.03%**
+Cancer	0.16	0.04	**(0.004, 0.077)**	**25.05%**
+Hypertension	0.16	0.04	**(0.003, 0.076)**	**24.26%**
+Diabetes	0.15	0.05	**(0.011, 0.084)**	**31.03%**
Highest level of parents' education: less than high school vs. high school diploma/GED and bachelor's degree+				
+Education	0.11	0.06	**(0.014, 0.098)**	**51.27%**
+Alcohol consumption	0.12	0.04	(−0.003, 0.090)	**36.13%**
+Smoking	0.12	0.04	(−0.019, 0.106)	**36.57%**
+Depression	0.12	0.05	(−0.016, 0.120)	**40.13%**
+Heart disease	0.11	0.04	(−0.026, 0.106)	**33.46%**
+Cancer	0.12	0.04	(−0.024, 0.110)	**34.00%**
+Hypertension	0.12	0.04	(−0.023, 0.110)	**35.08%**
+Diabetes	0.11	0.05	(−0.017, 0.119)	**44.67%**
Childhood welfare status				
+Education	0.11	0.02	**(0.001, 0.041)**	**15.26%**
+Alcohol consumption	0.22	0.03	**(0.005, 0.057)**	**12.56%**
+Smoking	0.18	0.07	**(0.024, 0.125)**	**40.18%**
+Depression	0.18	0.08	**(0.029, 0.135)**	**45.07%**
+Heart disease	0.16	0.10	**(0.034, 0.161)**	**61.47%**
+Cancer	0.15	0.10	**(0.033, 0.164)**	**62.87%**
+Hypertension	0.15	0.10	**(0.033, 0.164)**	**63.35%**
+Diabetes	0.16	0.09	**(0.022, 0.167)**	**57.63%**

relative to men who grew up in more advantaged households, adjusting for sociodemographic characteristics, substance use and mental health conditions, and underlying health conditions. These associations were not evident for women. Our results also show that among males, education, substance use, depression, and underlying health conditions explain a substantial portion of the association between all three of these indicators of childhood socioeconomic disadvantage and mortality. Our study expands on prior research that has examined childhood financial status in relation to all-cause mortality by considering the performance of three retrospective measures [41–43], testing for sex differences [37], and considering potential pathways [6, 14]. Considering first the different indicators of childhood socioeconomic disadvantage, we observed similar associations between all three indicators and all-cause mortality. These findings differ from previous work that suggests subjective measures have stronger associations with health than objective ones [21, 22].

With respect to sex differences within this association, our findings deviate from other studies that suggest associations between childhood socioeconomic disadvantage and mortality are stronger in women than men [4, 28]. These studies represent different populations during older time periods; Turrell et al. examine deaths in one county in California from 1965 to 1994, while Kuh et al. examine deaths in a European cohort from 1946 to 1971, while our study examines a national US cohort from 1995 to 2018. It is possible that our results differ from these

prior studies as the result of differences based on sample composition or secular changes. In particular, it is worth noting that males in our sample are significantly more educated than females (see Table 1), whereas education levels between men and women in previous studies are more similar.

Our findings are consistent with other work showing that financial adversity in adulthood is more strongly associated with poor health outcomes among men than women [4, 44–47]. A recent study involving 2152 French community-dwelling participants over the age of 65 found that experiencing major financial problems was associated with mortality risk only among men [45]. Another study utilizing the Health and Retirement Study found that the association between financial hardship and mortality risk was greater in men than in women [46]. Related results from a population-based study in Austria suggest that the relationship between improved area-level socioeconomic conditions and decreased odds of mortality is stronger for men compared to women [48].

Finally, our mediation analyses showed that education, substance use, depression, and underlying health conditions may partially explain the associations between childhood socioeconomic disadvantage and all-cause mortality. These findings are consistent with previous studies citing education as a significant mediator between childhood SES and mortality [6, 14] and quantify the impact of substance use, depression, and underlying health conditions as additional potential mediators. In a recent MIDUS study discussed previously [33], the authors found that smoking, sedentary behavior, obesity/BMI, and cardiovascular disease displayed indirect effects of 14%, 12%, 11%, and 4%, respectively, which falls in line with our findings. In particular, it is important to note the strength of association between smoking and mortality across all models. Relatedly, a recent study examining associations between wealth and mortality using the MIDUS cohort found that the association between wealth and lower probability of mortality was stronger among never smokers compared to current smokers, emphasizing the importance of smoking on mortality in the context of SES [49]. Although outside the scope of our paper, future research may benefit from investigating interactions between childhood socioeconomic disadvantage and smoking, in relation to mortality, especially considering the established association between smoking and mortality [50]. Given that our mediation analyses only explained a portion of the association between childhood socioeconomic disadvantage and mortality risk, additional research is needed to examine additional mediators that may explain the remainder of this relationship.

