Adverse childhood experiences and perceived stress in early adulthood in the context of disadvantage

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ABSTRACT

Background: Adverse childhood experiences (ACEs) may sensitize individuals to view situations in adulthood as more stressful, which may contribute to poor health outcomes. In populations facing disadvantage, ACEs may lead to the accumulation of stressors (stress proliferation or mediation hypothesis) throughout the life course. ACEs could also heighten perceived stress later in life due to its enduring impact (stress sensitization or effect modification hypothesis).

Objective: We examine the associations between ACEs and perceived stress in early adulthood, considering concurrent life stressors, in a longitudinal cohort of Puerto Rican youth exposed to a high degree of disadvantage.

Participants and setting: A community-based sample of 1626 Puerto Rican children living in disadvantaged contexts was followed longitudinally in the Boricua Youth Study from 2000 to 2017.

Methods: ACEs were measured prospectively during childhood (<18 yrs), and life stressors and past year perceived stress were measured in early adulthood (EA; mean age = 23.4, sd 2.22). Causal mediation analysis tested ACEs' effects on EA perceived stress indirectly through life stressors including potential effect modification.

Results: ACEs influenced perceived stress in EA (standardized total effect = 0.13, $p < .001$) with 35% mediated by increased exposure to life stressors in EA due to ACEs. There was no evidence of increased sensitization to EA life stressors among those with higher ACEs exposure.

Conclusions: ACEs contribute to perceived stress in EA, albeit with small effect, partially through accumulating effects of ongoing stressors, supporting the stress proliferation hypothesis. Policies aimed at reducing exposure to adversity from childhood to EA are needed to reduce the experience of ACEs and negative sequelae.

Abbreviations: ACEs, adverse childhood experiences.
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1. Background

Adverse childhood experiences (ACEs) are associated with poor physical and mental health outcomes, including heart disease and psychiatric disorders (Hughes et al., 2017). However, the processes responsible for the predictive association between ACEs and adult health outcomes remain a topic of debate. Stress perception is implicated in the causal pathway from ACEs to health problems in adulthood (Hager & Runtz, 2012).

Perceived stress is a known predictor of negative health outcomes, early all-cause mortality (Lovallo, 2015), and psychiatric disorders (Roos et al., 2020). When perceived stress and physiological markers of stress are measured together, perceived stress is often a better predictor of outcomes, including cognitive functioning (Oumohand et al., 2020) and body mass index (Olstad et al., 2016). Recent evidence suggests that the brain may be particularly sensitive to stress as it is perceived (Wu et al., 2020). Perceived stress has also been shown to correlate with biological markers of aging, such as telomere length (Mathur et al., 2016) and DNA methylation (Jiménez et al., 2018).

Complementary models from different disciplines theorize *how* ACEs lead to negative health outcomes later in life. Originating in the discipline of Sociology, the 'Stress Proliferation' Model (Turner & Butler, 2003) provides a foundation for operationalizing life course processes of adversity accumulation over time. The model stipulates that ACEs evoke stress responses at the time of exposure, threaten the individual's adaptive capacities, catalyze secondary stressors, and are associated with a likelihood of future stress exposures and inadequate resources to cope with future stressors. Another option, the 'Stress Sensitization' model states that ACEs in childhood, rather than leading to the proliferation of stressors, would increase negative responses to subsequent stressors (McLaughlin et al., 2010). A growing body of work indicates that early exposure to adversity engenders lifelong increases in sensitivity to stressful life events that heighten the risk for psychopathology and negative health outcomes (McLaughlin et al., 2010; Solís et al., 2015). These hypotheses are not mutually exclusive: ACEs may serve as primary stressors that both set the stage for and interact with secondary stressors in the form of further adversities. Though different, both theoretical models suggest that ACEs would be correlated with perceived stress in adulthood.

