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Specific domains of positive childhood experiences (PCEs) associated with improved adult health: A nationally representative study

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ABSTRACT

Background: Positive childhood experiences (PCEs) are supportive relationships and environments associated with improved health when aggregated into composite scores. Adverse childhood experiences (ACEs), a reciprocal measure to PCEs, are associated with worse health in aggregate scores *and* when disaggregated into measures of specific ACE types (hereafter domains). Understanding the associations between specific PCE domains and health, while accounting for ACEs, may direct investigations and intervention planning to foster PCE exposure.

Methods: We analyzed data from the nationally representative United States longitudinal Panel Study of Income Dynamics. Five PCE domains were examined: (i) peer support and healthy school climate, (ii) neighborhood safety, (iii) neighborhood support, and nurturing relationships with (iv) maternal and (v) paternal figures. Survey weighted logistic regression models tested associations between each PCE domain measure and adult general health rating, controlling for demographic covariates and nine ACE exposures: physical, emotional, or sexual abuse/assault; emotional neglect; witnessing intimate partner violence or household substance use; having a parent with mental illness; any parental separation or divorce; and/or having a deceased or estranged parent. Secondary outcomes included adult functional status and mental and physical health diagnoses. We also tested for statistical interactions between PCE domain and ACE score measures.

Results: The sample included 7105 adults. Higher scores for the "peer support and healthy school climate" and "neighborhood safety" domain measures showed the most protective relationships with the adverse health conditions tested, most notably for mental illness. The relationship between PCE domain measures and health outcomes was attenuated, but not statistically moderated by ACE exposure.

Conclusion: Experiencing childhood peer support, a healthy school climate, and neighborhood safety were especially protective against multiple adult health conditions, including for ACE exposed individuals. Interventions that promote PCEs may yield population health gains.

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1. Introduction

Childhood experiences shape health over the life course. Adverse childhood experiences (ACEs) are intensely or persistently stressful or traumatic childhood events, including maltreatment and household challenges such as parent mental illness, associated with poor lifelong health outcomes (Felitti et al., 1998). A greater number of ACEs confers greater risk for a wide range of negative health behaviors and conditions; combinations of different types of ACEs can also have differential risk profiles depending on the type of health outcomes assessed (Barboza, 2018; Hughes et al., 2017). Over half of U.S. adults have experienced an ACE, and ACE-attributable costs to society are high (Giano et al., 2020; Hughes et al., 2021). However, ACEs only tell part of the story of how childhood exposures influence lifelong health trajectories. Positive childhood experiences (PCEs), with domains such as supportive parental, school, and neighborhood relationships and environments, are associated with improved socioemotional and cardiovascular health and may buffer early life adversity, but which PCEs are most protective is unclear (Bethell et al., 2019; Crandall et al., 2019; Guo et al., 2021; Kosterman et al., 2011; Narayan et al., 2018; Slopen et al., 2017).

Multiple PCE domain-specific survey items and scales exist. Aggregating across the domains produces total PCE scores that offer an overall assessment of protective factors. Common PCE domains include parent-child relationships, school climate and peer relationships, and neighborhood safety and support (Bethell et al., 2019; Guo et al., 2021; Narayan et al., 2021). While specific ACE domains such as sexual abuse and parental mental illness have *each* been linked to health risks, evidence on the degree of association between separate PCE domains and adult health outcomes is not as robust (Lee et al., 2013; Manning & Gregoire, 2006; Turner et al., 2017). A single, cross-sectional, state level study found associations between individual PCE scale items and only adult depression diagnosis/current poor mental health symptoms after controlling for ACEs and found associations of comparable strength across the scale items (Bethell et al., 2019). The study omitted important PCE domains related to school and neighborhood safety and neighborhood social support.

Generally, it is posited that PCEs buffer the negative effect of ACEs on lifelong health (Elmore et al., 2020; Liu et al., 2020; Yu et al., 2022; Zhang et al., 2021). Alternatively, PCEs may protect health independent of ACE exposure (Bethell et al., 2019; Lynch et al., 2018). Prior studies testing models with both ACEs and PCEs have found evidence supporting both hypotheses, but they generally used small, non-nationally representative samples, or were cross-sectional (Bethell et al., 2019; Elmore et al., 2020; Liu et al., 2018; Lynch et al., 2018; Yu et al., 2022; Zhang et al., 2021). Despite evidence that ACEs and PCEs both influence health and may operate in concert, no national longitudinal study has examined the extent to which *individual PCE domains* affect physical and mental health outcomes while considering the level of ACE exposure.

To address these evidence gaps, through longitudinal analysis of data from a large, nationally representative survey we aim to: (1) compare the degree to which measures of distinct PCE domains differ are associated with adult health outcomes, including the primary outcome of adult general health rating, with and without adjusting for the level of ACE exposure and (2) evaluate whether the relationship between PCE domain measures and adult health is moderated by level of ACE exposure.

2. Methods

2.1. Data source and sample

We used data from the Panel Study of Income Dynamics (PSID), the world's longest-running national household panel survey (University of Michigan Institute of Social Research & Survey Research Center, 2023). We merged two PSID datafiles: the 2014 Childhood Retrospective Circumstances Study (PSID-CRCS) containing ACEs and PCEs measures with the 2017 primary survey containing health outcome measures. We used the participant unique ID number that is assigned by the administrators of the Panel Study of Income Dynamics (PSID) to each PSID participant to merge the two datafiles. A PSID participants maintains the same unique ID number over time.

2.1.1. Childhood experiences: 2014 PSID-CRCS

PSID-CRCS was a mixed-mode (web and mail) supplement to the biennial PSID primary survey that obtained retrospective self-reports from adults (aged 18–97) on positive and negative childhood experiences before age 17 for parent-related questions and after age 6 for school and neighborhood-related questions, given that school relationships are typically only available during school age. English-speaking reference persons (adults with primary financial responsibility for the family unit) and their spouse/partner in families that completed the 2013 primary PSID survey were eligible for the PSID-CRCS, and 8072 individuals completed a PSID-CRCS interview, with an unweighted response rate of 62% (weighted rate 67%) similar to other national panel web-based surveys (University of Michigan Institute for Social Research, 2015).

2.1.2. Adult health outcomes: PSID 2017 primary survey

The PSID biennial primary survey collected demographic, household, and health information via a telephone interview with one adult in each family. The PSID 2017 primary survey had an unweighted response rate of 89%; 9607 families completed the interview, providing information on 14,571 reference persons and spouses/partners (Beaule et al., 2019). The outcome measures were self-reported by the reference person or spouse/partner who completed the PSID interview and was proxy reported for the other person.

2.1.3. Analytic sample

We defined our analytic sample as those individuals who have data from the PSID-CRCS and the PSID 2017 primary surveys and had responses to at least one item within each of the PCE and ACE measures, and the primary outcome (general health rating) item. This included data from the survey respondents and any spouses/partner for which they reported proxy responses. Of 8072 PSID-CRCS respondents, 7105 (88%) met the eligibility criteria for inclusion in the analytic sample. See the sample flow diagram (Fig. 1).

2.2. Measures

2.2.1. PCE measures

We selected 26 PSID-CRCS questions comparable to items used in the "PCE Scale", Benevolent Childhood Experience (BCE) scale, and the

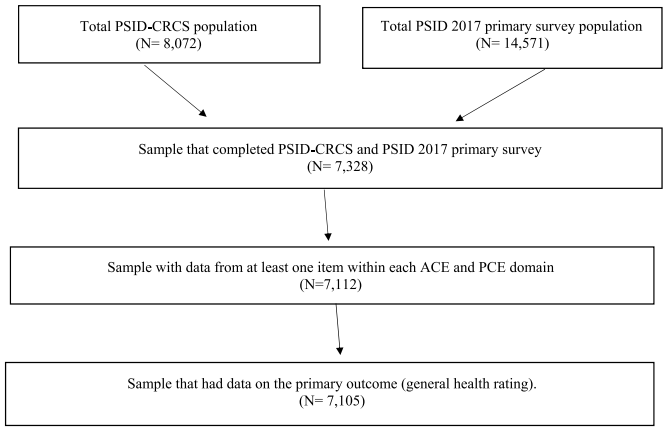

Fig. 1. Flow chart for defining analytic sample. PSID = Panel Study of Income Dynamics, CRCS = Childhood Retrospective Circumstance Study, ACE = Adverse Childhood Experiences, PCE = Positive Childhood Experiences.

Health Outcome from Positive Experience-PCE measure, all psychometrically validated PCE assessments (Bethell et al., 2019; Guo et al., 2021; Narayan et al., 2018). See Table A.1 for variable construction details.

We separately conducted a factor analysis, which identified five distinct PCE factors/domains (henceforth termed "domains"), each of which included multiple related PSID-CRCS items. All 26 PSID-CRCS items were included in the construction of the PCE domain measures given high internal consistency (Cronbach's alpha = 0.88). Each of the 26 PSID-CRCS items fit the criteria for one of the five domains. Each domain contained three to six items. We calculated an average score from 1 to 4 across PCE items in the following domains: (1) healthy school climate and supportive peer relationships, (2) neighborhood safety, (3) neighborhood support, (4) nurturing paternal relationship, and (5) nurturing maternal relationship. These five domains map neatly onto well-established PCE domains in the literature (Bethell et al., 2019; Guo et al., 2021; Narayan et al., 2018). We averaged responses within each domain and then standardized our five PCE domain measures by translating the values to z-scores to allow for meaningful comparisons across the domains.

2.2.2. Adult health primary outcome measure

Adult general health rating is a well-studied, validated measure of general health and predictor of morbidity and mortality (DeSalvo et al., 2005). The 2017 PSID primary survey asked adult respondents to rate their (or their spouse/partner's) general health as excellent, very good, good, fair, or poor. We dichotomized these responses as excellent/very good/good versus fair/poor, consistent with prior studies (Dowd & Zajacova, 2007).

