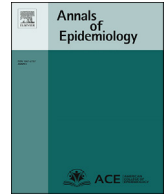




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Original article

Material hardship, perceived stress, and health in early adulthood

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ARTICLE INFO

Article history:

Received 18 June 2020

Accepted 21 August 2020

Available online 17 September 2020

Keywords:

Material hardship

Health status

Early adulthood

Perceived stress

ABSTRACT

Purpose: We examined the associations between material hardship and health outcomes in early adulthood and the extent to which these associations are mediated by perceived stress.

Methods: We used wave I and IV of the National Longitudinal Study of Adolescent Health, a nationally representative survey of young adults aged 18–34 years old ($n = 13,313$). Multivariate logistic regression and decomposition methods were used to evaluate the associations between types and depth of material hardship (food, bill-paying, and health resource hardship), health outcomes (self-rated health, depression, sleep problems, and suicidal thoughts) in early adulthood, and the extent to which these associations were mediated by perceived stress.

Results: The adjusted odds of fair or poor health status, depression, sleep problems, and suicidal thoughts were higher among individuals with material hardship than counterparts without. A considerable proportion of the association between material hardship and health outcomes was attributable to perceived stress.

Conclusions: Material hardship is associated with adverse health outcomes in early adulthood, and these relationships are robust after accounting for various sociodemographic characteristics and family background. Perceived stress accounted for a sizable portion of the effects of material hardship on health.

Public Health Implications: Efforts to promote health equity in young adults should focus on material hardship and associated stressful conditions.

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Material hardship occurs when people forgo necessities, such as food, medical care, housing, and basic utilities because of insufficient financial resources [1,2]. Since the onset of the coronavirus 2019 (COVID-19) pandemic in Spring 2020, 1 in 3 adults report experiencing material hardship [3,4]. While it is well understood that mortality and morbidity are generally higher among poor individuals than among their nonpoor counterparts [5–7], the correlation between material hardship and income poverty is moderate at best [2,8]. As a consequence, although the health impact of income poverty on population health has attracted much attention [9,10], our understanding of the relationship between material hardship and health outcomes is incomplete, particularly at the point of emerging and young adulthood (spanning approximately ages 18–30 years old [11]). Young adulthood represents an important developmental period that is distinct from adolescence

and older adulthood when investments in education and economic instability may increase the risk for material hardship. In addition, the impact of material hardships on health during this life stage may have implications for the sustained morbidity and mortality inequalities in later adulthood [12–16].

Previous studies have shown significant correlations between a single type of material hardship and individual physical and mental health status. For example, an increasing number of studies on the relationship between food hardship and health in recent years suggest that individuals from food insecure households have more acute and chronic health conditions and are in poorer health than are their food secure counterparts [17,18]. Another strand of research examines the causes and consequences of unmet medical needs. This type of hardship occurs when individuals are unable to receive needed health care due to cost [19]. Research in this area suggests that unmet health care needs in emerging adulthood is common [20,21], and it is a consistent predictor of poor adult health [22–24]. Another form of material hardship, housing hardship, occurs when individuals do not have stable housing arrangements. Individuals who experienced severe housing hardship, such as eviction and homelessness, suffer more health problems than

Conflict of interests: The authors declare no conflict of interests.

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individuals without such housing hardship [25–27]. Finally, bill-paying hardship occurs when individuals are unable to pay essential bills. The consequences of bill-paying hardship can be severe, leading to utility interruption or shutoff, housing instability or eviction, wage garnishment, or bankruptcy [28]. Each of these forms of material hardship is experienced as significant stressful events and are adversely associated with health outcomes, particularly mental health [29–32].

Psychosocial stress has emerged as a leading mechanism linking material hardship and poor health. The stress process model proposed by Pearlin [33,34] posits that social characteristics including those surrounding socioeconomic status lead to stress exposures that affect health and psychological well-being. The stress process framework specifically hypothesizes that stressful life conditions can set in motion physiological responses to maintain equilibrium within the body and that, under conditions of chronic stress, these responses may contribute to cumulative indicators of increased physiological risk [33,34]. Conditions surrounding material hardship may influence health if they are conducive to stress. It is proposed that individuals experiencing material hardship are more likely to experience both chronic and acute stressors in their lives [35,36]. Numerous studies have provided empirical support for the idea that material hardship is associated with more reported life stress [37,38]. In addition, when people are exposed to a serious stressor induced by material hardship, it is very likely that they will be exposed to other stressors in life as well. Thus, stress related to material hardship can trigger other stressors and strains, generating a cluster of stressors and activating physiological stress responses that may lead to negative health outcomes [39,40].

There is a paucity of research examining the relationships between material hardship and health outcomes in US young adult population. No study to our knowledge has examined the relevance of psychosocial stress in accounting for the effects of material hardship on young adults' health. In addition, most existing research on material hardship and health relied on regional data [17]. When researchers do use nationally representative surveys to assess the prevalence and impact of material hardship, they often focus on children [17,41] or populations traditionally targeted by the social safety net such as single mother families [42,43] or low-income households only [17,44]. Such targeting can miss most of material hardship facing many young adults at the transition to full-fledged adulthood [45].

To address these gaps in the literature, we use National Longitudinal Study of Adolescent Health (Add Health) data to determine the associations between types and depth of material hardship and individuals' physical and mental health. We also examine the extent to which perceived psychosocial stress explains the associations between material hardship and health outcomes. Although individuals in young adulthood are relatively healthy, studying this younger and healthier population is important. This is because health problems such as depression and suicide rates are rising sharply in young adult population [46,47]. If the adverse impact of material hardship on health begins early in life, then this denotes a potentially important intervention point for effective health and social policies that prevent health inequalities in later adulthood.

Methods

In the analyses, we used data from Add Health, a nationally representative study of adolescents in grades 7 through 12 in 1994–1995 who were followed into adulthood over four waves of data collection [48]. The first wave of data collection occurred during the 1994–1995 school year with 20,745 participants who were in 7th to 12th grade and consisted of an in-home and in-school assessment (wave I). A second wave of collection occurred

the following year in 1996 (wave II; $n = 14,738$; response rate, 88.6%), and a third wave assessment occurred in 2001–2002, when participants were aged 18–26 years (Wave III; $n = 15,197$; response rate, 77.4%). The fourth wave assessment was conducted in 2007–2008 with participants who were then aged 24–32 years (wave IV; $n = 15,701$; response rate, 80.3%). Data from wave I and IV were analyzed because Wave I provided information about family background, and Wave IV was the only wave that collected information on material hardship. Respondents were excluded if they did not report information on demographic characteristics, family sociodemographic data, and health information. The final analytical sample consists of 13,313 respondents. Previous studies analyzed attrition for potential bias across all waves, with results showing minimal to no bias to study estimates [49].