Empirical research supports the premise that ACEs are related to future stress, with ACEs showing slight to moderate correlations with perceived stress later in life (Bossé et al., 2018; Nurius et al., 2015). However, existing studies have several limitations. Most of these findings have been based on small samples, in relatively socio-economically advantaged groups, or in older populations, or specific clinical groups, e.g. cocaine-dependent adults (Hyman et al., 2007) or adult inpatients with psychiatric disorders (Edalati et al., 2020). Nearly all have used retrospective self-reports of ACEs, which could be biased by current perceived stress, a significant limitation in previous studies on the impact of childhood adversity (Baldwin et al., 2019). Most of these studies have not been carried out with individuals living in socioeconomically disadvantaged contexts, who face high levels of ongoing adversities across the life course (Assari, 2020; Giano et al., 2020). Two recent studies that specifically considered childhood adversities, current stressors in early adulthood, and perceived stress did not find an association between childhood adversity and early adult perceived stress when controlling for current life stressors (Baker et al., 2020; Tung et al., 2020). However only one of these studies (19) measured ACEs prospectively, and this study focused on intimate partner violence as a specific current life stressor during pregnancy. Finally, previous measurement approaches either analyzed ACES separately or as a cumulative score, which treats all ACEs equally, although the effects of different ACEs have been shown to vary (McLaughlin & Sheridan, 2016).

Addressing the limitations in existing research, we used a representative sample of a population exposed to a high degree of adversity, with prospectively collected data on ACEs in childhood and stressors in early adulthood, to analyze pathways of ACEs leading to perceived stress in young adults. The Boricua Youth Study is a longitudinal study of Puerto Rican youth in the South Bronx (SBx) in New York City and in San Juan, Puerto Rico (PR), nearly three quarters of whom report income levels at or below the federal poverty line, and half of whom report three or more ACEs (Ramos-Olazagasti et al., 2017). The study follows the youth over
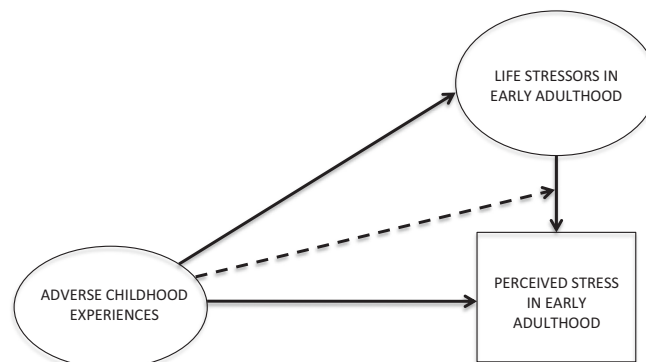
Fig. 1. Theoretical moderated mediation model for the effect of adverse childhood experiences on early adult perceived stress.
Note. The bold pathway represents the 'Stress Proliferation' hypothesis, that ACEs contribute to early adult perceive stress through the presence of stressors in adulthood. The dotted line represents the 'Stress Sensitization' hypothesis, that ACEs moderate the relationship between life stressors in early adulthood and perceived stress.

approximately 11 years since the childhood assessments and includes extensive data on their life experiences as well as perceived stress. The longitudinal design of the Boricua Youth Study enables us to analyze prospectively collected data on ACEs, avoiding recall bias. We also use a latent variable approach to measure ACEs, which allows for each ACE to contribute differentially to the measurement.

We hypothesized that there would be an indirect effect from ACEs to early adult life stressors to early adult perceived stress, supporting the 'stress proliferation' hypothesis. We also predicted that ACEs could moderate the relationship between life stressors in adulthood—such as food insecurity, discrimination, and inability to pay for medical care—and perceived stress, such that young adults with a history of ACEs would experience life events as more stressful, supporting the 'stress sensitization' hypothesis (Fig. 1).