2.2.3. Adult health secondary outcome measures

Secondary analyses explored three other types of outcomes: (1) the presence of a functional limitation, (2) physical health outcomes (any chronic physical condition, cardiovascular disease), and (3) mental health outcomes (psychological distress, depression diagnosis, anxiety diagnosis). Each measure is self-reported for the survey respondent and proxy reported for their spouse/partner, except the psychological distress measure which is only collected for survey respondents themselves.

Functional limitation was an exploratory measure of overall health, indicating a disabling health condition that did not require access to a clinician for diagnosis. We created an indicator variable for whether a "physical or nervous condition" limited the type of work or the amount of work that the respondent can do.

A composite measure of physical chronic health conditions was chosen for exploratory analysis since little prior work has been done on the link between PCEs and adult chronic physical health conditions. We also created a subset measure limited to cardiovascular diseases given prior limited evidence (Slopen et al., 2017). PSID asked respondents whether a doctor or other health professional ever diagnosed them with a (1) stroke, (2) heart attack, (3) coronary heart disease, angina, congestive heart failure, (4) hypertension, (5) asthma, (6) chronic lung disease such as bronchitis or emphysema, (7) diabetes, (8) arthritis, (9) cancer, (10) any other serious, chronic condition. We combined responses from items 1–10 into a single indicator variable for whether any of these serious chronic physical conditions was ever diagnosed. The same was done for items 1–4 for whether a cardiovascular condition was diagnosed.

Three mental health outcomes were selected to offer a more nuanced understanding of the association between PCEs and adult mental health since the link is better established in the literature (Bethell et al., 2019; Wang et al., 2021). PSID asked respondents to complete the six items on the validated and widely used Kessler-6 psychological distress scale (Kessler et al., 2003). They were also asked whether a doctor or other health professional ever diagnosed the participant with any emotional, nervous, or psychiatric condition. If reported, PSID then asked about the specific diagnosis. Three separate indicator variables were created for the presence of (1) severe psychological distress (if the participant met the published threshold of a Kessler-6 score of 13, which is highly predictive of a clinically diagnosable mental health condition), (2) a depression diagnosis, and (3) an anxiety diagnosis.

We also intended to explore two substance use outcomes (history of smoking and binge drinking), but we were unable to operationalize these variables in a meaningful way (to indicate severity and degree of functional impairment due to substance use) that would allow us to draw clear conclusions. See variable construction details and results for these variables in Table B7.

2.2.4. Covariates: construction of ACE measure

The PSID-CRCS survey included questions about adverse experiences before age 18 including physical, emotional, or sexual abuse/assault, emotional neglect, witnessing intimate partner violence or household substance use, having a parent with mental illness, any parental separation or divorce, and/or having a deceased or estranged parent. We used previously published methodology to construct ACE measure (A. Schickedanz et al., 2018; A. B. Schickedanz et al., 2019). We created separate indicator variables for each of the adverse experiences Next, we created a cumulative ordinal total ACE score by summing the number of adverse experiences reported from 0 to 9. Lastly, we binned the ACE count into categories of 0 ACEs, 1 ACE, 2–3 ACEs, and 4 or more as our main ACE measure.

2.2.5. Covariates: other covariates

We drew other covariates from the 2017 PSID primary survey, including participant age (in years), sex (male/female), reported race (Asian/Pacific Islander, Black, Other, White), reported ethnicity (if Hispanic/Latinx), education level (less than high school, high school graduate/GED, any college/vocational school, graduate school), household income in reference to federal poverty limit (<100%, 100–199%, 200–299%, 300–399%, and 400% or more), health insurance status (any health insurance, none), and whether reported outcome was self or proxy reported. Race, a social construct, was included as a marker of effects of structural and interpersonal racism.

2.3. Statistical analyses

2.3.1. Regression analyses

To evaluate whether PCE domain measures predict adult health conditions, we used multivariate logistic regression models to test the associations between each of the five PCE domain measures and general health after adjusting for covariates except ACEs (Aim 1). We then included the ACE composite categorical score measure in the models as a covariate to identify the residual independent association between each PCE domain measure and adult general health rating after adjusting for the level of ACE exposure. Next, we interacted each PCE domain measure with the ACE composite continuous score measure to evaluate whether ACE exposure moderated the relationship between the PCE domain and adult general health rating (Aim 2). We used a similar approach to examine associations between each of the five PCE domain measures and other adult health outcomes. We estimated adjusted odds ratios and predicted outcome probabilities.

We applied the PSID-CRCS cross-sectional weight to account for the complex sampling design, achieve population representation, and adjust for unequal selection probabilities. Standard errors were adjusted to reflect survey design and sampling approach. Stata 17.0 software was used for all analyses.

2.3.2. Missing data

To maintain maximal information, we retained responses if an individual only responded to a subset of items within a PCE or ACE measure. For the analytic sample, under 3% were missing data. We did not impute to avoid introducing bias (Sterne et al., 2009).

2.3.3. Sensitivity analyses

We ran sensitivity analyses for construction of the PCE and ACE measures with complete cases (i.e. those who responded to all PCE and ACE items; Table B.3), binary PCE domain measures (Table B.4-B.5), ordinal health rating on the original 5-point scale (Table B.4), and inclusion of a covariate with the PCE score minus the PCE domain tested (Table B.6). We dichotomized the PCE domain measures at the 75th percentile to create five indicator variables that designate higher exposure to PCEs within each domain, similar to other studies (Guo et al., 2021). We loaded a variable for the PCE score minus the PCE domain tested in the model to adjust for exposure to the other types of PCEs that may confound the relationship between the specific domain of interest and the adult health outcome tested. The PCE score was calculated by summing the other four PCE domain indicator variables. These different variable constructions produced substantially similar results.

This study was deemed exempt by our institution's Institutional Review Board. The STROBE guidelines were followed in preparing this manuscript (Strobe, 2023).

3. Results

3.1. Sample characteristics

The analytic sample consisted of 7105 adults. The total PCE average score across all 26-items was 3.3 (SD 0.44) on a 4-point scale (Table 1). The weighted means differed across the five PCE domain measures on the 4-point scale (i.e., average of the responses across the multiple related PSID-CRCS items with each domain): 3.52 (SD 0.49) for peer support and healthy school climate, 3.75 (SD 0.47) for neighborhood safety, 3.48 (SD 0.63) for neighborhood support, 2.54 (SD 1.06) for paternal relationship, 3.04 (SD 0.83) for maternal relationship.

Pairwise correlations between each PCE domain measure and composite total ACE score demonstrated consistently negative correlations: −0.29 (95% CI: −0.28 to −30) for peer support and healthy school climate, −0.23 (95% CI: −0.22 to −0.24) for neighborhood safety, −0.26 (95% CI: −0.25 to −0.27) for neighborhood support, −0.33 (95% CI: −0.32 to −0.34) for paternal relationship, −0.36 (95% CI: −0.35 to −0.37) for maternal relationship that were all statistically significant.

3.2. PCE domains associated with general adult health

3.2.1. Without Adjusting for ACEs

Higher scores for all the PCE domain measures were associated with a lower odds of reporting fair or poor general health status (Fig. 2, Table B.2). Higher scores for the "peer support and healthy school climate" (aOR 0.82, 95% CI: 0.76–0.89), paternal relationship (aOR 0.83, 95% CI: 0.76–0.91), and neighborhood safety (aOR 0.84, 95% CI: 0.76–0.92) measures were associated with the largest reductions in odds of fair or poor health.

3.2.2. Adjusting for ACEs

Associations between each of the PCE domain measures and general health were attenuated relative to before ACE measures were included (Fig. 2, Table B.2). Higher scores for the "peer support and healthy school climate" (aOR 0.90, 95% CI: 0.82–0.98) and neighborhood safety (aOR 0.89, 95% CI 0.80–0.98) measures remained associated with improved general health. T.

3.3. PCE domains associated with other health outcomes

3.3.1. Without Adjusting for ACEs

Higher "peer support and healthy school climate" domain scores had the most strongly and consistently protective associations against physical and mental health conditions (Figs. 2 and 3, Table A.2), and each health outcome was associated with at least one of the PCE domain measures.

Table 1
Characteristics of eligible respondents in study sample, N = 7105.

Individual Level Variables	Respondents N (weighted %)
Positive and Adverse Childhood Experience (PCE, ACE) Variables	
PCE Average, m (SD)[#]	3.3 (0.44)
PCE Average by Factor/Domain, m (SD)[^]	
Peer Support & Healthy School Climate	3.52 (0.49)
Neighborhood Safety	3.75 (0.47)
Neighborhood Support	3.48 (0.63)
Nurturing Paternal Relationship	2.54 (1.06)
Nurturing Maternal Relationship	3.04 (0.83)
Categorical ACE Score	
0 ACEs	2385 (36%)
1 ACE	2033 (28%)
2-3 ACEs	1951 (26%)
4 or more ACEs	736 (10%)
Adult Individual Variables	
Age in Years, m (SD)	53 (15.89)
Sex	
Female	4111 (53%)
Male	2994 (47%)
Race/Ethnicity	
Asian/Pacific Islander	90 (2%)
Black	1896 (10%)
Hispanic	349 (6%)
Other & Multiracial	282 (4%)
White	4447 (78%)
Marital Status	
Married	4646 (65%)
Never Married	1161 (15%)
Widowed, Divorced, Annulled, Separated	1297 (20%)
Educational Attainment	
Less than High School	674 (9%)
High School Graduate	1729 (25%)
Some College or Vocational School	1894 (26%)
College Graduate	1464 (22%)
Graduate School	1282 (19%)
Adult Household Variables	
Household Income	
<100% FPL	595 (6%)
100–199% FPL	977 (12%)
200–299% FPL	1086 (14%)
300–399% FPL	988 (14%)
400% or more FPL	3459 (54%)
Family Health Insurance	
Yes	6791 (96%)
Adult Outcome Variables	
General Health Rating	
Good/Very Good/Excellent	5931 (83%)
Fair/Poor	1174 (17%)
Functional Limitation	1216 (19%)
Any Chronic Physical Condition Diagnosis	4125 (62%)
Cardiovascular Disease Diagnosis	2527 (37%)
Symptoms of Severe Psychological Distress	178 (3%)
Depression Diagnosis	398 (6%)
Anxiety Diagnosis	320 (6%)

PCE = positive childhood experiences. FPL = federal poverty limit. SD = standard deviation.
# The PCE average was calculated as the average of the responses across all the PCE items on a scale from 0 to 4. Four indicated max exposure.
^The PCE average by domain was calculated as the average of the responses to the items under each domain on a scale from 0 to 4. Four indicated max exposure to the PCE.
The five domains were identified using a factor analysis.

