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Regional prevalence of adverse childhood experiences in the United States using a nationally representative school-based sample

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1. Introduction

Adverse childhood experiences (ACEs) are potentially traumatic experiences during childhood and youth. They have been shown to be strong risk factors for chronic diseases, substance use disorders, and mental health conditions (Anda et al., 2002; Gilbert et al., 2015; Moss et al., 2020; Sonu et al., 2019). Leading public health organizations, including the U.S. Centers for Disease Control and Prevention (CDC; CDC, 2019), the American Academy of Pediatrics (Garner et al., 2021), and the Departments of Health of California, Tennessee, North Carolina, and Oregon (Cooper & Hanlon, 2020) recommend routine screening for ACEs because this clinical information can assist health care providers in offering more effective and equitable health care, as well as steering appropriate patients towards targeted trauma-based clinical interventions that may enhance healing and long-term health (Purewal Boparai et al., 2018). Consequently, screening for ACEs has been successfully integrated into a wide range of clinical settings, including pediatric/adult primary care, behavioral health, women's health, and medical school curriculum (Osei et al., 2022; Pletcher et al., 2019; Rariden et al., 2021).

Understanding the geographic distribution of ACEs is important to health policy because it guides regional resource allocation for prevention, professional training about ACEs, screening methodology, and the implementation of trauma-informed programs of care in various care settings. However, there is limited availability of nationally representative data on regional variations in ACE prevalence in the U.S., and different limitations exist in the datasets used for regional prevalence estimations in previous studies (Bethell et al., 2017b; Giano et al., 2020; Merrick et al., 2018). For example, the National Survey of Children's Health (NSCH) assesses ACEs in a nationally representative sample of U. S. children, but its surveys are conducted with parents and guardians of children ages varying from 0 to 17, resulting in underestimation of lifetime prevalence of ACEs, especially for vulnerable populations such as those with foster care experience and unreported childhood abuse or neglect (Child and Adolescent Health Measurement Initiative, 2022; Turney & Wildeman, 2017). Another commonly used ACE data source, the Behavioral Risk Factor Surveillance System (BRFSS) ACE module provides community-based samples obtained in only a subset of U.S. states in any given survey year and therefore are not ideal for national prevalence estimates of ACEs (CDC, 2022).

In this study, we explored the regional differences in the prevalence of nine ACEs defined by the original CDC-Kaiser ACE Study (Felitti et al., 1998) using a nationally representative school-based sample from the National Longitudinal Study of Adolescents to Adult Health (Add Health; Harris, 2009). Add Health is a longitudinal study that used systematic sampling methods and implicit stratification to create a sample of middle and high schools representative of U.S. schools with respect to region of country, urbanity, school size, school type, and ethnicity (Chen & Chantala, 2014). As opposed to the NSCH and BRFSS ACE data, Add Health provides nationally representative data for all U.S. states on ACEs that were self-reported by the young adults who experienced them before age 18, thus allowing better lifetime prevalence estimations.

2. Material and methods

2.1. Data source

Add Health collected data from adolescents in grades 7–12 starting in 1994–1995 (Wave I) in the U.S. through in-home interviews and in-school questionnaires. In this study, we focused on the youths and adolescents who were interviewed in both Wave I and Wave II and continued following up at age 24–32 in 2008 (Wave IV) when survey data regarding ACEs were collected. The Wave IV survey time frame allowed the young adult participants to respond to the survey items on ACEs based on their entire childhood and youth, and thus it also allowed

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this study to estimate lifetime ACE prevalence.

There were 9,421 participants who were followed longitudinally across Waves I-IV, and 1,470 (15.60%) of them were excluded for self-reported dishonest survey responses, which were obtained using the item "How honestly have you answered the questions?" in Waves I and II. The responses of "very honest" or "completely honest" were categorized as "honest", and the responses "not honest at all" or "somewhat honest" were categorized as "dishonest".