Measures

Dependent variables

Four measures of health outcomes were assessed. *Self-rated poor health* was assessed at wave IV using a single question (“In general, how would you rate your health?”). Responses of poor and fair are grouped into poor health, and responses of good, very good, and excellent are categorized as good health. The use of self-rated poor health intends to capture a holistic view of health among young adults; it is reported to measure the same construct among different ethnicities of adolescents and young adults [50]. Depression was measured using 20 items of a slightly modified version of the Center for Epidemiological Studies Depression [51,52]. A cut point of ≥ 22 for men and ≥ 24 for women was established to maximize the sensitivity and specificity for detecting major depressive disorder in young adults [53]. *Sleep problems* was assessed by asking how often respondents had trouble falling and staying asleep through the night in the last four weeks. Respondents could choose from the following categories: never in the past four weeks, less than once a week, one or two times a week, three or four times a week, and five or more times a week. In addition, respondents were asked whether there were times when they snored or stopped breathing while sleeping. We used this information to create a dichotomous variable of sleep problems ($=1$) if respondents reported having any trouble falling and staying asleep or reported snoring/sleep apnea during the past four weeks. *Suicidal thoughts* are a dichotomous variable that measure whether respondents reported yes to the following question: “During the past 12 months, have you ever seriously thought about committing suicide?” These health measures are chosen because they are significant health issues faced by young adults [54–56], and these health issues are established predictors of morbidity and mortality in later adulthood [57,58].

Independent variables

Wave IV collected information on several types of material well-being. Each form of material hardship was represented with a dichotomous measure that indicated if the hardship was present (or not). *Food hardship* was indicated if the respondent answered affirmatively to the question: “in the past 12 months, was there a time when you worried whether food would run out before you would get money to buy more?” *Bill-paying hardship* was indicated if respondent had trouble paying utility, phone, rent/mortgage bills in the past 12 months. In the survey, respondents were asked if they did not pay the full amount of a gas, oil, or electricity bill had the service turned off by the gas or electric company, or the oil company would not deliver, or were without phone service. Respondents were also asked “was there a time when you didn't pay the full amount of the rent or mortgage because you didn't have enough money,” or “evicted from your house or apartment for not

paying the rent or mortgage the full amount because you didn't have enough money." If any of these items was answered affirmatively, the respondent was coded as having bill-paying hardship. *Health-resource hardship* was indicated if the respondent lacked health insurance in the past 12 months or answered in the affirmative to the question "In the past 12 months, has there been any time when you thought you should get medical care, but you did not?" *Material hardship* was then assessed in three ways: a) any experience of material hardship, b) types of material hardship, and c) total count of material hardship. Any experience of material hardship is a dichotomous measure that takes a value of 1 if respondent experienced at least one type of hardship in bill-paying, food, or access to health care. A summary score of material hardship is a count of total number of hardships experienced by a respondent which takes a value between 0 (no hardship) and 3 (all three domains of hardship). This summary score can estimate the degree of material hardship experienced by an individual overall. We also investigated the correlations between types of hardship and the health outcomes of young adults. We constructed our domain measures to closely match prior studies [1,44,59]. Measures of hardship domains provide information on whether particular types of hardship are more strongly related to a specific health outcome, and models that look at domains of hardship are superior to fully disaggregated measures [1].

Perceived psychological stress

A shorter version of the original Perceived Stress Scale by Cohen et al, consisting of four items, was used to measure respondents' perceived stress [60]. During wave IV interviews, respondents were asked how often in the past 30 days they (i) were unable to control important things in their lives, (ii) felt confident in their ability to handle their personal problems (reverse coded), (iii) felt things were going their way (reverse coded), and (iv) felt that difficulties were piling up so high that they were unable to overcome them. The response set to these items ranged from 0 (never), 1 (almost never), 2 (sometimes), 3 (fairly often), to 4 (very often). Responses to the four items were summed together to create the Perceived Stress Scale, with higher values representing more perceived stress ($\alpha = .73$). Previous research has established the validity and reliability of this measure in predicting health status [61,62].

Control variables

We controlled for several demographic characteristics previously shown to significantly predict young adult health, including age, sex, race/ethnicity, and immigration status. Age was a continuous measure, and we coded sex as 1 if respondent was woman and 0 if man. Race/ethnicity was a categorical variable, distinguishing non-Hispanic whites from Hispanics, African Americans, Asians, and other racial/ethnic groups. Respondent was defined as an immigrant if she/he was born outside of the United States. Other potential individual-level confounders of interest included educational attainment, family income, homeownership status, and recent job loss. Educational attainment was categorized as high school or less (reference group), some college, and college or more. Annual family income was recoded to a series dummy variable: \$24,999 or less (reference), \$25,000–39,999, \$40,000–74,999, \$75,000, and more. Homeownership (=1 if yes) and recent job loss (=1 if yes) were both dichotomous measures. We also included number of kids in the household and receipt of public assistance, as well as health behaviors including physical inactivity (=1 if yes) and whether respondent was a smoker (=1 if yes) at the time of survey. Finally, because family background and health profiles in adolescence may confound the relationship between material hardship and health outcomes in young adulthood [63,64], we further controlled for parental highest educational attainment and

family structure. The former was measured as a categorical variable ranging from less than high school to college or more. The family structure was a categorical variable distinguishing two-parent household, single-parent household, and other types of household. Parallel measures of adolescent self-rated poor health and depressive symptom scores were also included as covariates in the analysis. All these family background information and health covariates were taken from Wave I.

Analytical strategy

We first used logistic regression models to estimate each of the four self-reported health conditions as a function of material hardship. In the second analytic stage, we used the method developed by Karlson, Breen, and Holm [65–67] (KHB method hereafter) to assess the extent to which the associations between types of material hardship and health outcomes were attributable to perceived stress. In the traditional mediation analysis, the total effect of a certain variable on the outcome of interest cannot be decomposed into direct and indirect effects when using logit models because the error variance in a nonlinear probability model varies across models [68]. The KHB method addresses this problem and can be applied to nonlinear probability models. It estimated all (i.e., direct, indirect, and total) effects on the same scale, and the coefficients in logit models are thus not affected by rescaling, particularly when the total effect is decomposed into the direct and indirect effects. This value allowed researchers to compare the coefficients without any scale identification issues. Analyses were conducted with Stata version 15 (Stata, College Station, TX) to account for the complex sample design and provide estimates representative of the noninstitutionalized US population.

Results

Table 1 presented weighted descriptive statistics for the analytic sample. Almost one in tenth (8.90%) of respondents reported experiencing fair or poor health. About 18.30% of respondents reported depression, 12.20% reported sleep problems, and 6.40% reported suicidal thoughts. We observed that almost a quarter (23.4%) of young adults experienced at least one domain of material hardship during the past 12 months. The most common problems were health-resource hardship (35.90%), followed by bill-paying hardship (20.00%), and food hardship (10.80%). In addition, respondents were, on average, 29 years old ($SD = 1.74$). Among them, 56% were non-Hispanic white, 21% non-Hispanic black, 16% Hispanic, 6% Asian, and 1% other races. More than one fifth of respondents (21.20%) did not have education beyond the high school level. About 15% of respondents reported annual family income below \$25,000. Less than half of respondents were homeowners. Nearly 30% of young adults in the sample experienced a recent job loss, and more than 20% received public assistance during the past year. These descriptive statistics portrayed the economic vulnerability faced by young people. Although respondents had low depressive symptom scores in adolescence (13.17) and only a small proportion of respondents rated their health as poor (6.6%), they faced considerable disadvantage in family environment. For example, nearly half of respondents did not have both parents present at home in adolescence and more than one third of respondents' parents did not have education beyond high school.