3.3.2. After adjusting for ACE exposure

Including ACEs in the models attenuated the adjusted associations between the individual PCE domain measures and all the secondary health outcomes (Figs. 2 and 3, Table A.2). Higher scores on the "peer support and healthy school climate," neighborhood safety, and paternal relationship measures each remained protective against at least one adverse health outcome. The "peer support and healthy school climate" measure was associated with all the secondary outcomes except cardiovascular disease.

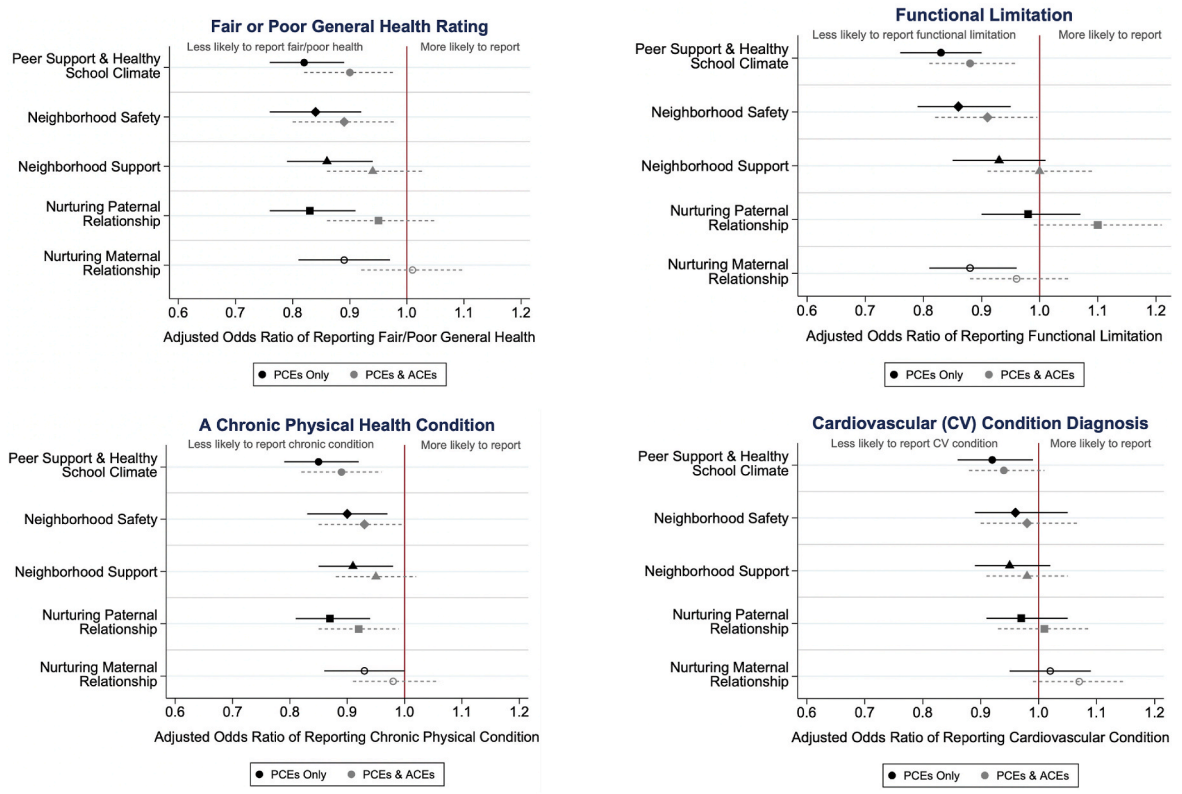

Fig. 2. The adjusted odds ratios and 95% confidence intervals for the weighted and adjusted regressions of the overall and physical health outcomes on the standardized PCE domain z-score measures. Models were adjusted for the covariates in Table 1. The solid lines indicate models that did not adjust for ACE score. The dashed lines indicate models that did adjust for ACE score.

(a) *Overall Functioning and Physical Health Conditions* - Higher scores on the "peer support and healthy school climate" was associated with lower odds of reporting both a functional limitation and any chronic physical health condition. Higher scores on neighborhood safety and nurturing paternal relationship were associated with lower odds of functional limitation and any chronic physical health condition, respectively.

(a) *Mental Health Conditions* – Higher scores on the "peer support and healthy school climate" measure was associated with lower odds of reporting psychological distress and depression and anxiety diagnoses. Higher scores on the neighborhood safety measure were also associated with lower odds of psychological distress (aOR 0.78, 95% CI: 0.66–0.92).

3.4. Testing for moderation

Individual PCE domain measures and total ACE score showed no statistically-significant interactions in moderation analyses with each of the primary and secondary outcomes (Table A.3).

3.5. Predicted probabilities

Survey weighted multivariate logistic regression adjusted odds ratio results from sections 3.2-3.3 were translated into the change in predicted probability of reporting each health outcome for a one standard deviation increase in the PCE domain measures (Table A.4).

4. Discussion

In this longitudinal, nationally-representative study comparing the life course health associations of individual PCE domains while considering the level of ACE exposure, we found that measures of each of the five PCE domains reflected in established PCE measures – (i) healthy school climate and supportive peer relationships, (ii) neighborhood safety, (iii) neighborhood support, (iv) nurturing paternal relationship, and (v) nurturing maternal relationship – were predictive of adult health outcomes before adjusting for ACEs (Bethell et al., 2019; Guo et al., 2021; Narayan et al., 2018). Additionally, these associations persisted primarily for the (i) peer support and healthy school climate and (ii) neighborhood safety PCE domain measures after adjusting for ACEs. This is the first study to establish that PCE domain measures predict adult health outcomes (overall, physical, and mental health) in a national sample and evaluate interactions at the domain level between PCE domains and level of ACE exposure. These findings may inform PCE interventions.

It is important to consider what these PCE domain measures are describing in interpreting our findings. The "peer support and healthy school climate" domain includes questions about comfort with friends, happiness at school, and school safety. These items are included in school climate measures and may be capturing other features of a supportive childhood school environment (i.e., caring relationships with school staff, a sense of belonging at school, anti-bullying policies). Our findings reinforce prior evidence that a supportive and safe school climate is associated with improved mental health outcomes and reduced substance use in childhood (Areba et al., 2021; Dudovitz et al., 2017; Guzmán-Ramírez et al., 2021; Ko et al., 2023; Lester & Cross, 2015; Palma et al., 2021; Singla et al., 2021; Wong et al., 2021). There is also evidence that these findings extend into adulthood - positive student-teacher relationships are associated with improved physical and mental health and less substance use; supportive childhood peer relationships are associated with lower depressive symptoms; and school connectedness in adolescence show a protective association against emotional distress, suicidal ideation, STI diagnosis, and substance use in adulthood (Kim, 2021; Steiner et al., 2019). Future studies can elucidate