Participants of Add Health provided written informed consent for participation in accordance with the University of North Carolina School of Public Health Institutional Review Board guidelines. Our study utilizing the Add Health restricted use dataset was approved by the University of California, Riverside Institutional Review Board.

2.2. Measures of sociodemographics and ACEs

Sociodemographics and ACEs were defined and composited from Add Health surveys across different waves using procedures described by Moss et al. (2020). Demographics included sex, race/ethnicity (non-Hispanic White, African American, Hispanic/Latino, and Other), education attainment (high school or below, associate degree or alternatives, and four-year college graduate or above), the frequency of receiving social welfare reflecting economic stress (never, only once, and multiple years), and childhood residential urbanity (rural, suburban, urban, and moved between rural/suburban/urban residence). Residential urbanity was assessed by the survey question "How would you describe the immediate area or street where you lived?" in both Waves I and II.

ACEs were modified from the 10-item ACEs that were defined by the CDC-Kaiser ACE study (Felitti et al., 1998). One of the items–"Before your 18th birthday, your mother or stepmother was pushed, grabbed, slapped, had something thrown at her, kicked, bitten, hit with a fist, hit with something hard, repeatedly hit for over at least a few minutes, or ever threatened or hurt by a knife or gun by your father (or stepfather) or mother's boy-friend."–was not assessed in Add Health. Therefore, a modified instrument including nine specific ACEs–*emotional abuse*, *physical abuse*, *sexual abuse*, *substance abuse in household*, *mental illness in household*, *parental separation/divorce*, *incarcerated member in household*, *emotional neglect*, and *physical neglect*–was used. Following a categorical score scale commonly used to report the cumulative number of ACEs of an individual, ACE score was categorized into 0, 1, 2, 3, and 4+ (4 or more), with 4+ being an ACE score category found to have strong associations with worse health outcomes in past studies (Bethell et al., 2017a; Hughes et al., 2017).

2.3. Statistical analysis

Add Health was designed as a multi-stage complex sampling survey, and all national estimations in this study were based on sample-weighted methods (Chen & Chantala, 2014). Prevalence was estimated by sample-weighted percentages, then a survey design-adjusted Pearson Chi-square test (i.e., the Rao-Scott Chi-square test) was used to examine the association between lifetime prevalence and sociodemographic factors. Sensitivity analysis was performed to evaluate how the samples excluded due to self-reported dishonest survey responses impacted statistical estimations.

Relative risk of ACE scores across the four regions was assessed by a survey-based logistic regression model. In this model, ACE score was the dependent variable (score 0 as the control group), and region was the independent variable. To account for confounding effects, the model was adjusted by sociodemographic factors, including biological sex, race/ethnicity, educational attainment (highest level of education completed), frequency of receiving welfare, and childhood residential urbanity. In addition, due to the complex survey design of Add Health (Chen & Chantala, 2014), school was used as a clustering factor that was required to correctly estimate variables in the model. The outcomes of the risk analysis were reported as relative risks presented as odds ratio (OR) for each region and for all sociodemographic factors.

All analyses were conducted in SAS 9.4.

3. Results

3.1. National sociodemographics represented by the study sample

Table 1 shows the distribution of sociodemographic factors in each of the four major geographical regions of the United States (Northeast[1], Midwest[2], South[3], and West[4]), as defined by the U.S. Census Bureau (U.S. Department of Commerce, 1994). The Add Health sample used in this study represents (1) 47.3% males, 52.7% females; (2) 68.3% non-Hispanic Whites, 13.1% African Americans, 11.7% Hispanic Americans, 6.9% other racial/ethnic groups; (3) 11.2% completed four-year college or above, 44.0% associate degree or alternatives, 44.9% high school or below; and (4) 20.0% lived in rural areas, 41.9% suburban, 30.0% urban, 8.1% varied childhood residential urbanity. The average age was 14.4 years (95% CI: 14.1–14.6) during Wave I.