Table 2 presented the results of the logistic regression models that estimate health conditions as a function of material hardship. Panel 1 presented the association between any type of material hardship and health outcomes, adjusting for demographic and socioeconomic variables. The results show that individuals with any kind of material hardship, compared with their counterparts

Table 1
Descriptive statistics for variables in the analysis of material hardship and health outcomes in emerging adulthood: add Health IV

Variables	Mean or %	SD.	Range
Dependent variables			
Self-rated poor health	8.90%		
Depression	18.30%		
Sleeping problems	12.20%		
Suicidal thoughts	6.40%		
Material hardship measures			
Any material hardship	23.40%		
Number of material hardship	0.44	0.94	
Types of material hardship			
Food hardship	10.80%		
Bill-paying hardship	20.00%		
Health-resource hardship	35.90%		
Mediator			
Perceived stress	4.72	2.91	0–16
Control variables			
Age	28.97	1.74	24–34
Female	53.70%		
Race/ethnicity			
Non-Hispanic white	56.30%		
Hispanic	15.60%		
African American	20.60%		
Asian	6.40%		
Other racial groups	1.10%		
Foreign-born immigrant	6.10%		
Educational attainment			
High school or less	21.20%		
Some college	44.50%		
College or more	34.30%		
Family income			
0–\$24,999	15.40%		
\$25,000–\$39,999	27.90%		
\$40,000–\$74,999	24.60%		
\$75,000 and up	32.10%		
Homeownership (yes = 1)	42.60%		
Recent job loss (yes = 1)	29.40%		
Number of kids	0.92	1.14	0–7
Ever married (yes = 1)	51.60%		
Received public assistance (yes = 1)	22.10%		
Smoker (yes = 1)	20.70%		
Physical inactivity (yes = 1)	14.70%		
Parental education (wave 1)			
Less than high school	12.30%		
High school	24.70%		
Some college	26.20%		
College or more	36.90%		
Family structure (wave 1)			
Two-parent household	54.80%		
One-parent household	26.10%		
Other types of households	19.10%		
Depressive score (wave 1)	13.17	6.99	0–56
Self-rated poor health (wave 1) (yes = 1)	6.60%		
N	13,313		

without a hardship, have 1.66 (95% confident interval (CI) = 1.64, 1.68) times the odds of poor health, 1.56 (95% CI = 1.35, 1.81) times the odds of depression, 1.49 (95% CI = 1.24, 1.79) times the odds of having sleep problems, and 2.13 (95% CI = 1.65, 2.75) times the odds of having suicidal thoughts. Also presented is the average marginal effects (AMEs). The AMEs in panel 1 indicate that, compared with individuals of no material hardship, individuals of any material hardship have around .04 higher predicted probability of reporting poor health, sleep problems, and suicidal thoughts and .06 higher predicted probability of having depression. In panel 2, we examined the association between the depth of material hardship and health. The results show that there is a strong dose effect of material hardship on young adults' health; increases in the depth of material hardship are significantly associated with worsened self-rated health, higher risk of reporting depression, sleep problems, and suicidal thoughts. The AMEs suggest that, for one additional type of material hardship experienced by young adults, the predicted

probability of reporting health problems is expected to increase by .01–.03 points.

The models examining the effects of different types of material hardship were presented in panel 3 of Table 2. The results show that there are significant effects of material hardships on young adults' health over and beyond effects of individual sociodemographic factors. When domains of material hardship indicators (food hardship, bill-paying hardship, and health-resource hardship) are used in the models, different types of material hardship are associated with worse health outcomes, suggesting that individuals with different types of material hardship are more likely to be in poorer self-rated health, depression, and to have sleep problems and suicidal thoughts than are individuals not experiencing these hardships. In supplemental analysis, we conducted paired tests of coefficients to test whether different domains of material hardships have differential impact on respective health outcomes. All paired tests revealed that the differences in the coefficients of material hardship types were not different from zero. The results suggest that the relative association of each form of material hardship and health outcomes were quite similar.

Next, we introduced the proposed mediating variable—perceived stress—into the models to potentially explain why individuals with material hardship have poorer health outcomes than individuals without these hardships. Table 3 summarized the results from models with and without perceived stress, which were referred to as direct and total effects of material hardship, respectively. Captured by the term Δ (%) due to perceived stress in Table 3, the results suggest that the associations between material hardship and different health measures are attributable, to a varying degree, to perceived stress. For example, perceived stress accounts for a significant portion of the effects of bill-paying hardship on self-rated poor health (43%), depression (103%), sleep problems (44%), and suicidal thoughts (103%). In addition, perceived stress also explained more than 30% of the effect of food hardship on all health measures. Figure 1 visually presented the role of perceived stress in accounting for the associations between material hardship and different health measures, captured by the term Δ (%) due to perceived stress in Table 3. On every health measure, at least a quarter of the health effect of material hardship is attributable to perceived stress. Specifically, as indicated by the orange bars, the indirect effect of perceived stress is especially pronounced for the relationship between bill-paying hardship and mental health outcomes: it explained nearly half of the total effect on sleep problems (44%), all effect on depression (103%), and virtually all effect on suicidal thoughts (103%).

Discussion

Even though individuals in young adulthood face greater financial instability than prime-aged adults, very little research has investigated young adults' experiences with material hardship and its health consequences. Using data from Add Health, we have provided the first examination of the association between material hardship and self-reported health among young adults. We also assessed the mediating role of perceived stress in accounting for these associations. Findings from this study enhanced the understanding of the role that material hardship plays in the etiology of young adults' health in two ways. First, our findings provided evidence that health was shaped by unmet needs for adequate food, housing, utility, and health care. Experiences in material hardship—measured as any hardship, total count of hardships, and types of hardship in food, bill-paying, and health resources—were associated with poor health and mental health issues such as depression and suicidal thoughts, independent of their socio-demographic background, including income and education. The

Table 2
Weighted logistic regression models of material hardship types and health outcomes, add health wave IV

	Poor health		Depression		Sleep problems		Suicidal thoughts	
	OR (95% CI)	AME	OR (95% CI)	AME	OR (95% CI)	AME	OR (95% CI)	AME
Panel 1: Any material hardship								
Had any material hardship	1.66*** (1.64, 1.68)	0.04***	1.56*** (1.35, 1.81)	0.06***	1.49*** (1.24, 1.79)	0.04***	2.13*** (1.65, 2.75)	0.04***
Panel 2: Depth of material hardship								
Number of hardships	1.17*** (1.16, 1.18)	0.01***	1.25*** (1.17, 1.34)	0.03***	1.21*** (1.12, 1.31)	0.02***	1.39*** (1.28, 1.50)	0.02***
Panel 3: Types of material hardship								
Food hardship	1.41*** (1.39, 1.44)	0.03***	1.47*** (1.23, 1.76)	0.05***	1.32** (1.07, 1.62)	0.03***	2.20*** (1.65, 2.94)	0.04***
Bill-paying hardship	1.27*** (1.25, 1.29)	0.02*	1.30*** (1.11, 1.52)	0.03***	1.30** (1.08, 1.54)	0.03**	1.35* (1.01, 1.82)	0.02*
Health-resource hardship	1.71*** (1.69, 1.73)	0.04***	1.52*** (1.31, 1.76)	0.05**	1.44*** (1.23, 1.69)	0.04***	1.63*** (1.30, 2.04)	0.03**

*P < .05, **P < .01, ***P < .001 (two tailed tests).

Each column and panel is from a different logistic regression.