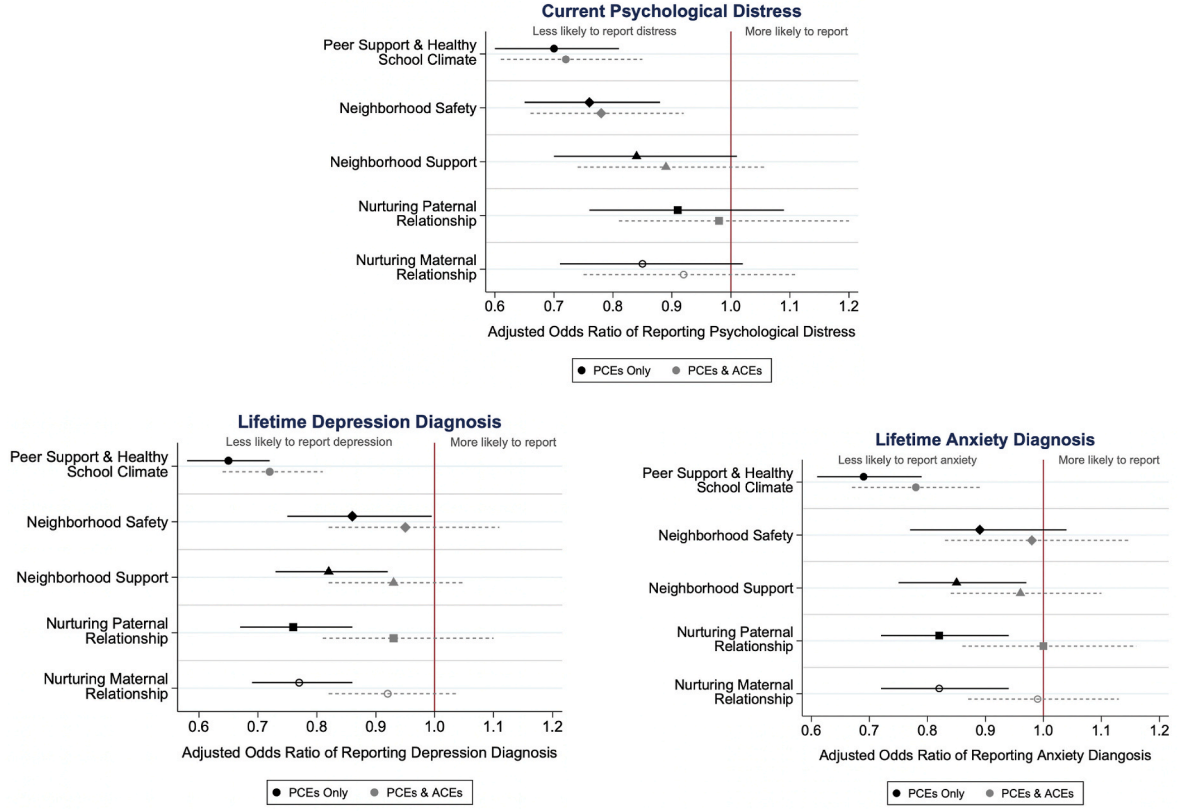

Fig. 3. The adjusted odds ratios and 95% confidence intervals for the weighted and adjusted regressions of the mental health outcomes on the standardized PCE domain z-score measures. Models were adjusted for the covariates in Table 1. The solid lines indicate models that did not adjust for ACE score. The dashed lines indicate models that did adjust for ACE score.

the underlying mechanism between school supports and adult health, but it may be related to reduced experiences of bullying, increased self-esteem, and reduced substance use behaviors (Gerlinger & Wo, 2016; Kim, 2021; Singla et al., 2021; Zhao et al., 2021). It is also possible that we are measuring the persistence of positive or poor mental health from childhood into adulthood since these measures were retrospectively reported; those individuals with positive childhood mental health may be better equipped to form strong peer relationships and enjoy their school experience to a greater extent than children with poor mental health.

The neighborhood safety domain included items about whether respondents felt their childhood neighborhood was safe for children and at night. It may also be a proxy for other features of childhood neighborhood context (i.e., access to safe and available green spaces) or whether the individual was exposed to violence in their neighborhood. Being a victim of community violence is considered to be an ACE exposure among some researchers (Cronholm et al., 2015). Our findings support prior literature. Neighborhood safety during childhood is associated with child self-reported well-being across 11 countries (Lee & Yoo, 2015). In the experimental Moving to Opportunities Study, adolescents in households who were randomly assigned to receive a housing voucher to move out of public housing in a high poverty area reported improved mental health that was mediated by less social disorder (hearing gunshots or illegal drug use/sales) in their new neighborhood (Schmidt et al., 2020). Moreover, childhood neighborhood contexts are associated with overall and mental health in adulthood that may be partially mediated by health behaviors (i.e. physical activity) and psychosocial factors (i.e., sense of vulnerability) (Bures, 2003; Cronholm et al., 2015; Robert, n.d.; Vartanian & Houser, 2010).

The general lack of association between the maternal and paternal relationship PCE domains and the adult health outcomes after adjusting for ACE exposure is unexpected based on the large evidence base demonstrating the benefits of nurturing caregiver relationships including for those exposed to ACEs (Yamaoka & Bard, 2019). In one study, individuals with four or more ACEs who grew up with an adult who made them feel safe and protected were less likely to report poor mental health (Crouch et al., 2019).There are multiple potential reasons for our finding. It is possible that ACEs explain much of the family or household dynamic and including PCE domain measures does not contribute much more to explain the association between childhood household experiences and adult health. This may be partly because we were unable to account for the setting or individual(s) who contributed to the ACE exposure or other family circumstances - living in multiple households or alternative caregiver configurations. Furthermore, since the PSID is an intergenerational panel, adult children with poor relationships with their parents and estranged adult children may be less likely to participate. Lastly, the PSID-CRCS items ask about maternal and paternal relationships separately resulting in two parental relationship domains based on the factor analysis. This differs from the "PCE scale" items, which asks three separate questions about family relationships generally and the household environment. Family ties and households are complex and dynamic and limiting to parental relationships in the CRCS-PSID may not capture other protective family relationships. We hope future studies will explore whether similar patterns are found in other datasets.

Although there is prior evidence to support a buffering effect of PCEs (Elmore et al., 2020; Yu et al., 2022), our study found that the total ACE score did not interact with the individual PCE domains. This suggests that the effect of PCEs may operate independently of ACEs to influence adult health outcomes, which is in line with other work (Bethell et al., 2019; Lynch et al., 2018). Interventions that increase PCE exposure may thus benefit children equally regardless of their level of ACE exposure. Therefore, universal rather than targeted approaches to increase PCE exposure may improve lifelong health for all children regardless of their

degree of ACE exposure. Our findings though also suggest that caution is needed in relying exclusively on PCEs to buffer the effect of high ACE exposure.

Lastly, the strongest protective relationships were between the PCE domain measures and mental health, which is in line with the prior literature (Bethell et al., 2019). Although the physical health outcomes were not as strongly associated with the PCE domain measures, it is notable that the association between multiple PCE domain measures and the adult overall and physical health outcomes maintained their significance after adjusting for ACEs. The relationship between PCE exposure and adult physical health outcomes is not as well established in the literature. Further study is needed to confirm this link and identify the physical health conditions driving the association as the cardiovascular composite measure did not maintain its significance after adjusting for ACEs.

4.1. Limitations

Although this study benefits from its national sample and longitudinal design, there are limitations. The PSID includes a nationally representative sample and sample weights to account for non-response, but the PSID-CRCS had lower response rates among younger, immigrant, and low-income respondents (University of Michigan Institute for Social Research, 2015). Moreover, we dropped individuals who participated in the PSID-CRCS, but did not complete the PSID 2017 primary survey, which could introduce selection bias. Reassuringly, a sensitivity analysis using longitudinal weights which should account for differential attrition produced similar findings. Childhood experiences were retrospectively reported contributing to possible recall bias. PSID-CRCS had numerous items available that captured relevant PCEs, but there may be others that are important and not available in the PSID-CRCS. For instance, the PSID-CRCS did not ask about childhood participation in activities outside of school or about particular relationships with non-caregiving adults that may be important (Bethell et al., 2019; Narayan et al., 2018). Although relationships with non-caregiving adults may be partially described by the PSID-CRCS items related to school happiness and relationships with neighbors, it is possible this analysis is missing other protective PCE domains. Given that this is an observational study, unmeasured confounding is possible despite adjusting for covariates. The relationships should therefore not be interpreted as causal. Given dataset limitations, we were unable to consider sexual orientation and gender minority status. Expanding this research to include these individuals is also an important next step for future research.

4.2. Implications

Despite these limitations, we draw important implications from these findings. First, neighborhood and perceived safety items are not included in the "PCE Scale" that is currently being used for adults to retrospectively report PCEs (Bethell et al., 2019). Our findings argue for an expanded PCE scale incorporating these domains. Second, future investigations should consider analyzing PCEs by domain to understand their differential impact and underlying mechanisms. A structural equation modeling model would be an interesting next step for future research to explore the potential mediating pathways between childhood PCEs and adult health outcomes to direct intervention efforts. In addition to the PSID-CRCS, there are also a small subset of PCE-related questions in the PSID Child Development and Transition to Adulthood Supplements as well as opportunities to study PCEs using longitudinal data from the ABCD Study (Bravo et al., in press). Third, the consistent and significant relationship between "peer support and school climate," neighborhood safety, and adult health conditions suggest that investing in research and interventions in schools and neighborhoods during childhood may benefit individuals regardless of their degree of ACE exposure. Lastly, we need to continue efforts to prevent ACEs and find additional ways to mitigate the impact of ACEs on lifelong health.

5. Conclusion

This study has important implications for pediatric researchers, public health practitioners, pediatricians, educators, and child health advocates. Our findings suggest PCEs, particularly ones related to the school and neighborhood environments, demonstrate protective associations with multiple adult health conditions, especially against adult mental illness. Greater childhood peer support and exposure to a healthy school climate and neighborhood safety remained protective, even for those affected by ACEs. Interventions to improve school climate, peer relationships, and neighborhood safety may have the potential to yield population health gains, including among those affected by adversity and trauma.

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Author statement

Jaime La Charite: Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing- original draft; **Mariam Khan**: Conceptualization, Writing-review and editing; **Rebecca Dudovitz**: Supervision, Writing-review and editing; **Teryl Nuckols**: Writing-review and editing; **Narayan Sastry**: Methodology, Software, Writing – review and editing; **Cher Huang**: Writing-review and editing; **Yvonne Lei**: Writing – review and editing; **Adam Schickedanz**: Conceptualization, Data curation, Methodology, Supervision, Writing-reviewing and editing.

Declaration of competing interest

Declarations of interest: none.

Data availability

The data that has been used is confidential.