2. Methods

2.1. Sample

The Boricua Youth Study is a longitudinal study of Puerto Rican youth in the SBx, New York City, and in the Standard Metropolitan Area of San Juan and Caguas, PR. Each sample is a multistage probability sample representative of the target areas based on the 2000 Census. Households with at least one child aged 5–13 years at enumeration were eligible to participate if the child and at least one parent identified as Puerto Rican. Up to three children per household were randomly selected to participate in the study. Children with severe developmental delays and those who had not lived in the household in the past 9 months were ineligible. A primary caretaker, 89% of whom were biological mothers, and eligible children, were assessed yearly for three years between 2000 and 2004 (Waves 1–3). Retention rates at the third assessment were very high (89.7% in PR and 85.6% in SB) (Bird et al., 2007). The study design and procedures are described in more detail in previous publications (Bird et al., 2006a; Bird et al., 2006b; Bird et al., 2007). After intensive tracking over approximately 11 years (S.D. 1.14), Wave 1 participants were re-interviewed between 2013 and 2017, with retention rates of 82.48% ($n = 1083$) in PR and 83.12% ($n = 921$) in the SBx. Data from these Wave 4 interviews were used to measure life stressors and perceived stress in early adulthood as described in more detail below. Participants who were <20 years old at Wave 4 were excluded because we were interested in the outcome of perceived stress in early adulthood. The sample size at Wave 4, therefore, was 1626. Young adults were, on average, 23.4 years old (std dev 2.22).

Interviews were conducted in the participants' homes in Spanish or English, based on the interviewee's preference, by trained laypersons who had at least a high school diploma. Interviews were computerized and participants had the option of switching languages at any time during the interview. To ensure privacy, parents and children were interviewed separately and alone by different interviewers. In Waves 1–3, parents reported on background characteristics and family psychiatric history, and children and parents reported on children's experiences of maltreatment and abuse, as described in more detail below. Parents provided informed consent and youth signed assent forms. In Wave 4, young adults (original child participants) provided informed consent and reported on life stressors and perceived stress, within a larger interview. During the consent process, participants were informed that if there was any report of current risk to self, others, or child abuse, confidentiality would be broken and the case would be reported to the appropriate authorities. When participants endorsed child abuse during the interview, this information was immediately brought to the attention of the clinical team, who provided clinical backup and decided how to proceed. The Institutional Review Boards of the New York State Psychiatric Institute, the Massachusetts General Hospital, and the University of Puerto Rico Medical School approved study procedures.

2.2. Measures

2.2.1. Adverse childhood experiences
A detailed description of the measures has been previously reported (Ramos-Olazagasti et al., 2017). In brief, eleven adverse childhood experiences were assessed yearly at Waves 1, 2, and 3, with consistent measures. Children were 5–15 years old at Wave 1, however questions in Wave 1 asked if children had *ever* experienced the ACE. Thus, the first reporting covered the period from birth until the child's age at Wave 1. In Waves 2 and 3, questions asked if children had experienced the ACE since the last interview. The following ACEs were measured: physical neglect, physical abuse, emotional abuse, sexual abuse, exposure to violence, parental death, parental divorce/separation, parental intimate partner violence, parental substance use problems, parental incarceration, and parental mental health problems.

Youth and parents reported on experiences of maltreatment (physical neglect, physical abuse, and emotional abuse) using the parent version and child-adapted version of the Parent-Child Conflict Tactics Scale (PCCTS) (Straus et al., 1998), which has been used previously in large, epidemiologic studies (Goodman et al., 1998). Items included: *Ever did not take to doctor/hospital* (physical neglect), *Beat up very hard* (physical abuse), *Swore or cursed* (emotional abuse). Parents and children reported on sexual abuse by responding to items from the Sexual Victimization Scale developed by Finkelhor and Dziuba-Leatherman (Finkelhor & Dziuba-Leatherman, 1994), including *Tried to touch, grab, or kiss in a sexual way*. For all experiences of maltreatment, ever having experienced the maltreatment, as endorsed by *either* parent or child, was coded as 1; never having experienced it was coded as 0.

Children reported on exposure to violence using Richter's Exposure to Violence scale (Richters & Martinez, 1993), including items such as *Being chased by gangs or individual*. Parents reported on parental maladjustment variables (parental death, parental divorce/separation, parental intimate partner violence, parental substance use problems, and parental mental health problems) through clinical interviews and the Family Psychiatric Screening Instruments for Epidemiologic Studies, which has displayed strong psychometric properties for adult psychiatric disorders in epidemiologic studies (Lish et al., 1995).