Control variables include age, sex, race/ethnicity, immigration status, educational attainment, family income, homeownership status, employment status (recent job loss), number of kids in the household, receipt of public assistance, health behaviors including physical inactivity and smoking, as well as family background information including parental highest educational attainment and family structure from Wave I, and self-rated poor health and depressive symptom scores in Wave I. See Appendix Table S1 for full listing of the covariates.

Comparisons of significant differences between all types of hardships show no evidence to suggest that they have different impacts on health outcomes.

n = 13,313.

AME = Average marginal effects.

health measures we used were widely studied predictors of maladjustment in later adulthood, including depression, a leading cause of disability and health burden worldwide [69,70]. This finding, derived from a nationally representative cohort sample, constitutes the strong evidence that along with conventional measures of socioeconomic status, material hardship is another important social determinant of health in young adulthood.

Second, strong correlations between types of material hardship and health outcomes were attenuated or eliminated after we controlled for perceived stress. The results are consistent with arguments that material hardship constitutes a distinct source of stress in the already stressful lives of young people. The stress level, in turn, is adversely related to multiple health outcomes [71]. Being unable to provide needed food, shelter, health care, and other necessities for oneself or one's family represents a significant stressor that have been linked to a variety of adverse physiological responses that are thought to damage health [72]. Among three types of material hardship, bill-paying hardship seems to have a pronounced impact on young adults' mental health outcomes through its effect on elevating perceived stress. It may be that being behind on payments induces fear of housing loss, involuntary move, and

threatens the central identity of being independent. These negative feelings, in turn, can induce and elevate stress that could be detrimental for young adults' mental health.

Limitations

Our study had several limitations. First, our results pertain to health outcomes at young adulthood. Thus, it is unclear how material hardship would be associated with morbidity and mortality later in life, when such hardship could be more consequential. Second, the statistical associations in this study were based on observational data that prevent causal conclusions. Although we controlled for a robust set of covariates, including income, it is possible that those who experienced material hardship differ in unobserved ways from those who did not experience material hardship. We subjected our main findings to sensitivity checks by replicating the associations between material hardship and health outcomes by using propensity score matching and inverse probability weighting; these are methods that are thought to be rigorous by reducing the potential impact of selection bias. In all cases, the results were qualitatively similar to the main findings. In addition,

Table 3
Weighted KHB decomposition of nested logistic regression models of material hardship types and health outcomes, add health wave IV

	Reduced (effect without mediator)		Full (effect with mediator)		Total difference		Δ (%) due to stress [†]
	b	OR	b	OR	b	OR (95% CI)	
Outcome: Poor health							
Food hardship	0.35***	1.41	0.24	1.27	0.11***	1.12 (0.06, 0.16)	31%
Bill-paying hardship	0.24***	1.27	0.14	1.15	0.10***	1.11 (0.06, 0.15)	43%
Health-resource hardship	0.54***	1.71	0.48***	1.62	0.06***	2.01 (0.03, 0.10)	12%
Outcome: Depression							
Food hardship	0.45***	1.47	0.11	1.12	0.34***	1.36 (0.22, 0.41)	73%
Bill-paying hardship	0.27***	1.30	-0.01	0.99	0.28***	1.34 (0.19, 0.38)	103%
Health resource-hardship	0.42***	1.52	0.14**	1.15	0.28***	1.32 (0.10, 0.27)	42%
Outcome: Sleep problem							
Food hardship	0.28**	1.32	0.15	1.16	0.13***	1.14 (0.08, 0.18)	46%
Bill-paying hardship	0.26**	1.30	0.15	1.16	0.11***	1.13 (0.08, 0.16)	44%
Health resource-hardship	0.37***	1.44	0.29***	1.34	0.08***	1.08 (0.04, 0.12)	21%
Outcome: Suicidal thoughts							
Food hardship	0.79***	2.20	0.52**	1.68	0.27***	1.40 (0.23, 0.45)	40%
Bill-paying hardship	0.32*	1.35	0.01	0.99	0.31***	1.36 (0.21, 0.42)	103%
Health resource-hardship	0.49***	1.63	0.30*	1.35	0.20***	1.22 (0.10, 0.30)	40%

*P < .05, **P < .01, ***P < .001 (two tailed tests).

Control variables include age, sex, race/ethnicity, immigration status, educational attainment, family income, homeownership status, recent job loss, number of kids in the household, receipt of public assistance, as well as health behaviors including physical inactivity and smoking.

Complete tables listing all coefficients are shown in Appendix Table S1.

n = 13,313.

KHB = Karlson-Holm-Breen.

[†] Δ(%) is the percentage reduction in the logit coefficient between the reduced and full models attributable to perceived stress, net of rescaling.

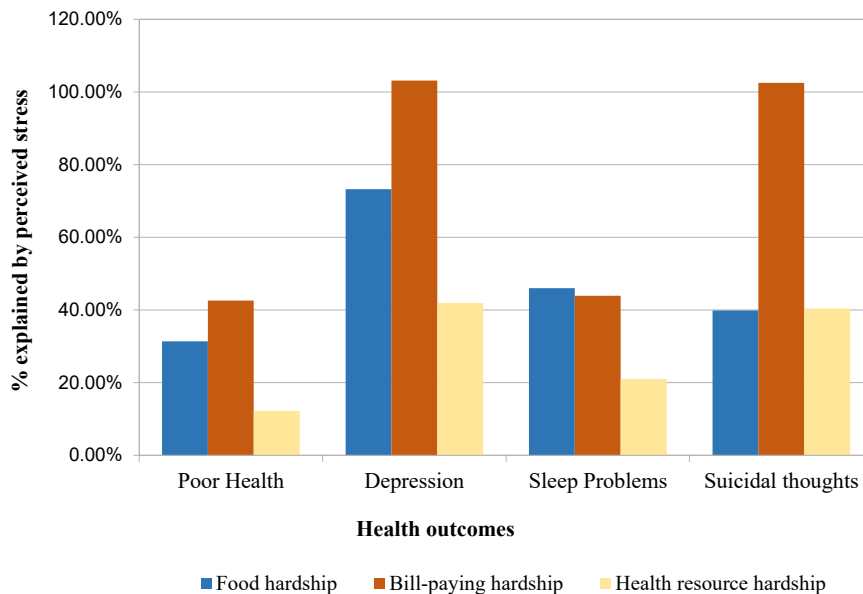


Fig. 1. Percentage of total effect of material hardships on health outcomes due to perceived stress, Add Health wave IV.

our falsification test suggests that prior health problems (measured as poor self-rated health, depression, and sleep problems) have no statistically significant association with concurrent material hardship. We present these sensitivity analysis results in Appendix 1. Finally, although we found that the stress pathway is responsible for some of the health effects of material hardship, we cannot preclude other plausible mechanisms through which material hardship may influence health. For example, nutritional deficiencies may accompany food hardship, which in turn, leads to poor health outcomes. It is also plausible that the bill-paying hardship exposes individuals to hazardous living conditions that bring harm to physical and mental health. Future research may consider using longitudinal data to address some of these limitations. It may also be fruitful to investigate other mechanisms through which material hardship adversely impacts health in young adulthood. Despite these limitations, the empirical evidence presented here underscored the role of material hardship as a social determinant of population health in young adulthood.