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Appendix A

Table A.1
Variable Construction for Positive Childhood Experiences (PCEs) Using the Panel Study of Income Dynamics' Childhood Retrospective Circumstances (PSID-CRCS) Study

PSID PCE Constructs Based on PCE, PCE-HOPE, BCE Scales			
PCE Domain	**Number of PSID Items**	**PSID Items**	**Equivalent items in PCE, PCE-HOPE, BCE Scales (Bethell et al., 2019; Guo et al., 2021; Narayan et al., 2018)**
Peer Support and Healthy School Climate	6 questions (3 for age 6–12, 3 for age 13–16)	When you were between age 6 and 12: 1) How often did you have a group of friends that you felt comfortable spending time with? [Often, Sometimes, Not very often, Never] 2) How often did you feel happy at school? [A lot, Some, A Little, Not at all] 3) How often did you feel worried about your physical safety at school? [A lot, Some, A Little, Not at all] The same question was asked for age 13 to 16.	Felt supported by friends (PCE Scale) At least one good friend I have many friends (HOPE-PCE measure) Felt sense of belonging at high school (PCE Scale) Enjoyment at school (BCE Scale)
Neighborhood Safety	6 questions (3 for age 6–12, 3 for age 13–16)	Think back to the neighborhood in which you lived the longest when you were between age 6 and 12. How true is each of the following statements about this neighborhood: [Very true, Somewhat true, Not very true, Not true at all] 1) It was safe being out alone in my neighborhood at night. 2) My neighborhood was safe for children during the daytime. 3) My neighborhood was safe for children during the nighttime. The same questions were asked for ages 13 to 16.	Is it safe for children to play outside during the day (HOPE-PCE measure)
Neighborhood Support	4 questions (2 for age 6–12, 2 for age 13–16)	Think back to the neighborhood in which you lived the longest when you were between age 6 and 12. How true is each of the following statements about this neighborhood: [Very true, Somewhat true, Not very true, Not true at all] 1) My neighbors were willing to help each other out. 2) My neighborhood was close-knit. The same questions were asked for age 13 to 16.	Good neighbors (BCE Scale) "How often does the study child see or spend time with your neighbors?" (HOPE-PCE measure)
Nurturing Maternal and Paternal Relationship	5 questions for maternal, 5 questions for paternal	Before you were age 17, 1) How would you rate the communication between you and (your mother/your stepmother/the woman who raised you)? [Excellent, Very Good, Good, Fair, Poor] 2) How much could you confide in her about things that were bothering you? [A lot, Some, A Little, Not at all] 3) How much did (your mother/your stepmother/the woman who raised you) understand your problems and worries? [A lot, Some, A Little, Not at all] 4) How emotionally close were you with (your mother/your stepmother/the woman who raised you)? [Very, Somewhat, Not very, Not at all] 5) How would you rate your relationship with (your mother/your stepmother/the woman who raised you)? [Excellent, Very Good, Good, Fair, Poor] The same questions were asked about "your father/your stepfather/the man who raised you."	Able to talk to family about feelings (PCE Scale) Felt family stood by them during difficult times (PCE Scale) My parents accept me as I am (HOPE-PCE measure) Felt safe and protected by adults in your home (PCE Scale) At least one caregiver with whom you felt safe (BCE Scale)

PCE = positive childhood experience, BCE = Benevolent Childhood Experience, HOPE = Healthy Outcomes from Positive Experiences, ACE = adverse childhood experience, PSID = Panel Study of Income Dynamics.

Table A.2
Adjusted Odds Ratios with 95% Confidence Interval for Multivariate Regression Models of Adult Physical Health Outcomes on the Positive Childhood Experience (PCE) Domains Without and With Adjusting for ACE Exposure.

	General Health Rating	**Functional Limitation**	**Any Physical Condition**	**Cardiovascular Disease**	**Psychological Distress**	**Depression**	**Anxiety**
			PCE Domains Measures Without ACE Adjustment				
			Adjusted Odds Ratios (95% CI)				
Peer Support & Healthy School Climate	0.82 (0.76, 0.89)***	0.83 (0.76, 0.90)***	0.85 (0.79, 0.92)***	0.92 (0.86, 0.99)*	0.70 (0.60, 0.81)***	0.65 (0.58, 0.72)***	0.69 (0.61, 0.79)***
Neighborhood Safety	0.84 (0.76, 0.92)***	0.86 (0.79, 0.95)**	0.90 (0.83, 0.97)**	0.96 (0.89, 1.05)	0.76 (0.65, 0.88)***	0.86 (0.75, 0.995)*	0.89 (0.77, 1.04)
Neighborhood Support	0.86 (0.79, 0.94)**	0.93 (0.85, 1.01)	0.91 (0.85, 0.98)*	0.95 (0.89, 1.02)	0.84 (0.70, 1.01)	0.82 (0.73, 0.92)***	0.85 (0.75, 0.97)*
Nurturing Paternal Relationship	0.83 (0.76, 0.91)***	0.98 (0.90, 1.07)	0.87 (0.81, 0.94)***	0.97 (0.91, 1.05)	0.91 (0.76, 1.09)	0.76 (0.67, 0.86)***	0.82 (0.72, 0.94)**
Nurturing Maternal Relationship	0.89 (0.81, 0.97)**	0.88 (0.81, 0.96)**	0.93 (0.86, 1.00)*	1.02 (0.95, 1.09)	0.85 (0.71, 1.02)	0.77 (0.69, 0.86)**	0.82 (0.72, 0.94)**
			PCE Domains Measures With ACE Adjustment				
			Adjusted Odds Ratios (95% CI)				
Peer Support & Healthy School Climate	0.90 (0.82, 0.98)*	0.88 (0.81, 0.96)**	0.89 (0.82, 0.96)**	0.94 (0.88, 1.01)	0.72 (0.61, 0.85)***	0.72 (0.64, 0.81)***	0.78 (0.67, 0.89)***

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Table A.2 (*continued*)

	General Health Rating	Functional Limitation	Any Physical Condition	Cardiovascular Disease	Psychological Distress	Depression	Anxiety
Neighborhood Safety	0.89 (0.80, 0.98)*	0.91 (0.82, 0.996)*	0.93 (0.85, 1.00)	0.98 (0.90, 1.07)	0.78 (0.66, 0.92)**	0.95 (0.82, 1.11)	0.98 (0.83, 1.15)
Neighborhood Support	0.94 (0.86, 1.03)	1.00 (0.91, 1.09)	0.95 (0.88, 1.02)	0.98 (0.91, 1.05)	0.89 (0.74, 1.06)	0.93 (0.82, 1.05)	0.96 (0.84, 1.10)
Nurturing Paternal Relationship	0.95 (0.86, 1.05)	1.10 (0.99, 1.21)	0.92 (0.85, 0.99)*	1.01 (0.93, 1.09)	0.98 (0.81, 1.20)	0.93 (0.81, 1.10)	1.00 (0.86, 1.16)
Nurturing Maternal Relationship	1.01 (0.92, 1.10)	0.96 (0.88, 1.05)	0.98 (0.91, 1.06)	1.07 (0.99, 1.15)	0.92 (0.75, 1.11)	0.92 (0.82, 1.04)	0.99 (0.87, 1.13)

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
Models were survey weighted logistic regressions adjusted for covariates in Table 1. Each PCE domain z-score measure was used as a separate independent variable in the models. The aORs reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
*indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, ***.

Table A.3
Adjusted Odds Ratios with 95% Confidence Interval for Multivariate Regression Models for General Health Rating on the Positive Childhood Experience (PCE) Domains After Interacting with ACE Score

	Peer Support & Healthy School Climate	Neighborhood Safety	Neighborhood Support	Nurturing Paternal Relationship	Nurturing Maternal Relationship
			Adjusted Odds Ratios (95% CI)		
Intercept	0.85 (0.23–3.14)	0.86 (0.23–3.19)	0.89 (0.24, 3.27)	0.95 (0.26, 3.51)	0.93 (0.26, 3.38)
PCE Domain	0.88 (0.76–1.01)	0.91 (0.75–1.09)	1.01 (0.85, 1.19)	0.97 (0.81, 1.16)	1.11 (0.93, 1.32)
ACE score	1.39 (1.27–1.52)***	1.41 (1.29–1.54)***	1.41 (1.29, 1.54)***	1.40 (1.28, 1.54)***	1.43 (1.31, 1.57)***
PCE domain ## ACE score	1.01 (0.94–1.09)	0.99 (0.90, 1.08)	0.96 (0.88, 1.04)	0.99 (0.89, 1.09)	0.94 (0.86, 1.03)

PCE = positive childhood experience, ACE = adverse childhood experience, CI = confidence intervals.
Models were survey weighted logistic regressions adjusted for covariates in Table 1.
* indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

Table A.4
Change in the Predicted Probability of the Health Outcome for a One Standard Deviation Increase in the PCE Domain Measure

	General Health Rating	Functional Limitation	Any Physical Condition	Cardiovascular Disease	Psychological Distress	Depression	Anxiety
				Change in Predicted Probability (p-value)			
Peer Support & Healthy School Climate	−1.3% (p = 0.01)	−1.6% (p = 0.003)	−2.1% (p = 0.002)	−1.1% (p = 0.11)	−0.7% (p = 0.00)	−1.9% (p = 0.00)	−1.3% (p = 0.00)
Neighborhood Safety	−1.5% (p = 0.02)	−1.3% (p = 0.04)	−1.4% (p = 0.06)	−0.5% (p = 0.53)	−0.6% (p = 0.003)	−0.3% (p = 0.52)	−0.1% (p = 0.79)
Neighborhood Support	−0.8% (p = 0.17)	−0.1% (p = 0-.91)	−0.9% (p = 0.16)	−0.5% (p = 0.51)	−0.3% (p = 0.19)	−0.4% (p = 0.23)	−0.2% (p = 0.58)
Nurturing Paternal Relationship	−0.6% (p = 0.32)	1.1% (p = 0.07)	−1.5% (p = 0.02)	−0.1% (p = 0.94)	0.0 (p = 0.86)	−0.4% (p = 0.29)	0.0 (p = 0.99)
Nurturing Maternal Relationship	0.1% (p = 0.90)	−0.5% (p = 0.37)	−0.3 (p = 0.66)	0.9% (p = 0.22)	−0.2% (p = 0.38)	−0.5% (p = 0.17)	−0.1% (p = 0.88)

Predicted probabilities based on the models used in Table A2.