We derived a *single dimensional measure of overall ACEs* closely following work previously described (Polanco-Roman et al., 2021). Specifically, the eleven childhood ACEs fit well to a two factor confirmatory factor analysis (CFA) model with one factor underlying the items measuring experiences of neglect and abuse on the child as well as exposure to violence, and the other parental ACEs and family problems that could impact the child. Fit indices used for selecting the two-factor model are included in Supplementary Table 1. Parental death did not load on either of the two factors, but did load on a second order factor of overall ACEs underlying both of the first order factors. The second order factor model is empirically equivalent to the two-factor model previously fit (Root mean square of approximation (RMSEA) 0.033; 90% CI 0.027–0.038; comparative fit index (CFI) = 0.938; Tucker-Lewis index (TLI) = 0.921). In the present analyses we utilize the factor score derived from the second order factor model as our primary measure of overall ACEs. This latent variable approach allows for each ACE to contribute to a different degree to the overall ACE measurement.

2.2.2. Primary outcome: past year perceived stress

Perceived stress was measured by the Perceived Stress Scale (Cohen et al., 1983), a 14-item instrument designed to measure the degree to which situations in one's life over the last month are appraised as stressful. Questions include, "In the past month, how often have you found that you could not cope with all the things that you had to do?" A 5-point Likert scale provides response options from "never" to "very often." Responses were summed across items to create a total score.

2.2.3. Stressors in early adulthood

The following stressors were measured at Wave 4, when participants were young adults.

1) Stressful life events were measured by the *Chronic Stress* Scale. The scale asks about "ongoing problems in everyday life." Items include: *Close friend or family member died because of an accident, homicide, or suicide; Lived with anyone who was a problem drinker or alcoholic who used street drugs;* and *Household member depressed or mentally ill or attempted suicide.* Respondents indicate whether each endorsed problem began "Before I was a teenager," "When I was a teenager," or "After I was a teenager." For our analysis of "Stressors in Early Adulthood," an item was considered present if the participant endorsed the item "After I was a teenager."
2) Food insufficiency was assessed by a questionnaire developed by the US Department of Agriculture for assessing food insecurity and hunger (Carlson et al., 1999). Questions ask participants whether they experienced certain situations in the past 12 months. Items include *Were very hungry but didn't eat because there wasn't enough money for food* and *Ate less than you felt you should because there wasn't enough money for food.* Households were considered food-insecure if they answered affirmatively to three or more of the questions.
3) Discrimination was measured by the following two questions, which followed endorsement of racial or ethnic discrimination: Overall, how much has discrimination interfered with you having a full and productive life? Overall, how much harder has your life been because of discrimination?
4) Difficulty paying for medical care was measured by one item asking, In the past 12 months, was there ever a time when someone in your household needed to see a doctor or go to the hospital, but didn't go because they could not afford it?

To combine the different types of life stressors into a composite measure "Life Stressors in Early Adulthood" we used the factor score from a single factor model fit to the 12 indicators— *nine items from the chronic stress scale, food insufficiency, discrimination,* and *difficulty paying for medical care.* The one factor model fit indices were good (RMSEA 0.019 [010–026], CFI 0.95, TLI 0.94) and the factor loadings of the indicators were moderate to strong (between 0.15 and 0.75) and all statistically significant. Because we were interested in a composite measure of life stressors, we did not explore additional factors for the life stressors latent measure.

2.2.4. Covariates

Study site (SBx or PR), young adult gender, age at Wave 4, education level at Wave 4, and whether a participant was living with a child were used as covariates. Study site, young adult gender and age are included as potential confounders associated with ACEs and/ or early adulthood perceived stress (VanderWeele, 2019). Moreover, site and gender were also considered as potential effect modifiers and were included in additional sensitivity analyses stratifying by them as described in the analytic strategy. Education level at Wave 4 and whether a participant was living with a child are both potential factors which may be along the mediating pathway from ACEs to early adulthood perceived stress. Hence, we included them as control variables to delineate the specific indirect path from ACEs through EA life stressors to perceived stress above and beyond their influence.