Among the sociodemographic factors considered in this study, race/ethnicity and childhood residential urbanity differed significantly among the four regions. The Midwest had the highest proportion of non-Hispanic Whites (81.6%), and the South had the highest proportion of African Americans (23.0%). Both Hispanic and Other have higher population shares in the Northeast (23.2% and 16.5%, respectively) than in the other regions. The percentage of children and youth who lived in the rural, suburban, and urban areas was highest in the South (29.8%), Northeast (52.3%), and Midwest (36.4%), respectively. Compared to other regions, the South had the lowest percentage of young adults who had attained post-secondary education, and the West had the highest.

3.2. Prevalence and risk estimations of ACEs and ACE scores

Table 2 shows the prevalence estimations of individual ACEs and ACE scores within each region. The individual ACEs *emotional abuse*, *physical abuse*, and *incarcerated member in household* differed significantly among the four regions. Prevalence of *emotional abuse* was 15.4%, 13.1%, 10.1%, and 12.5% in the Northeast, the Midwest, the South, and the West, respectively ($p < 0.001$); and prevalence of *physical abuse* was 11.5%, 9.6%, 7.4%, and 11.8%, respectively ($p < 0.001$). In these four regions, prevalence of *incarcerated member in household* was estimated to be 1.5%, 2.5%, 1.4%, and 0.5%, respectively ($p = 0.01$). The prevalence of four of the ACEs–*emotional abuse* (15.4%), *sexual abuse* (13.0%), *substance abuse in household* (17.2%), and *emotional neglect* (10.7%)–were higher in the Northeast than in the other regions. Six specific ACEs had the lowest prevalence in the South–*emotional abuse* (10.1%), *physical abuse* (7.4%), *sexual abuse* (10.8%), *substance abuse in household* (12.1%), *mental illness in household* (7.0%), and *physical neglect* (2.5%).

Regional variations were also seen among young adults not endorsing any ACEs (Northeast: 44.8%, Midwest: 47.0%, South: 50.1%, West: 47.5%; $p = 0.10$). In other words, ACEs were most prevalent in the Northeast, with 55.2% of the young adults having at least one ACE,

[1] Northeast Region: *New England Division*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Middle Atlantic Division*: New Jersey, New York, and Pennsylvania.

[2] Midwest Region: *East North Central Division*: Illinois, Indiana, Michigan, Ohio, and Wisconsin; *West North Central Division*: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.

[3] South Region: *South Atlantic Division*: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; *East South Central Division*: Alabama, Kentucky, Mississippi, and Tennessee; *West South Central Division*: Arkansas, Louisiana, Oklahoma, and Texas.

[4] West Region: *Mountain Division:* Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; *Pacific Division*: Alaska, California, Hawaii, Oregon, Washington.

Table 1
Nationally representative proportions* of sociodemographic factors in each of four U.S. regions[a].

Sociodemographic Factors	Percentage in each region (%)					*p*-value#
	Northeast[1]	Midwest[2]	South[3]	West[4]	Overall	
Sex						
Male	45.9	46.6	48.4	47.7	47.3	0.58
Female	54.1	53.4	51.6	52.3	52.7	
Race/Ethnicity						
Non-Hispanic White	56.2	81.7	60.4	73.5	68.3	<0.001
Non-Hispanic African American	4.1	9.0	23.0	6.7	13.1	
Hispanic	23.2	3.8	12.8	13.0	11.7	
Other	16.5	5.5	3.8	6.9	6.9	
Education attainment						
Four-year college or above	9.7	13.4	8.5	15.2	11.2	0.08
Associate degree or alternatives	46.4	43.0	42.1	48.4	44.0	
High school or below	44.0	43.6	49.4	36.4	44.9	
Childhood residential urbanity						
Rural	14.9	14.6	29.8	12.2	20.0	<0.001
Suburban	52.3	41.7	34.9	49.0	41.9	
Urban	26.3	36.4	26.2	30.3	30.0	
Moved between rural/suburban/urban	6.6	7.3	9.2	8.5	8.1	
Frequency of receiving public support/welfare						
Never	82.0	82.1	81.0	84.2	82.0	0.47
Once	12.6	9.9	10.8	10.1	10.7	
Multiple times	5.4	8.0	8.2	5.7	7.3	