Appendix B

Table B.1
Variable Construction for Adverse Childhood Experiences (ACEs) Using the Panel Study of Income Dynamics' Childhood Retrospective Circumstances (PSID-CRCS) Study

PSID ACE Constructs Based on Felitti et al. (1998) ACE Scale			
ACE Domain	**Number of PSID Items**	**PSID Items – Questions asked about time "Before you were age 17 …"**	Felitti et al. (1998) **ACE Scale**
Physical Abuse	6 (3 for mother, 3 for father)	How often did your mother [Often, Sometimes, Not very often, Never, N/A] *Repeat all for father* 1. Throw something at you? 2. Slap or hit you? 3. Physical harm in any other way?	Did a parent or other adult in the household often or very often … Push, grab, slap, or throw something at you? or Ever hit you so hard that you had marks or were injured?
Sexual Abuse	1	What was the crime that was committed against you? [if Assault (battery, rape aggravated assault, attempted manslaughter) was selected]	Did an adult or person at least 5 years older than you ever … Touch or fondle you or have you touch their body in a sexual way? Or Attempt or actually have oral or anal intercourse with you?

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Table B.1 (*continued*)

PSID ACE Constructs Based on Felitti et al. (1998) ACE Scale			
ACE Domain	**Number of PSID Items**	**PSID Items – Questions asked about time "Before you were age 17 …"**	Felitti et al. (1998) **ACE Scale**
Emotional Abuse	2 (1 for mother, 1 for father)	How much tension did you have in your relationship with your mother (including stepmother or the woman who raised you? [A lot, Some, A little, None at all, N/A]. *Repeat identical question for father*	Did a parent or other adult in the household often or very often … Swear at you, insult you, put you down, or humiliate you? or Act in a way that made you afraid that you might be physically hurt?
Neglect	3 total (2 for mother, 1 for father)	1. How much love and affection did your mother (including stepmother or the woman who raised you) give you? 2. How much effort did you mother put into watching over you and making sure you had a good upbringing? 3. How much love and affection did your father (including stepfather or the man who raised you) give you? [A lot, Some, A little, None at all, N/A]	Did you often or very often feel that … No one in your family loved you or thought you were important or special? Or Your family didn't look out for each other, feel close to each other, or support each other.
Parent Mental Health	4 (2 for mother, 2 for father)	1. Did your mother ever have anxiety attacks where all of a sudden, she felt frightened, anxious or panicky? [Y/N] *Repeat for father* 2. Did your mother ever have periods lasting 2 weeks or more where she was sad or depressed most of the time? [Y/N] *Repeat for father*	Was a household member depressed or mentally ill? or Did a household member attempt suicide?
Parent Substance Use Disorder	2 (1 for mother, 1 for father)	Did your mother have a problem with alcohol or drugs? [Y/N] *Repeat identical question for father*	Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?
Parent Divorce or Separation	1	Thinking about your mother and father, did they separate or divorce during your childhood, that is, before you were 17? [Y/N]	Was a biological parent ever lost to you through divorced, abandonment, or other reason?
Intimate Partner Violence	4	1. How often did your mother and father push, grab, or shove each other? [Often, Sometimes, Not very often, Never, My parents were never together] 2. How often did your mother and father 2a. Throw something at each other 2 b. Slap or hit each other? 2c. Physically harm each other in any other way?	Was your mother or stepmother: Often or very often pushed, grabbed, slapped, or had something thrown at her? or Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? or Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?

We created eight indicator variables for whether an individual responded affirmatively to any of the questions within each of the eight ACE domains.

Table B.2
Full Regression Results of the Fully Adjusted Multivariate Regression Models for General Health Rating on the Positive Childhood Experience (PCE) Domains.

	Peer Support & Healthy School Climate	**Neighborhood Safety**	**Neighborhood Support**	**Nurturing Paternal Relationship**	**Nurturing Maternal Relationship**
	aOR (95% CI)	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**
PCE Domain	0.90 (0.82–0.98)*	0.89 (0.80–0.98)*	0.94 (0.86–1.03)	0.95 (0.86–1.05)	1.01 (0.92–1.10)
ACE score					
0 ACE	Reference	Reference	Reference	Reference	Reference
1 ACE	1.52 (1.20–1.92)***	1.55 (1.23–1.96)***	1.55 (1.23–1.97)***	1.52 (1.20–1.93)***	1.57 (1.24–1.98)***
2-3 ACE	1.84 (1.46–2.32)***	1.89 (1.50–2.39)***	1.90 (1.50–2.39)***	1.86 (1.46–2.40)***	1.53 (1.47–2.45)***
4+ ACEs	2.89 (2.16–3.86)***	3.02 (2.27–4.01)***	3.04 (2.27–4.05)***	3.01 (2.24–4.04)***	3.20 (2.37–4.31)***
Age	1.03 (1.02–1.04)***	1.03 (1.02–1.04)***	1.03 (1.02–1.04)***	1.03 (1.02–1.04)***	1.03 (1.02–1.04)***
Sex					
Male	Reference	Reference	Reference	Reference	Reference
Female	1.00 (0.84–1.20)	0.99 (0.83–1.18)	0.99 (0.83–1.18)	0.98 (0.81–1.17)	0.99 (0.83–1.78)
Race/Ethnicity					
White, non-Hispanic	Reference	Reference	Reference	Reference	Reference
Hispanic	1.17 (0.79–1.72)	1.10 (0.74–1.62)	1.14 (0.78–1.68)	1.18 (0.80–1.73)	1.18 (0.80–1.73)
Black, non-Hispanic	1.13 (0.88–1.46)	1.06 (0.82–1.37)	1.13 (0.87–1.45)	1.12 (0.87–1.44)	1.12 (0.87–1.44)
Asian/PI, non-Hispanic	1.67 (0.84–3.29)	1.70 (0.86–3.33)	1.72 (0.87–3.39)	1.76 (0.90–3.41)	1.77 (0.91–3.44)
Multiracial/Other, non-Hispanic	0.91 (0.57–1.44)	0.91 (0.57–1.43)	0.91 (0.58–1.44)	0.92 (0.58–1.46)	0.91 (0.58–1.44)
Household Income					
Income: FPL <1	Reference	Reference	Reference	Reference	Reference
Income: FPL 1 to < 2	0.63 (0.45–0.89)**	0.62 (0.44–0.88)**	0.62 (0.44–0.88)**	0.62 (0.44–0.87)**	0.62 (0.44–0.88)**
Income: FPL 2 to < 3	0.54 (0.38–0.78)***	0.53 (0.37–0.76)***	0.52 (0.36–0.75)***	0.52 (0.36–0.75)***	0.52 (0.36–0.75)***
Income: FPL 3 to < 4	0.51 (0.36–0.75)**	0.50 (0.35–0.73)***	0.50 (0.35–0.72)***	0.49 (0.34–0.71)***	0.49 (0.34–0.71)***
Income: FPL 4 or more	0.22 (0.15–0.32)***	0.22 (0.15–0.31)***	0.21 (0.15–0.31)***	0.21 (0.15–0.30)***	0.21 (0.15–0.30)***
Educational Attainment					
Less than high school	Reference	Reference	Reference	Reference	Reference
High school graduate/GED	0.55 (0.42–0.73)***	0.55 (0.41–0.73)***	0.54 (0.41–0.72)***	0.54 (0.41–0.72)***	0.55 (0.41–0.72)***
Some college/vocational school	0.48 (0.36–0.64)***	0.48 (0.35–0.64)***	0.47 (0.35–0.63)***	0.47 (0.35–0.63)***	0.47 (0.35–0.63)***
College graduate	0.42 (0.30–0.58)***	0.41 (0.30–0.58)***	0.40 (0.29–0.56)***	0.41 (0.29–0.56)***	0.41 (0.29–0.57)***
Graduate school	0.36 (0.25–0.51)***	0.35 (0.25–0.50)***	0.34 (0.24–0.49)***	0.35 (0.24–0.49)***	0.35 (0.24–0.49)***
Health Insurance					
None	Reference	Reference	Reference	Reference	Reference

(*continued on next page*)

Table B.2 (*continued*)

	Peer Support & Healthy School Climate	Neighborhood Safety	Neighborhood Support	Nurturing Paternal Relationship	Nurturing Maternal Relationship
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Yes	0.91 (0.57–1.46)	0.93 (0.58–1.48)	0.92 (0.58–1.47)	0.91 (0.57–1.46)	0.91 (0.57–1.46)
Married					
Never married	Reference	Reference	Reference	Reference	Reference
Married	0.90 (0.67–1.20)	0.88 (0.66–1.18)	0.89 (0.67–1.19)	0.90 (0.67–1.20)	0.89 (0.66–1.18)
Widowed, divorced, annulled, separated	0.90 (0.65–1.25)	0.90 (0.65–1.24)	0.90 (0.65–1.24)	0.90 (0.65–1.24)	0.89 (0.65–1.23)
Respondent					
Proxy-report	Reference	Reference	Reference	Reference	Reference
Self-report	0.18 (0.06–0.56)**	0.18 (0.06–0.57)**	0.18 (0.06–0.57)**	0.18 (0.06–0.55)**	0.18 (0.06–0.56)**

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
Models were survey weighted logistic regressions adjusted for the displayed covariates. Each PCE domain z-score measure was used as a separate independent variable in the models. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
* indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

Table B.3
Multivariate Regression Results for Primary and Secondary Health Outcomes by Positive Childhood Experience (PCE) Domain With Complete Cases for PCEs and Adverse Childhood Experiences (ACEs)