Public health implications

Our findings suggest that strategies to improve population health and to reduce health disparities must address a range of basic human needs in emerging adulthood, including affordable, quality health care, food, and housing. Considering the significant impact of the coronavirus 2019 pandemic on material hardship, federal, state, and local responders need to consider targeted solutions to ensure that young adults can stay fed and their basic needs are met. Given that a significant portion of the health effects of material hardship operated through perceived stress, efforts to promote health equity in young adults should focus on material hardship and associated stressful conditions. Communities and local governments may consider providing short-term, emergency assistance and other public services for those young adults who are facing material hardships. Expansion of affordable housing and other need-based assistance may also help diminish the potential health tolls linked to material hardship.

CRediT authorship contribution statement

Ying Huang: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft. Colleen M. Heflin: Conceptualization, Methodology, Writing - review & editing. Asiya Validova: Writing - review & editing, Validation.

Acknowledgements

This research uses data from Add Health, a program project directed by Kathleen Mullan Harris and designed by J. Richard Udry, Peter S. Bearman, and Kathleen Mullan Harris at the University of North Carolina at Chapel Hill, and funded by grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 23 other federal agencies and foundations. Special acknowledgment is due Ronald R. Rindfuss and Barbara Entwisle for assistance in the original design. Information on how to obtain the Add Health data files is available on the Add Health website (<http://www.cpc-unc.edu/addhealth>). No direct support was received from grant P01-HD31921 for this analysis.

References

- [1] Heflin C, Sandberg J, Rafail P. The structure of material hardship in US households: an examination of the coherence behind common measures of well-being. *Soc Probl* 2009;56(4):746–64.
- [2] Iceland J, Bauman KJ. Income poverty and material hardship: how strong is the association? *J Socio Econom* 2007;36(3):376–96.
- [3] Bauer L. The COVID-19 crisis has already left too many children hungry in America Washington D.C.: Brookings Institute. <https://www.brookings.edu/blog/up-front/2020/05/06/the-covid-19-crisis-has-already-left-too-many-children-hungry-in-america/>. [Accessed 6 May 2020].
- [4] Karpman M, Zuckerman S, Gonzalez D, Kenney GM. The COVID-19 pandemic is straining families' abilities to afford basic needs. *Urban Institute*; 2020. <https://www.urban.org/research/publication/covid-19-pandemic-straining-families-abilities-afford-basic-needs>. [Accessed 20 May 2020].
- [5] Keith-Jennings B, Llobrera J, Dean S. Links of the supplemental nutrition assistance program with food insecurity, poverty, and health: evidence and potential. *Am J Public Health* 2019;109(12):1636–40.
- [6] Lee H, Andrew M, Gebremariam A, Lumeng JC, Lee JM. Longitudinal associations between poverty and obesity from birth through adolescence. *Am J Public Health* 2014;104(5):e70–6.
- [7] Najman JM, Hayatbakhsh MR, Clavarino A, Bor W, O'Callaghan MJ, Williams GM. Family poverty over the early life course and recurrent