2.3. Analytic strategy

Descriptive proportions of specific ACEs and life stressors were calculated across the whole sample and stratified and tested via chi-square by context SBx vs PR. Mean past year life stress was compared between SBx vs PR with two sample *t*-test.

We utilized mediation analysis with exposure-mediator interaction (Valeri & VanderWeele, 2013) to 1) estimate the total, indirect, and direct effects of overall ACEs on past year perceived stress in early adulthood mediated through early adult life stressors, and 2) assess whether overall ACEs modify the effect of life stressors in early adulthood on perceived stress (Fig. 1). As described above, observed composite measures were used for overall ACEs, life stressors, and perceived life stress and each was modeled on a continuous scale in the model for the mediator (i.e. life stressors as outcome), and the model for perceived stress as the outcome. The mediation analysis also included as predictors' gender, site, age (at Wave 4), educational attainment (at Wave 4) and having a child (dichotomous at Wave 4). Standardized total, total natural indirect, and pure natural direct effect (VanderWeele, 2015) of overall ACEs on perceived

stress were estimated and tested for statistical significance different from zero with *p*-values less than .05. The regression coefficient of the interaction between overall ACEs and life stressors provided the test of effect modification. Previous research has shown that psychological outcomes differ by study site—which involved being an ethnic minority in the SBx versus being the ethnic majority in PR—as well as by gender (Alegria et al., 2020; Polanco-Roman et al., 2021). Therefore, as an additional step, all models were tested separately by site and by gender using stratified analysis.

All responses were weighted to be representative of the target study sampling areas based on the 2000 Census. Weights are site-specific and account for non-response at Wave 4. For Wave 4, non-response propensity weights were developed as described elsewhere (Duarte et al., 2021) using standard methods that incorporate known information from participants collected at earlier waves. Family ID was used as the clustering variable to account for non-independence of participants in the same family. The majority of missing data was from non-response at subsequent waves—not more than 20% given the study overall participation rate at Wave 4 was 82.4%, adjusting for ineligibility (Duarte et al., 2021)—and was accounted for using the non-response propensity weights. Other missing data was low (under 2% for all variables, except for parental divorce/separation: 3.8%) and was handled by the default settings in Mplus for structural equation models using full information maximum likelihood under the missing at random assumption. SAS 9.4 (Cary, NC, 2013) was used for data preparation and descriptive analyses; mediation analysis was assessed using Mplus v 8.6 (Muthén & Muthén, 2021).

3. Results

3.1. ACEs, stressors, and perceived stress by context

In the total sample (*n* = 1626), participants were 48% male, 46% from the SBx site. On average, participants had slightly more years of education in PR than in the SBx (11.34 versus 10.10, *p* < .001). Approximately 30% had a child in the home, and this did not differ by site. Generally, the prevalence of specific ACEs and EA life stressors were higher among individuals from SBx than PR (Table 1). Perceived stress in early adulthood was also higher among individuals who grew up in SBx compared PR (standardized difference = 0.399, *p* < .001).

3.2. Mediation analysis with exposure-mediator interaction

Overall ACEs had a significant effect on life stressors in early adulthood (standardized beta (b) = 0.114; *p* < .001) consistent with the stress proliferation hypothesis (Table 2). Moreover, overall ACEs had a significant total causal effect on perceived stress

Table 1
Participants reporting ACEs and early adult life stressors in the total sample and by study site (SBx and PR) from 2000 to 2017.