Note.
P-value was obtained using the survey design-adjusted Pearson Chi-square test (Rao-Scott Chi-square test).
* These regional estimations were statistically calculated by the method of sample weights.
[a] These are the four major geographical regions defined by the U.S. Census Bureau. The same classification of U.S. regions is used throughout this article.

Table 2
Sample-weighted prevalence estimations of individual ACEs and ACE scores[a] in each of four U.S. regions.

Type of ACE	Prevalence (%)					*p*-value#
	Northeast	Midwest	South	West	Overall	
Emotional abuse	15.4	13.1	10.1	12.5	12.3	<0.001
Physical abuse	11.5	9.6	7.4	11.8	9.4	<0.001
Sexual abuse	13.0	12.1	10.8	11.3	11.7	0.46
Substance abuse in household	17.2	14.6	12.1	14.7	14.1	0.06
Mental illness in household	9.4	7.8	7.0	10.0	8.1	0.50
Parental separation or divorce	24.4	23.9	25.1	23.8	24.4	0.96
Incarcerated member in household	1.5	2.5	1.4	0.5	1.6	0.01
Emotional neglect	10.7	9.3	10.4	10.7	10.3	0.74
Physical neglect	2.7	2.8	2.5	3.3	2.7	0.87
ACE Score	**Prevalence (%)**					***p*-value#**
	Northeast	**Midwest**	**South**	**West**	**Overall**	
0	44.8	47.0	50.1	47.5	47.9	0.10
1	27.0	28.6	28.3	24.9	27.7	
2	15.2	13.4	13.7	16.9	14.3	
3	8.1	6.7	4.9	7.2	6.3	
4+	4.8	4.2	3.0	3.5	3.8	

Note.
P-value was obtained using the survey design-adjusted Pearson Chi-square test (Rao-Scott Chi-square test).
[a] These regional estimations were statistically calculated by sample weights.

whereas their peers in the South had the lowest prevalence of at least one ACE (49.9%). Moreover, the prevalence of 3 ACEs (8.1%) and 4+ ACEs (4.8%) were highest in the Northeast. The South had the lowest prevalence of 3 (4.9%), and 4+ (3.0%) ACEs. Overall, these regional trends demonstrated that ACEs were most prevalent in the Northeast and least in the South.

Survey-based logistic regression was applied to model ACE score as the dependent variable and region as the independent variable, adjusted by sociodemographic factors to account for covariates. Table 3 presents relative risk estimations of ACE scores in each region relative to the Northeast. Compared to the Northeast, individuals in the South were less likely to have ACE scores of 2 (OR = 0.7, 95% CI: 0.5–1.0), 3 (OR = 0.5, 95% CI: 0.3–0.8), and 4+ (OR = 0.5, 95% CI: 0.3–0.9).

All sociodemographic factors considered in this study were found to have strong associations with ACE scores (Table 4). Biological sex had a graded association with ACE scores, with males having lower odds (OR = 0.4, 95% CI: 0.3–0.6) than females for 4+ ACE scores. The frequency of receiving social welfare also had a graded relationship with ACE scores: individuals who received social welfare for multiple years had 2.4 (95% CI: 1.6–3.6), 3.4 (95% CI: 2.3–5.1), and 3.7 (95% CI: 2.3–6.0) times higher odds of having 2, 3, and 4+ ACE scores, respectively. Compared to White, African American had higher risks of having one (OR = 1.5, 95% CI: 1.2–1.9) or two (OR = 1.9, 95% CI: 1.4–2.5) ACEs, but no significant associations were found for ACE scores higher than two. Higher education was associated with decreased risks for multiple ACEs. For example, individuals who had a four-year college degree or

Table 3
Relative risk estimations of ACE scores for U.S. regions.