- adolescent and young adult anxiety and depression: a longitudinal study. *Am J Public Health* 2010;100(9):1719–23.
- [8] Sullivan JX, Turner L, Danziger S. The relationship between income and material hardship. *J Policy Anal Manage* 2008;27(1):63–81.
- [9] Strully KW, Rehkopf DH, Xuan Z. Effects of prenatal poverty on infant health: state earned income tax credits and birth weight. *Am Sociol Rev* 2010;75(4):534–62.
- [10] Neckerman KM, Garfinkel I, Teitler JO, Waldfogel J, Wimer C. Beyond income poverty: measuring disadvantage in terms of material hardship and health. *Acad Pediatr* 2016;16(3):S52–9.
- [11] Bonnie RJ, Stroud CE, Breiner HE. Investing in the health and well-being of young adults. Washington D.C.: National Academies Press; 2014.
- [12] O'Connor M, Sanson AV, Toumbourou JW, Norrish J, Olsson CA. Does positive mental health in adolescence longitudinally predict healthy transitions in young adulthood? *J Happiness Stud* 2017;18(1):177–98.
- [13] Richards M, Huppert FA. Do positive children become positive adults? Evidence from a longitudinal birth cohort study. *J Posit Psychol* 2011;6(1):75–87.
- [14] Marion D, Laursen B, Zettergren P, Bergman LR. Predicting life satisfaction during middle adulthood from peer relationships during mid-adolescence. *J Youth Adolesc* 2013;42(8):1299–307.
- [15] Thapar A, Collishaw S, Pine DS, Thapar AK. Depression in adolescence. *Lancet* 2012;379(9820):1056–67.
- [16] Anderson DM, Cesur R, Tekin E. Youth depression and future criminal behavior. *Econ Inq* 2015;53(1):294–317.
- [17] Yoo JP, Slack KS, Holl JL. Material hardship and the physical health of school-aged children in low-income households. *Am J Public Health* 2009;99(5):829–36.
- [18] Cook JT, Black M, Chilton M, Cutts D, Ettinger de Cuba S, Heeren TC, et al. Are food insecurity's health impacts underestimated in the US population? Marginal food security also predicts adverse health outcomes in young US children and mothers. *Adv Nutr* 2013;4(1):51–61.
- [19] Tumin D, Menegay M, Shrider EA, Nau M, Tumin R. Local income inequality, individual socioeconomic status, and unmet healthcare needs in Ohio, USA. *Health Equity* 2018;2(1):37–44.
- [20] Hargreaves DS, Elliott MN, Viner RM, Richmond TK, Schuster MA. Unmet health care need in US adolescents and adult health outcomes. *Pediatrics* 2015;136(3):513–20.
- [21] Marshall EG. Do young adults have unmet healthcare needs? *J Adolesc Health* 2011;49(5):490–7.
- [22] Tucker-Seeley RD, Mitchell JA, Shires DA, Modlin Jr CS. Financial hardship, unmet medical need, and health self-efficacy among African American men. *Health Educ Behav* 2015;42(3):285–92.
- [23] Fuller AE, Brown NM, Grado L, Oyeku SO, Gross RS. Material hardships and health care utilization among low-income children with special health care needs. *Acad Pediatr* 2019;19(7):733–9.
- [24] Ko H. Unmet healthcare needs and health status: panel evidence from Korea. *Health Policy* 2016;120(6):646–53.
- [25] Pevalin DJ. Housing repossessions, evictions and common mental illness in the UK: results from a household panel study. *J Epidemiol Community Health* 2009;63(11):949–51.
- [26] Burgard SA, Seefeldt KS, Zelner S. Housing instability and health: findings from the Michigan Recession and Recovery Study. *Soc Sci Med* 2012;75(12):2215–24.
- [27] Desmond M, Kimbro RT. Eviction's fallout: housing, hardship, and health. *Soc Forces* 2015;94(1):295–324.
- [28] Finnigan R, Meagher KD. Past due: combinations of utility and housing hardship in the United States. *Soc Perspect* 2019;62(1):96–119.
- [29] Yoshikawa H, Aber JL, Beardslee WR. The effects of poverty on the mental, emotional, and behavioral health of children and youth: implications for prevention. *Am Psychol* 2012;67(4):272.
- [30] McCarthy B, Carter A, Jansson M, Benoit C, Finnigan R. Poverty, material hardship, and mental health among workers in three front-line service occupations. *J Poverty* 2018;22(4):334–54.
- [31] Burgard SA, Ailshire JA, Kalmousova L. The great recession and health: people, populations, and disparities. *Ann Am Acad Pol Soc Sci* 2013;650(1):194–213.
- [32] Schenck-Fontaine A, Panico L. Many kinds of poverty: three dimensions of economic hardship, their combinations, and children's behavior problems. *Demography* 2019;56(6):2279–305.
- [33] Pearlin LI. The sociological study of stress. *J Health Soc Behav* 1989:241–56.
- [34] Pearlin LI, Menaghan EG, Lieberman MA, Mullan JT. The stress process. *J Health Soc Behav* 1981:337–56.
- [35] Weaver A, Taylor RJ, Chatters LM, Himle JA. Depressive symptoms and psychological distress among rural African Americans: the role of material hardship and self-rated health. *J Affect Disord* 2018;236:207–10.
- [36] Ranjit S, Kissoon N, Jayakumar I. Aggressive management of dengue shock syndrome may decrease mortality rate: a suggested protocol. *Pediatr Crit Care Med* 2005;6(4):412–9.
- [37] Evans GW, Kim P. Childhood poverty, chronic stress, self-regulation, and coping. *Child Develop Perspect* 2013;7(1):43–8.
- [38] Kim J, Shim J, Lee R. Material hardship and depression among low-income households in South Korea: differences by household type. *Int J Soc Welfare* 2016;25(2):187–98.
- [39] Hernández D. Understanding 'energy insecurity' and why it matters to health. *Soc Sci Med* 2016;167:1–10.
- [40] Sun W, Li D, Zhang W, Bao Z, Wang Y. Family material hardship and Chinese adolescents' problem behavior: a moderated mediation analysis. *PLoS One* 2015;10(5):e0128024.
- [41] Rodems R, Shaefer HL. Many of the kids are not alright: material hardship among children in the United States. *Child Youth Serv Rev* 2020:104767.
- [42] Eamon MK, Wu C-F. Effects of unemployment and underemployment on material hardship in single-mother families. *Child Youth Serv Rev* 2011;33(2):233–41.
- [43] Ybarra M, Stanczyk A, Ha Y. Paid leave, welfare, and material hardship after a birth. *Fam Relat* 2019;68(1):85–103.
- [44] Danziger S, Corcoran M, Danziger S, Heflin CM. Work, income, and material hardship after welfare reform. *J Consum Aff* 2000;34(1):6–30.
- [45] Rodems R. Hidden hardship: three essays on material well-being and poverty in the United States. University of Michigan: Ph.D. Dissertation; 2018.
- [46] Spiller HA, Ackerman JP, Spiller NE, Casavant MJ. Sex-and age-specific increases in suicide attempts by self-poisoning in the United States among youth and young adults from 2000 to 2018. *J Pediatr* 2019;210:201–8.
- [47] Ribeiro JD, Pease JL, Gutierrez PM, Silva C, Bernert RA, Rudd MD, et al. Sleep problems outperform depression and hopelessness as cross-sectional and longitudinal predictors of suicidal ideation and behavior in young adults in the military. *J Affect Disord* 2012;136(3):743–50.
- [48] Bearman PS, Jones J, Udry JR. The national longitudinal study of adolescent health. Chapel Hill, NC: Carolina Population Center; 1997.
- [49] Brownstein N, Kalsbeek WD, Tabor J, Entzel P, Daza E, Harris KM. Non-response in wave IV of the National Longitudinal Study of Adolescent Health. Chapel Hill: Carolina Population Center, University of North Carolina; 2011.
- [50] Allen CD, McNeely CA, Orme JG. Self-rated health across race, ethnicity, and immigration status for US adolescents and young adults. *J Adolesc Health* 2016;58(1):47–56.
- [51] Rushton JL, Forcier M, Schectman RM. Epidemiology of depressive symptoms in the National Longitudinal Study of Adolescent Health. *J Am Acad Child Adolesc Psychiatry* 2002;41(2):199–205.
- [52] Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. *Appl Psychol Meas* 1977;1(3):385–401.
- [53] John F. Ethnic and gender disparities in needed adolescent mental health care. *J Health Care Poor Underserved* 2011;22(1):101.
- [54] Dahl RE, Lewin DS. Pathways to adolescent health sleep regulation and behavior. *J Adolesc Health* 2002;31(6):175–84.
- [55] Weis D, Rothenberg L, Moshe L, Brent DA, Hamdan S. The effect of sleep problems on suicidal risk among young adults in the presence of depressive symptoms and cognitive processes. *Arch Suicide Res* 2015;19(3):321–34.
- [56] Evans CR, Erickson N. Intersectionality and depression in adolescence and early adulthood: a MAHDA analysis of the national longitudinal study of adolescent to adult health, 1995–2008. *Soc Sci Med* 2019;220:1–11.
- [57] McLeod GF, Horwood LJ, Fergusson DM. Adolescent depression, adult mental health and psychosocial outcomes at 30 and 35 years. *Psychol Med* 2016;46(7):1401–12.
- [58] Johnson D, Dupuis G, Piche J, Clayborne Z, Colman I. Adult mental health outcomes of adolescent depression: a systematic review. *Depress Anxiety* 2018;35(8):700–16.
- [59] Heflin CM, Iceland J. Poverty, material hardship, and depression. *Soc Sci Q* 2009;90(5):1051–71.
- [60] Katsarou A, Panagiotakos D, Zafeiropoulou A, Vryonis M, Skoularigis I, Tryposkiadis F, et al. Validation of a Greek version of PSS-14; a global measure of perceived stress. *Cent Eur J Public Health* 2012;20(2):104–9.
- [61] Beaver KM, Vaughn MG, Wright JP, DeLisi M. An interaction between perceived stress and 5HTTLPR genotype in the prediction of stable depressive symptomatology. *Am J Orthopsychiatry* 2012;82(2):260.
- [62] Karmakar M, Elhai JD, Amialchuk AA, Tietjen GE. Do personality traits mediate the relationship between childhood abuse and migraine? An exploration of the relationships in young adults using the add health dataset. *Headache* 2018;58(2):243–59.
- [63] Richards M, Wadsworth M. Long term effects of early adversity on cognitive function. *Arch Dis Child* 2004;89(10):922–7.
- [64] Johnson RC, Schoeni RF, Rogowski JA. Health disparities in mid-to-late life: The role of earlier life family and neighborhood socioeconomic conditions. *Soc Sci Med* 2012;74(4):625–36.
- [65] Breen R, Karlson KB. Counterfactual causal analysis and nonlinear probability models. In: *Handbook of causal analysis for social research*. Dordrecht: Springer; 2013. p. 167–87.
- [66] Karlson KB, Holm A, Breen R. Comparing regression coefficients between same-sample nested models using logit and probit: a new method. *Soc Methodol* 2012;42(1):286–313.
- [67] Kohler U, Karlson KB, Holm A. Comparing coefficients of nested nonlinear probability models. *Stata J* 2011;11(3):420–38.
- [68] Mustillo SA, Lizardo OA, McVeigh RM. Editors' comment: a few guidelines for quantitative submissions. Los Angeles, CA: SAGE Publications Sage CA; 2018.
- [69] Murray CJ, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: global burden of disease study. *Lancet* 1997;349(9064):1498–504.
- [70] Thompson T, McQueen A, Croston M, Luke A, Caito N, Quinn K, et al. Social needs and health-related outcomes among medicaid beneficiaries. *Health Educ Behav* 2019;46(3):436–44.
- [71] Toussaint L, Shields GS, Dorn G, Slavich GM. Effects of lifetime stress exposure on mental and physical health in young adulthood: How stress degrades and forgiveness protects health. *J Health Psychol* 2016;21(6):1004–14.
- [72] Baum A, Garofalo J, Yali AM. Socioeconomic status and chronic stress: does stress account for SES effects on health? *Ann N Y Acad Sci* 1999;896(1):131–44.