	Total (N = 1626)	SBx (N = 752)	PR (N = 874)
Waves 1–3 ACEs	%	%	%
Neglect	18.86	18.83	18.88
Physical abuse	27.65	32.15	23.89**
Sexual abuse	7.83	9.15	6.74
Emotional abuse	32.04	42.70	23.05**
Exposure to violence	27.23	29.66	25.19
Parental divorce/separation	58.69	70.28	49.25**
Parental domestic violence	3.96	2.83	4.91
Parental arrest or jail	12.40	16.88	8.69**
Parental substance abuse	19.98	17.64	21.92
Parental MH problems	35.69	35.63	35.74
Parent death	6.28	7.78	5.05
ACE count (*mean/SE*)	2.47 (0.054)	2.78 (0.072)	2.21 (0.080)**
Stressors early adulthood wave 4			
Lost someone to violent death	19.19	17.58	20.51
Lived with substance abuser	2.66	2.56	2.74
Lived with someone with a mental illness	4.38	3.91	4.77
Serious ongoing health problem	3.18	3.76	2.72
Difficulties with job or school	3.49	4.89	2.36**
Difficulties in a close relationship	4.81	7.15	2.91**
Someone close had drug/alcohol problem	7.05	7.54	6.66
Caring for someone sick or old	11.61	12.03	11.25
Other ongoing problems	0.72	1.11	0.40
Food insufficiency	22.82	21.30	24.10
Discrimination (*mean/SE*)	0.582 (0.033)	0.829 (0.057)	0.375 (0.038)**
Difficulty paying for medical care	9.68	12.38	7.42**
Perceived Stress past month W4 (*mean/SE*)	12.072 (0.175)	13.599 (0.260)	10.782 (0.234)**

** *P* < .05 for difference between sites.

(standardized total effect = 0.129; p < .001) with 35% of it mediated by stressors in early adulthood. Higher life stressors led to higher perceived stress (b = 0.40; p < .001). Also, women, participants from SBx, and younger participants had higher past month perceived stress even after accounting for overall ACEs and life stressors. Contrary to the stress sensitization hypothesis prediction, ACEs did not modify the effect of early adulthood stressors and perceived stress (interaction beta = −0.01, p = .74).

Our results did not change meaningfully when models were tested separately by site or by gender (Supplementary Tables 2 and 3), or when using the two factors measuring ACEs (parent-related and child-related ACEs) separately.

4. Discussion

In this study of Puerto Rican youth living in contexts of disadvantage throughout childhood and early adulthood, ACEs were significantly, though weakly, correlated with perceived stress in early adulthood. One third of that effect was mediated through life stressors in early adulthood, supporting the 'Stress Proliferation' model. The overall weak association between ACEs and perceived stress suggests that, in this population experiencing high economic and social disadvantage, factors beyond ACEs likely impact stress perception in early adulthood, including but not limited to additional stressors occurring across the life course. The hypothesis that the experience of ACEs in childhood would sensitize individuals to the effects of future stressors (Stress Sensitization hypothesis) was not supported.

Our analysis method—examining the indirect pathway from ACEs to early adult life stressors to perceived stress—allows us to highlight the role of continued exposure to adversity in negative outcomes later in life. By doing so, we quantify the role that early adulthood life stressors serve as mediators of ongoing adversity in life course processes of ACEs and negative health and developmental outcomes. Similarly, performing analyses in a less socioeconomically disadvantaged group precludes an understanding of the role of ongoing disadvantage in ACEs effects on adult health.

A weak association between ACEs and perceived stress does not imply that stress is not on the pathway between ACEs and negative health outcomes. Individuals with ACE exposure may not endorse high perceived stress, yet high levels of ACE-related stress may manifest as impulsivity (Moustafa et al., 2017) or directly as cellular aging (Ridout et al., 2019), inflammatory processes (Rohleder, 2019) or DNA methylation (Hing et al., 2018), which could impact the onset of chronic disease and decrease longevity.

Several limitations should be noted. As described in the methods section, ACEs were first reported at Wave 1 when the children were 5–15 years old. The questions asked whether the child had *ever* experienced the adversity, essentially providing a retrospective report from birth until age at Wave 1. This is still likely to be more accurate than a retrospective lifetime report decades later. Similarly, ACEs are generally considered adversities occurring before age 18. Because children were 7–17 years old at Wave 3, adversities that occurred only later in childhood/adolescence were not captured in the Wave 1–3 ACE measurement. Additionally, *exposure to violence* was only reported by children, potentially introducing measurement error for that ACE to the extent that young children may not have been able to accurately report their exposure to violence. Still, the youngest children at Wave 3 were 7 years old, an age at which they would likely have been able to remember significant exposure to violence, particularly if that exposure was ongoing. Discrimination could have been an additional source of adversity, particularly for those living in the SBx (Ramos-Olazagasti et al., 2013) and was not included in the ACE measurement because young children were not asked about discrimination in Waves 1–3. However, we would expect to see effects of discrimination based on race/ethnicity partially reflected in site differences, which we did not find. Finally, our analyses do not include other characteristics of adverse childhood experiences that could have lasting effects on stress perception, including chronicity, age of first occurrence, and who the perpetrator was. These factors could act as moderators, a possibility we are not able to assess in the current analysis. We also did not assess nonlinear relationships between the variables.