	General Health Rating	Functional Limitation	Any Physical Condition	Cardiovascular Disease	Psychological Distress	Depression	Anxiety
			PCE Domains Measures Without ACE Adjustment Adjusted Odds Ratios (95% CI)				
Peer Support & Healthy School Climate	0.83 (0.76–0.90)***	0.83 (0.76–0.90)***	0.84 (0.78–0.91)***	0.92 (0.86–0.998)*	0.69 (0.59–0.82)***	0.64 (0.57–0.72)***	0.70 (0.61–0.80)***
Neighborhood Safety	0.84 (0.76–0.93)***	0.87 (0.78–0.96)**	0.91 (0.83–0.98)*	0.97 (0.88–1.06)	0.75 (0.64–0.88)***	0.87 (0.75–1.02)	0.91 (0.77–1.06)
Neighborhood Support	0.87 (0.79–0.96)**	0.92 (0.84–1.01)	0.90 (0.83–0.97)**	0.93 (0.85–1.00)	0.82 (0.68–0.999)*	0.83 (0.73–0.94)**	0.85 (0.74–0.98)*
Nurturing Paternal Relationship	0.84 (0.76–0.93)***	0.98 (0.89–1.07)	0.88 (0.81–0.95)**	0.96 (0.89–1.04)	0.91 (0.75–1.10)	0.77 (0.67–0.88)***	0.83 (0.72–0.96)**
Nurturing Maternal Relationship	0.90 (0.82–0.99)*	0.88 (0.81–0.97)*	0.94 (0.87–1.01)	1.01 (0.94–1.09)	0.83 (0.69–1.01)	0.78 (0.69–0.88)***	0.84 (0.73–0.96)*
			PCE Domains Measures With ACE Adjustment Adjusted Odds Ratios (95% CI)				
Peer Support & Healthy School Climate	0.90 (0.82–0.99)*	0.87 (0.81–0.95)***	0.87 (0.80–0.95)**	0.95 (0.88–1.03)	0.72 (0.60–0.86)***	0.72 (0.64–0.81)***	0.79 (0.68–0.91)***
Neighborhood Safety	0.90 (0.81–0.996)*	0.94 (0.86–1.02)	0.94 (0.86–1.02)	0.99 (0.91–1.09)	0.78 (0.66–0.92)**	0.97 (0.82–1.15)	1.01 (0.84–1.19)
Neighborhood Support	0.95 (0.86–1.04)	0.93 (0.86–1.01)	0.93 (0.86–1.01)	0.95 (0.88–1.04)	0.87 (0.71–0.1.06)	0.94 (0.82–1.08)	0.97 (0.84–1.11)
Nurturing Paternal Relationship	0.95 (0.86–1.06)	0.92 (0.85–1.00)	0.93 (0.86–1.02)	1.00 (0.92–1.10)	0.97 (0.79–1.20)	0.94 (0.81–1.09)	1.02 (0.87–1.20)
Nurturing Maternal Relationship	1.02 (0.93–1.13)	1.00 (0.93–1.08)	1.00 (0.92–1.09)	1.06 (0.98–1.15)	0.89 (0.73–1.00)	0.94 (0.82–1.07)	1.02 (0.88–1.17)

PCE = positive childhood experience, ACE = adverse childhood experience, CI = confidence intervals.
Models were survey weighted logistic regressions adjusted for covariates in Table 1. Each PCE domain z-score measure was used as a separate independent variable in the models shown in the table. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure. Models included complete cases meaning only those individuals who responded to all the PCE and ACE items without any missing ACE or PCE data were included in the analysis.
*indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

Table B.4
Multivariate Regression Results for General Health Rating by Positive Childhood Experience (PCE) Domain Measure With and Without Adverse Childhood Experience (ACE) Exposure Adjustment Using Different PCE Domain and General Health Rating Specifications

	PCEs only				Both PCEs and ACEs			
	Binary General Health Rating[a]		Ordinal General Health Rating[b]		Binary General Health Rating[a]		Ordinal General Health Rating[b]	
	PCE Domain *Z*-Score[c]	PCE Domain Binary[d]	PCE Domain Z-Score	PCE Domain Binary	PCE Domain Z-Score	PCE Domain Binary	PCE Domain Z-Score	PCE Domain Binary
	aOR (95% CI)[e]		adjusted b (95% CI)[e]		aOR (95% CI)[e]		adjusted b (95% CI)[e]	
Peer Support & Healthy School Climate	0.82 (0.76, 0.89)***	0.79 (0.65,0.96)*	−0.12 (−0.15, −0.09)***	−0.17 (−0.23, −0.11)***	0.90 (0.82, 0.98)*	0.94 (077, 1.15)	−0.09 (−0.12, −0.06)***	−0.12 (−0.18, −0.06)***
Neighborhood Safety	0.84 (0.76, 0.92)***	0.78 (0.65, 0.94)**	−0.07 (−0.11, −0.04)***	−0.12 (−0.18, −0.06)***	0.89 (0.80, 0.98)*	0.87 (0.72, 1.05)	−0.05 (−0.08, −0.01)**	−0.08 (−0.15, −0.02)**
Neighborhood Support	0.86 (0.79, 0.94)**	0.90 (0.76, 1.07)	−0.06 (−0.09, −0.03)***	−0.06 (−0.11, 0.00)	0.94 (0.86, 1.03)	1.02 (0.85, 1.22)	−0.03 (−0.06, 0.00)	−0.01 (−0.07, −0.05)

(*continued on next page*)

Table B.4 (*continued*)

	PCEs only				Both PCEs and ACEs			
	Binary General Health Rating[a]		Ordinal General Health Rating[b]		Binary General Health Rating[a]		Ordinal General Health Rating[b]	
	PCE Domain *Z*-Score[c]	PCE Domain Binary[d]	PCE Domain Z-Score	PCE Domain Binary	PCE Domain Z-Score	PCE Domain Binary	PCE Domain Z-Score	PCE Domain Binary
	aOR (95% CI)[e]		adjusted b (95% CI)[e]		aOR (95% CI)[e]		adjusted b (95% CI)[e]	
Nurturing Paternal Relationship	0.83 (0.76, 0.91)***	0.82 (0.67, 1.00)	−0.08 (−0.11, −0.05)***	−0.13 (−0.20, −0.06)***	0.95 (0.86, 1.05)	1.00 (0.81, 1.23)	−0.03 (−0.07, −0.00)*	−0.07 (−0.13, 0.00)*
Nurturing Maternal Relationship	0.89 (0.81, 0.97)**	1.08 (0.88, 1.33)	−0.04 (−0.07, 0.01)**	−0.00 (−0.07, 0.07)	1.01 (0.92, 1.10)	1.25 (1.01, 1.54)*	0.01 (−0.02, 0.04)	0.05 (−0.02, 0.12)

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
* indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.
[a] Models were survey weighted and covariate adjusted logistic regressions.
[b] Models were survey weighted and covariate adjusted linear regressions.
[c] Each PCE domain z-score measure was used as a separate independent variable in the models shown in the table. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
[d] Each PCE domain measure was dichotomized at the 75th percentile and the binary construction of the PCE domain was used in the models shown in the table. The adjusted odds ratios reflect the change in overall health rating between those that rated the PCE domain below the 75th percentile compared to those that rated the PCE domain above the 75th percentile.
[e] Regression models were adjusted for covariates in Table 1. Values in the table are the adjusted odds ratios with the 95% confidence intervals for each of the five PCE domains.

Table B.5
Multivariate Regression Results for Secondary Health Outcomes by Positive Childhood Experience (PCE) Domain Measure With and Without Adverse Childhood Experience (ACE) Exposure Adjustment Using Different PCE Domain Measure Specifications