Appendix

Table S1
Odds ratios from logistic regression models predicting the relationship between types of material hardship and health outcomes, Add Health wave I & IV

	Poor health		Depression		Sleep problems		Suicidal thoughts	
	Reduced model	Full model	Reduced model	Full model	Reduced model	Full model	Reduced model	Full model
	OR	OR	OR	OR	OR	OR	OR	OR
Food hardship	1.41*** (1.39, 1.44)	1.27 (0.97, 1.68)	1.47*** (1.45, 1.50)	1.12 (0.92, 1.35)	1.32** (1.30, 1.34)	1.16 (0.94, 1.43)	2.20*** (2.16, 2.25)	1.68** (1.26, 2.27)
Bill-paying hardship	1.27*** (1.25, 1.29)	1.15 (0.90, 1.46)	1.30*** (1.29, 1.32)	0.99 (0.98, 1.01)	1.30** (1.29, 1.33)	1.16 (0.96, 1.40)	1.35* (1.23, 1.48)	0.99 (0.71, 1.37)
Health-resource hardship	1.71*** (1.69, 1.73)	1.62*** (1.39, 1.73)	1.52*** (1.50, 1.53)	1.15** (1.10, 1.41)	1.44*** (1.42, 1.46)	1.34*** (1.14, 1.57)	1.63*** (1.61, 1.66)	1.35* (1.07, 1.70)
Perceived stress		1.10*** (1.08, 1.11)		1.30*** (1.29, 1.31)		1.12*** (1.11, 1.12)		1.34*** (1.33, 1.34)
Control variables								
Age at wave IV	1.04*** (1.03, 1.04)	1.04*** (1.03, 1.04)	0.98*** (0.98, 0.99)	0.98*** (0.98, 0.98)	0.98*** (0.98, 0.99)	0.98*** (0.98, 0.99)	0.94*** (0.94, 0.95)	0.94*** (0.94, 0.95)
Female	1.15*** (1.14, 1.17)	1.11*** (1.10, 1.12)	2.21*** (2.19, 2.23)	2.07*** (2.04, 2.09)	0.91*** (0.90, 0.92)	0.87*** (0.86, 0.88)	1.16*** (1.14, 1.17)	0.99 (0.98, 1.01)
Race/ethnicity								
Hispanics	2.04*** (2.01, 2.07)	2.11*** (2.07, 2.14)	0.48*** (0.47, 0.49)	0.49*** (0.48, 0.50)	1.14*** (1.12, 1.15)	1.17*** (1.15, 1.19)	0.61*** (0.60, 0.63)	0.65*** (0.63, 0.67)
Non-Hispanic black	1.33*** (1.31, 1.35)	1.34*** (1.32, 1.37)	0.48*** (0.47, 0.48)	0.45*** (0.45, 0.46)	0.86*** (0.85, 0.88)	0.86*** (0.85, 0.88)	0.75*** (0.74, 0.77)	0.75*** (0.74, 0.77)
Non-Hispanic Asian	1.82*** (1.77, 1.87)	1.74*** (1.70, 1.79)	0.42*** (0.40, 0.43)	0.35*** (0.34, 0.36)	0.85*** (0.82, 0.87)	0.80*** (0.77, 0.82)	0.66*** (0.64, 0.69)	0.59*** (0.57, 0.61)
Non-Hispanic other races	1.62*** (1.54, 1.71)	1.59*** (1.51, 1.67)	1.05* (1.00, 1.09)	0.93** (0.89, 0.97)	0.80*** (0.76, 0.84)	0.75*** (0.71, 0.79)	0.63*** (0.59, 0.68)	0.55*** (0.51, 0.60)
Educational attainment (reference = high school or less)								
Some college	0.83*** (0.82, 0.84)	0.84*** (0.83, 0.85)	1.20*** (1.18, 1.21)	1.22*** (1.21, 1.24)	1.08*** (1.06, 1.09)	1.09*** (1.07, 1.10)	1.18*** (1.15, 1.20)	1.18*** (1.16, 1.21)
College or more	0.41*** (0.40, 0.42)	0.42*** (0.41, 0.43)	1.12*** (1.10, 1.14)	1.17*** (1.15, 1.19)	0.79*** (0.78, 0.80)	0.81*** (0.79, 0.82)	0.96** (0.93, 0.98)	1.00 (0.98, 1.03)
Family income (reference = below \$24,999)								
\$25,000–\$39,999	0.77*** (0.76, 0.79)	0.77*** (0.75, 0.78)	0.71*** (0.70, 0.72)	0.69*** (0.68, 0.70)	0.96*** (0.94, 0.98)	0.96*** (0.94, 0.97)	1.09*** (1.07, 1.11)	1.08*** (1.06, 1.11)
\$40,000–\$74,999	0.77*** (0.76, 0.79)	0.77*** (0.75, 0.78)	0.98** (0.96, 0.99)	0.97*** (0.95, 0.99)	1.24*** (1.21, 1.26)	1.24*** (1.21, 1.26)	1.12*** (1.09, 1.15)	1.10*** (1.07, 1.13)
\$75,000 and up	0.73*** (0.71, 0.74)	0.73*** (0.72, 0.75)	0.78*** (0.77, 0.80)	0.80*** (0.79, 0.81)	1.15*** (1.13, 1.17)	1.17*** (1.14, 1.19)	1.14*** (1.11, 1.17)	1.18*** (1.15, 1.21)
Homeownership (yes = 1)	0.81*** (0.80, 0.82)	0.84*** (0.83, 0.85)	0.81*** (0.80, 0.82)	0.90*** (0.89, 0.91)	0.77*** (0.76, 0.78)	0.81*** (0.80, 0.82)	0.66*** (0.65, 0.67)	0.74*** (0.73, 0.75)
Foreign-born immigrant (yes = 1)	0.69*** (0.67, 0.71)	0.70*** (0.68, 0.72)	0.65*** (0.63, 0.67)	0.68*** (0.66, 0.70)	0.65*** (0.63, 0.67)	0.66*** (0.64, 0.68)	1.36*** (1.31, 1.41)	1.50*** (1.44, 1.56)
Recent job loss (yes = 1)	1.05*** (1.04, 1.06)	1.02** (1.01, 1.03)	1.24*** (1.23, 1.25)	1.16*** (1.14, 1.17)	1.23*** (1.22, 1.25)	1.20*** (1.18, 1.21)	1.28*** (1.26, 1.30)	1.17*** (1.15, 1.19)
Number of kids	0.93*** (0.93, 0.94)	0.93*** (0.92, 0.93)	0.97*** (0.97, 0.98)	0.96*** (0.95, 0.96)	1.03*** (1.02, 1.03)	1.02*** (1.02, 1.03)	0.97*** (0.96, 0.98)	0.95*** (0.95, 0.96)
Ever married (yes = 1)	1.24*** (1.23, 1.26)	1.25*** (1.24, 1.27)	0.96*** (0.95, 0.97)	1.00 (0.99, 1.02)	1.05*** (1.04, 1.06)	1.07*** (1.06, 1.08)	1.09*** (1.07, 1.11)	1.11*** (1.09, 1.13)
Current smoker (yes = 1)	1.32*** (1.30, 1.34)	1.30*** (1.28, 1.31)	1.19*** (1.17, 1.20)	1.12*** (1.11, 1.14)	1.05*** (1.03, 1.06)	1.02** (1.01, 1.03)	1.18*** (1.16, 1.20)	1.08*** (1.06, 1.10)
Physical inactivity (yes = 1)	1.26*** (1.25, 1.28)	1.22*** (1.21, 1.24)	1.38*** (1.37, 1.40)	1.30*** (1.28, 1.31)	0.91*** (0.90, 0.93)	0.88*** (0.86, 0.89)	1.28*** (1.25, 1.30)	1.11*** (1.08, 1.13)