A strength of this research is that we conducted these analyses longitudinally in a large, population-based sample of children, minimizing the likelihood of recall bias that is common among studies of childhood adversity (Reuben et al., 2016). A recent meta-

Table 2
Effect of adverse childhood experiences on past month perceived stress mediated by stressors in early adulthood[a] in individuals in SBx and PR from 2000 to 2017.

	Stressors in early adulthood W4			Past month perceived Stress W4		
	Beta	SE	P value	Beta	SE	P value
Overall ACEs	0.114	0.029	<.001	0.081	0.025	0.001
Stressors in early adulthood W4				0.400	0.026	<.001
Overall ACEs × stressors in early adulthood				−0.007	0.022	0.742
Gender (women vs. men)	0.015	0.056	0.79	0.188	0.051	<.001
Site (PR vs. SBx)	−0.192	0.058	0.001	−0.320	0.052	<.001
Age (W4)	0.032	0.013	0.01	−0.041	0.011	<.001
Education attainment (W4)	0.004	0.012	0.71	−0.011	0.012	0.375
Has child (W4)	−0.09	0.062	0.15	0.087	0.058	0.131
Total causal effect				0.129	0.028	<.001
Pure natural direct effect				0.085	0.027	0.001
Total natural Indirect effect				0.045	0.012	<.001
% mediated				35%		

[a] Stressors measured by a composite factor score derived from 12 measures (9 stressful life events, food insufficiency, discrimination, difficulty paying for medical care). ACEs measured by a composite of 11 ACEs from 2nd order factor model.

analysis found that correlations between retrospective and prospective reports are very low (k = 0.19) (Baldwin et al., 2019), making analyses using prospectively collected data on childhood adversities imperative.

Second, our use of modern causal mediation analysis able to partition effects into direct and indirect while accounting for potential interaction allowed us to examine a richer set of hypotheses including exposure-mediator interaction. Our data provide support to the 'Stress Proliferation' model, suggesting that the accumulating effect of stressors through early adulthood contribute more to perceived stress than sensitization caused solely by ACEs. Moreover, our use of a second order factor score to create a composite measure of overall childhood ACEs accounts for multiple ACEs simultaneously so that meaningful information could be gleaned without simply summing across the number of ACEs experienced (McLaughlin & Sheridan, 2016).

5. Public health implication

In a large, prospective study of Puerto Ricans exposed to a high degree of adversity, we show that ACEs are significantly, though weakly, correlated with perceived stress in early adulthood. Perceived stress is highly correlated with negative health and behavioral outcomes (Lindholdt et al., 2021; Nielsen et al., 2008; Redmond et al., 2013) and may be an early indicator of primary bio-psycho-social dysfunction. Intervention strategies to reduce stress in disadvantaged groups may need to target broader conditions that contribute to ongoing stressors across the life course, including economic insecurity, housing instability, and continuous exposure to violence, racism, and discrimination. Concrete examples include initiatives to reduce gun violence (Branas et al., 2021), interventions for youth facing housing insecurity—(Semborski et al., 2021) such as Housing First, a model that prioritizes providing housing for youth before resolving other problems in their lives (Tsemberis, 2011)—and poverty reduction strategies such as cash transfers (Troller-Renfree et al., 2022). Our results also emphasize the need to consider level of socioeconomic disadvantage in public health research that aims to understand how life course processes of childhood adversities' impact adult outcomes.

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Declaration of competing interest

None.

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