	PCEs Only		Both PCEs and ACEs	
	PCE Domain Z-Score	PCE Domain Binary	PCE Domain Z-Score	PCE Domain Binary
Functional Limitation		aOR (95% CI)		
Peer Support & Healthy School Climate	0.83 (0.76, 0.90)***	0.79 (0.65, 0.95)*	0.88 (0.81, 0.96)**	0.89 (0.73, 1.08)
Neighborhood Safety	0.86 (0.79, 0.95)**	0.81 (0.67, 0.97)*	0.91 (0.82, 0.996)*	0.87 (0.73, 1.05)
Neighborhood Support	0.93 (0.85, 1.01)	0.87 (0.73, 1.04)	1.00 (0.91, 1.09)	0.96 (0.80, 1.14)
Nurturing Paternal Relationship	0.98 (0.90, 1.07)	0.97 (0.79, 1.18)	1.10 (0.99, 1.21)	1.12 (0.91, 1.37)
Nurturing Maternal Relationship	0.88 (0.81, 0.96)**	0.83 (0.67, 1.03)	0.96 (0.88, 1.05)	0.92 (0.74, 1.14)
Any Physical Condition		aOR (95% CI)		
Peer Support & Healthy School Climate	0.85 (0.79, 0.92)***	0.73 (0.63, 0.84)***	0.89 (0.82, 0.96)**	0.78 (0.67, 0.90)***
Neighborhood Safety	0.90 (0.83, 0.97)**	0.78 (0.67, 0.90)***	0.93 (0.85, 1.00)	0.81 (0.70, 0.95)**
Neighborhood Support	0.91 (0.85, 0.98)*	0.90 (0.79, 1.04)	0.95 (0.88, 1.02)	0.95 (0.83, 1.10)
Nurturing Paternal Relationship	0.87 (0.81, 0.94)***	0.81 (0.69, 0.95)**	0.92 (0.85, 0.99)*	0.86 (0.73, 1.01)
Nurturing Maternal Relationship	0.93 (0.86, 1.00)*	0.96 (0.81, 1.13)	0.98 (0.91, 1.06)	1.02 (0.86, 1.20)
Cardiovascular Disease		aOR (95% CI)		
Peer Support & Healthy School Climate	0.92 (0.86–0.998)*	0.85 (0.74–0.99)*	0.95 (0.88–1.03)	0.88 (0.76–1.03)
Neighborhood Safety	0.97 (0.88–1.06)	0.95 (0.82–1.11)	0.99 (0.91–1.09)	0.98 (0.84–1.14)
Neighborhood Support	0.93 (0.85–1.00)	1.00 (0.87–1.15)	0.95 (0.88–1.04)	1.03 (0.90–1.19)
Nurturing Paternal Relationship	0.96 (0.89–1.04)	0.95 (0.81–1.11)	1.00 (0.92–1.10)	0.99 (0.84–1.17)
Nurturing Maternal Relationship	1.01 (0.94–1.09)	1.06 (0.90–1.26)	1.06 (0.98–1.15)	1.10 (0.93–1.31)
Psychological Distress		aOR (95% CI)		
Peer Support & Healthy School Climate	0.70 (0.60, 0.81)***	0.66 (0.39, 1.12)	0.72 (0.61, 0.85)***	0.74 (0.43, 1.29)
Neighborhood Safety	0.76 (0.65, 0.88)***	0.50 (0.33, 0.77)**	0.78 (0.66, 0.92)**	0.53 (0.34, 0.83)**
Neighborhood Support	0.84 (0.70, 1.01)	0.84 (0.55, 1.28)	0.89 (0.74, 1.06)	0.92 (0.60, 1.40)
Nurturing Paternal Relationship	0.91 (0.76, 1.09)	0.69 (0.42, 1.11)	0.98 (0.81, 1.20)	0.77 (0.47, 1.27)
Nurturing Maternal Relationship	0.85 (0.71, 1.02)	0.64 (0.38, 1.06)	0.92 (0.75, 1.11)	0.71 (0.42, 1.19)
Depression		aOR (95% CI)		
Peer Support & Healthy School Climate	0.65 (0.58, 0.72)***	0.44 (0.31, 0.61)***	0.72 (0.64, 0.81)***	0.57 (0.40, 0.81)**
Neighborhood Safety	0.86 (0.75, 0.995)*	0.80 (0.61, 1.05)	0.95 (0.82, 1.11)	0.95 (0.72, 1.26)
Neighborhood Support	0.82 (0.73, 0.92)***	0.68 (0.52, 0.88)**	0.93 (0.82, 1.05)	0.83 (0.63, 1.09)
Nurturing Paternal Relationship	0.76 (0.67, 0.86)***	0.65 (0.47, 0.89)**	0.93 (0.81, 1.10)	0.86 (0.62, 1.19)
Nurturing Maternal Relationship	0.77 (0.69, 0.86)**	0.67 (0.48, 0.93)*	0.92 (0.82, 1.04)	0.84 (0.59, 1.18)
Anxiety		aOR (95% CI)		
Peer Support & Healthy School Climate	0.69 (0.61, 0.79)***	0.48 (0.34, 0.69)***	0.78 (0.67, 0.89)***	0.62 (0.43, 0.90)*
Neighborhood Safety	0.89 (0.77, 1.04)	0.75 (0.56, 1.00)	0.98 (0.83, 1.15)	0.87 (0.65, 1.18)
Neighborhood Support	0.85 (0.75, 0.97)*	0.69 (0.52, 0.92)*	0.96 (0.84, 1.10)	0.84 (0.63, 1.13)
Nurturing Paternal Relationship	0.82 (0.72, 0.94)**	0.67 (0.48, 0.95)*	1.00 (0.86, 1.16)	0.88 (0.62, 1.25)
Nurturing Maternal Relationship	0.82 (0.72, 0.94)**	0.68 (0.47, 0.98)*	0.99 (0.87, 1.13)	0.85 (0.58, 1.23)

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
Models were survey weighted and covariate adjusted logistic regressions. Regressions were adjusted for covariates in Table 1. Each PCE domain z-score measure was used as a separate independent variable in the models shown in the table. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
* indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

Table B.6
Multivariate Regression Results for Primary and Secondary Health Outcomes by Positive Childhood Experience (PCE) Domain Measure With and Without Adverse Childhood Experience Exposure Adjustment With Inclusion of PCE Score as Covariate

	General Health Rating	Functional Limitation	Any Physical Condition	Cardiovascular Disease	Psychological Distress	Depression	Anxiety
PCE Domains Measures Without ACE Adjustment							
Adjusted Odds Ratios (95% CI)							
Peer Support & Healthy School Climate	0.83 (0.76–0.90) ***	0.84 (0.77–0.91) ***	0.87 (0.81–0.94) ***	0.93 (0.86–1.00)	0.84 (0.78–0.91) ***	0.66 (0.59–0.74)***	0.72 (0.64–0.81)***
Neighborhood Safety	0.85 (0.77–0.95) **	0.88 (0.80–0.98) *	0.92 (0.85–1.01)	0.96 (0.88, 1.05)	0.92 (0.85–1.01)	0.96 (0.82–1.12)	0.99 (0.84–1.17)
Neighborhood Support	0.87 (0.79–0.96) **	0.97 (0.88–1.06)	0.96 (0.89–1.04)	0.98 (0.90–1.06)	0.92 (0.85–0.99)*	0.87 (0.77–0.99)*	0.92 (0.80–1.07)
Nurturing Paternal Relationship	0.84 (0.77–0.92) ***	1.02 (0.93–1.12)	0.90 (0.83–0.97)*	0.98 (0.91–1.0)	0.95 (0.88–1.02)	0.81 (0.71–0.92)***	0.87 (0.75–1.00)
Nurturing Maternal Relationship	0.91 (0.83–0.99) *	0.89 (0.81–0.97) **	0.96 (0.89–1.03)	1.02 (0.95–1.10)	0.93 (0.87–0.99)*	0.82 (0.73–0.93)**	0.88 (0.76–1.01)
PCE Domains Measures With ACE Adjustment							
Adjusted Odds Ratios (95% CI)							
Peer Support & Healthy School Climate	0.89 (0.81–0.97) **	0.88 (0.81–0.96) **	0.90 (0.83–0.97) **	0.95 (0.88–1.02)	0.87 (0.81–0.94) ***	0.72 (0.63–0.82)***	0.78 (0.68–0.91)***
Neighborhood Safety	0.88 (0.79–0.97) *	0.90 (0.82–0.99) *	0.94 (0.86–1.02)	0.97 (0.89–1.06)	0.94 (0.86–1.02)	1.00 (0.85–1.17)	1.03 (0.87–1.22)
Neighborhood Support	0.92 (0.83–1.02)	1.04 (0.93–1.17)	0.99 (0.91–1.07)	1.00 (0.92–1.08)	0.95 (0.88–1.03)	0.95 (0.83–1.08)	1.01 (0.87–1.16)
Nurturing Paternal Relationship	0.95 (0.86–1.05)	1.12 (1.01–1.24) *	0.93 (0.86–1.01)	1.01 (0.93–1.09)	1.02 (0.94–1.10)	0.95 (0.82–1.09)	1.03 (0.88–1.19)
Nurturing Maternal Relationship	1.01 (0.92–1.10)	0.96 (0.87–1.05)	1.00 (0.93–1.08)	1.05 (0.97–1.14)	0.99 (0.92–1.06)	0.95 (0.84–1.07)	1.02 (0.89–1.18)

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
Models were survey weighted logistic regressions adjusted for covariates in Table 1. Additionally, these analyses controlled for the binned total PCE score minus the PCE domain measure tested (i.e. for models using the maternal relationship domain independent variable, the model controlled for the binned PCE score that summed the indicators for the peer support/healthy school climate, neighborhood safety, neighborhood support, and paternal relationship domains for a binned PCE score of 0, 1–2, or 3–4 PCEs).
Each PCE domain z-score measure was used as a separate independent variable in the models shown in the table. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
*indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

Table B.7
Adjusted Odds Ratios with 95% Confidence Interval for Multivariate Regression Models of Adult Substance Use Outcomes on the Positive Childhood Experience (PCE) Domain Measures Without and With Adverse Childhood Experience (ACE) Exposure Adjustment

	Ever Smoker	Binge Drinking
PCE Domains Measures Before Controlling for ACEs		
Adjusted Odds Ratios (95% CI)		
Peer Support & Healthy School Climate	0.98 (0.92–1.05)	0.97 (0.91–1.04)
Neighborhood Safety	1.01 (0.94–1.08)	1.00 (0.93–1.08)
Neighborhood Support	0.95 (0.89–1.01)	0.96 (0.89–1.02)
Nurturing Paternal Relationship	0.88 (0.82–0.94)***	0.87 (0.81–0.93)***
Nurturing Maternal Relationship	0.87 (0.82–0.93)***	0.87 (0.82–0.93)***
PCE Domains Measures After Controlling for ACEs		
Adjusted Odds Ratios (95% CI)		
Peer Support & Healthy School Climate	1.05 (0.98–1.12)	1.04 (0.91–1.19)
Neighborhood Safety	1.05 (0.98–1.14)	1.25 (1.06–1.48)**
Neighborhood Support	1.00 (0.94–1.07)	1.07 (0.93–1.24)
Nurturing Paternal Relationship	0.95 (0.88–1.02)	0.99 (0.87–1.14)
Nurturing Maternal Relationship	0.94 (0.88–1.00)	0.94 (0.82–1.07)

PCE = positive childhood experience, ACE = adverse childhood experience, aOR = adjusted odds ratios, CI = confidence intervals.
We created two indicator variables for whether the respondent reported (1) ever smoking cigarettes and (2) binge drinking in the past year, defined as reporting at least one day of drinking five (for men) or four (for women) drinks or more in one occasion within the past year. Models were survey weighted logistic regressions adjusted for covariates in Table 1. Each PCE domain z-score measure was used as a separate independent variable in the models shown in the table. The adjusted odds ratios reflect the change in the health outcome for every 1 standard deviation change in the given PCE domain z-score measure.
*indicate significant difference from referent group with p-value <0.05, ** p-value <0.01, *** p-value <0.001.

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