Table S1 (continued)

	Poor health		Depression		Sleep problems		Suicidal thoughts	
	Reduced model	Full model	Reduced model	Full model	Reduced model	Full model	Reduced model	Full model
	OR	OR	OR	OR	OR	OR	OR	OR
Receipt of public assistance (yes = 1)	1.21***	1.19***	1.38***	1.39***	1.16***	1.15***	1.05***	1.02*
	(1.19, 1.23)	(1.17, 1.21)	(1.36, 1.39)	(1.38, 1.41)	(1.15, 1.18)	(1.13, 1.17)	(1.03, 1.07)	(1.00, 1.04)
Parental educational attainment (wave I) (reference = less than high school)								
High school	0.87***	0.85***	1.14***	1.08***	1.04***	1.02*	0.82***	0.77***
	(0.86, 0.89)	(0.84, 0.87)	(1.12, 1.16)	(1.06, 1.10)	(1.02, 1.06)	(1.00, 1.04)	(0.80, 0.84)	(0.75, 0.79)
Some college	0.97**	0.95***	1.16***	1.13***	1.27***	1.25***	1.04**	0.99
	(0.95, 0.99)	(0.94, 0.97)	(1.14, 1.19)	(1.11, 1.15)	(1.25, 1.29)	(1.23, 1.27)	(1.01, 1.07)	(0.96, 1.02)
College or more	0.85***	0.84***	1.29***	1.26***	0.90***	0.89***	1.12***	1.07***
	(0.83, 0.87)	(0.83, 0.86)	(1.27, 1.32)	(1.24, 1.28)	(0.89, 0.92)	(0.87, 0.91)	(1.09, 1.15)	(1.04, 1.10)
Family structure (wave I) (reference = two-parent household)								
One-parent household	0.96***	0.96***	1.20***	1.18***	1.13***	1.12***	1.08***	1.05***
	(0.95, 0.98)	(0.95, 0.97)	(1.19, 1.22)	(1.17, 1.20)	(1.11, 1.14)	(1.11, 1.14)	(1.06, 1.10)	(1.03, 1.07)
Other types of households	1.01	1.02	1.19***	1.18***	0.87***	0.87***	1.23***	1.21***
	(1.00, 1.03)	(1.00, 1.03)	(1.18, 1.21)	(1.16, 1.19)	(0.86, 0.88)	(0.86, 0.88)	(1.20, 1.25)	(1.19, 1.23)
Depressive symptom score (wave I)	1.01***	1.01***	1.05***	1.03***	1.03***	1.02***	1.04***	1.02***
	(1.01, 1.01)	(1.01, 1.01)	(1.05, 1.05)	(1.03, 1.03)	(1.03, 1.03)	(1.02, 1.02)	(1.04, 1.04)	(1.02, 1.02)
Self-rated poor health (wave I)	2.41***	2.41***	1.23***	1.22***	1.22***	1.21***	1.06***	1.05***
	(2.37, 2.45)	(2.37, 2.45)	(1.21, 1.25)	(1.20, 1.24)	(1.20, 1.24)	(1.19, 1.23)	(1.03, 1.08)	(1.02, 1.08)
N	13,313	13,313	13,313	13,313	13,313	13,313	13,313	13,313

*P < .05, **P < .01, ***P < .001 (two-tailed tests).

95% confidence intervals in parentheses.

OR = odds ratio.

Table S2

Odds ratios and coefficient from regression models predicting the relationship between wave III health conditions and wave IV material hardships and perceived stress

	Food hardship	Bill-paying hardship	Health-resource hardship	Any material hardship	Number of material hardship	Perceived stress
	OR	OR	OR	OR	OR	b
Self-rated poor health in wave III	1.11	0.95	0.89	0.98	0.99	0.18
	(0.83, 1.48)	(0.74, 1.21)	(0.70, 1.15)	(0.77, 1.24)	(0.78, 1.24)	(-0.08, 0.45)
Depressive symptom score in wave III	1.13	1.02	1.14	1.07	1.06	-0.04
	(0.87, 1.47)	(0.79, 1.31)	(0.93, 1.40)	(0.85, 1.35)	(0.85, 1.33)	(-0.27, 0.19)
Sleeping problems in wave III	0.94	0.95	1.05	0.96	0.95	-0.13**
	(0.84, 1.06)	(0.85, 1.05)	(0.96, 1.14)	(0.87, 1.06)	(0.86, 1.04)	(-0.21, -0.05)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	13,044	13,044	13,044	13,044	13,044	13,044

*P < .05, **P < .01, ***P < .001 (two-tailed tests).

95% confidence intervals in parentheses.

All models controlled for covariates shown in Table S1.

OR = odds ratio.

Table S3
The average treatment effects (ATE) of any material hardship on different health outcomes, Add Health wave I to wave IV

	ATE	Std. Err.	95% CI for ATE
Estimates from inverse probability weighting (IPW) [†]			
Poor health	0.06***	(0.01)	(0.04, 0.08)
Depression	0.08***	(0.01)	(0.06, 0.11)
Sleep problem	0.04***	(0.01)	(0.02, 0.06)
Suicidal thoughts	0.04***	(0.01)	(0.03, 0.06)
Estimates from propensity score matching (PSM) [‡]			
Poor health	0.05***	(0.01)	(0.03, 0.07)
Depression	0.08***	(0.01)	(0.06, 0.11)
Sleep problem	0.04***	(0.01)	(0.02, 0.06)
Suicidal thoughts	0.04***	(0.01)	(0.03, 0.06)

Each column and panel is from a different ATE estimate.

* $P < .05$, ** $P < .01$, *** $P < 0.001$ (two-tailed tests).

95% confidence intervals in parentheses.

$n = 13,313$.

Std. Err. = standard error.

[†] We use *teffects* commands in STATA 15 to estimate the average treatment effects using IPW approach. See Graham, Campos De Xavier Pinto [1] for details of the IPW methodology.

[‡] We use *teffects* commands in STATA 15 to estimate the average treatment effects using PSM approach. The independent variables used in the propensity score matching include factors that are hypothesized to affect the probability of experiencing any material hardship and/or health outcomes. This constraint guides our choice of socio-demographic variables in the propensity scores, including age, sex, educational attainment, race/ethnicity, earnings, citizenship status, unemployment status, family size, and number of kids, receipt of public assistance, consistent depression (wave I through III), consistent poor health (wave I through III), family structure (wave I), and parent-child relationship quality (wave I) in calculating the propensity score.

Reference

[1] Graham BS, Campos De Xavier Pinto C, Egel D. Inverse probability tilting estimation of average treatment effects in stata. *Stata J* 2011:1–16.