Limitations

There are several limitations of the present study. First, this study relies on retrospective measures of childhood socioeconomic disadvantage, which may be vulnerable to recall bias [51]. Notably, a prior study found that retrospective report of childhood experiences is reliable, with over 80% agreement between adult female twins reporting parental education and childhood financial status relative to others [52]. In contrast, our study showed lower concordance between twins reporting childhood socioeconomic disadvantage (perceived relative childhood financial status, $\kappa = 0.30$; highest level of mothers' education, $\kappa = 0.66$; highest level of fathers' education, $\kappa = 0.64$; childhood welfare status, $\kappa = 0.61$).

Given the potential stigma of growing up poor, it is possible that survey responses are vulnerable to social desirability bias (e.g., individuals who grew up in families that received welfare may not report it). Accordingly, our study may be vulnerable to exposure misclassification, especially for perceived relative childhood financial status, which may have biased our results toward the null. Second, the MIDUS cohort is relatively homogeneous (disproportionately non-Hispanic White and higher socioeconomic status), and thus, our results may not be generalizable to the broader US population. Notably, our excluded participants (see Appendix Table 4) are more likely to be disadvantaged or be non-White compared to our included participants, which may also contribute to this potential bias. Future research should focus on replicating these results with more diverse samples to examine these relationships among other racial and ethnic groups. This study is also limited by the subjective reporting of perceived childhood financial status and childhood welfare status. Future work is needed using objective measures of childhood welfare status, such as administrative records, to decrease the likelihood of exposure misclassification. Finally, given that this is an observational study, there are likely important unobserved characteristics that may function as confounders of the associations of interest.

Conclusions and implications

Using a large national cohort, we examined the associations between three retrospective reports of childhood socioeconomic disadvantage and all-cause mortality. We found relatively consistent associations across three retrospective reports of childhood socioeconomic disadvantage, with stronger associations for males relative to females. Our study also identified education, substance use, depression, heart disease, cancer, hypertension, and diabetes as mediators, thus providing information that can be used to developed and prioritize public health interventions to address health disparities that originate from differences in childhood SES. In future research, it will be important to replicate these findings with prospective data on childhood socioeconomic disadvantage and carefully examine potential mechanisms that may lead to the sex differences found in our study. In addition to examining associations between childhood socioeconomic disadvantage and other health outcomes, including cause-specific mortality, it is also imperative to investigate the biological mechanisms. This line of work has the potential to prevent or alleviate poor health conditions among socioeconomically disadvantaged populations.

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Declarations

Competing interests The authors declare no competing interests.

Appendix

Table 4 Comparison of sample characteristics between excluded ($N = 275$) and included participants ($N = 7425$)

Variable	Excluded participants ($N = 275$)	Full sample ($N = 7425$)
Perceived childhood financial status, %		
Better off than others	9.09	24.18
About the same as others	26.18	34.71
Worse off than others	64.73	41.12
Highest level of parents' education,%		
Bachelor's degree or higher	17.82	33.67
High school diploma/GED	32.73	34.91
Less than high school	49.45	31.42
Childhood welfare status, %	10.67	8.57
Deceased, %	34.18	19.08
Age at baseline, *M* (SD)	52.05 (13.14)	46.64 (12.96)
Minority status, %	53.45	26.30
Highest level of education, %		
Bachelor's degree or higher	36.36	57.29
High school diploma/GED	26.91	26.75
Less than high school	36.73	15.96
Conscientiousness (range 0–4), *M* (SD)	3.32 (0.48)	3.42 (0.44)
Neuroticism (range 0–4), *M* (SD)	2.40 (0.69)	2.23 (0.66)
Regular smoking, %	29.20	23.07
Alcohol consumption (range 1–6), *M* (SD)	3.27 (1.69)	3.17 (1.53)
Clinical depression, %	16.36	13.01
History of heart problems, %	25.61	18.13
History of cancer, %	7.35	7.03
History of hypertension, %	28.00	18.96
History of diabetes, %	4.17	5.02

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