Region	Relative risk estimations	Comparisons of ACE scores			
		1 vs. 0	2 vs.0	3 vs.0	4+ s.0
Midwest vs. Northeast	Odds ratio	1.0	0.8	0.8	0.8
	95% CI	0.8–1.3	0.6–1.2	0.5–1.2	0.5–1.4
	p-value	0.90	0.38	0.22	0.51
South vs. Northeast	Odds ratio	0.9	0.7	0.5	0.5
	95% CI	0.7–1.1	0.5–1.0	0.3–0.8	0.3–0.9
	p-value	0.25	0.05	0.004	0.02
West vs. Northeast	Odds ratio	0.9	1.2	0.9	0.8
	95% CI	0.7–1.2	0.7–1.9	0.6–1.4	0.4–1.5
	p-value	0.59	0.50	0.65	0.53

Note:*These odds ratios were estimated by a survey-based logistic regression model using ACE score as the dependent variable and region as the main effect after the model was adjusted by sociodemographics, including sex, race/ethnicity, education level, frequency of receiving public support/welfare, and childhood residential urbanity (the control group or level was set as female, White, never went to college, never received welfare, and rural residence, respectively).

Table 4
Relative risk estimations of ACE scores for different sociodemographic factors.

Covariates	Relative risk estimations	Comparisons of ACE scores			
		1 vs. 0	2 vs.0	3 vs.0	4+ s.0
Sex					
Male vs. female	Odds ratio	0.7	0.7	0.6	0.4
	95% CI	0.6–0.8	0.6–0.8	0.5–0.8	0.3–0.6
	p-value	<0.001	<0.001	0.002	<0.001
Race/Ethnicity					
African American vs. White	Odds ratio	1.5	1.9	1.3	1.1
	95% CI	1.2–1.9	1.4–2.5	0.8–1.9	0.7–1.6
	p-value	<0.001	<0.001	0.26	0.73
Hispanic vs. White	Odds ratio	1.1	1.2	0.8	0.9
	95% CI	0.8–1.4	0.9–1.6	0.5–1.3	0.5–1.6
	p-value	0.50	0.28	0.36	0.76
Others vs. White	Odds ratio	1.1	1.3	1.3	1.5
	95% CI	0.8–1.5	0.9–1.9	0.7–2.1	0.9–2.5
	p-value	0.43	0.14	0.37	0.12
Education					
Four-year college vs. No college	Odds ratio	0.5	0.3	0.3	0.2
	95% CI	0.4–0.6	0.2–0.4	0.2–0.5	0.1–0.3
	p-value	<0.0011	<0.001	<0.001	<0.001
Associate degree vs. No college	Odds ratio	0.6	0.4	0.5	0.3
	95% CI	0.5–0.7	0.4–0.6	0.3–0.7	0.2–0.4
	p-value	<0.001	<0.001	<0.001	<0.001
Frequency of receiving social welfare					
Once vs. Never	Odds ratio	1.5	1.6	2.1	2.3
	95% CI	1.2–1.9	1.2–2.1	1.5–3.0	1.4–3.6
	p-value	<0.001	0.001	<0.001	<0.001
Multiple times vs. Never	Odds ratio	1.6	2.4	3.4	3.7
	95% CI	1.2–2.2	1.6–3.6	2.3–5.1	2.3–6.0
	p-value	0.002	<0.001	<0.001	<0.001
Childhood residential urbanity					
Suburban vs. Rural	Odds ratio	1.2	1.1	1.3	1.3
	95% CI	1.0–1.5	0.8–1.4	1.0–1.9	0.8–2.3
	p-value	0.12	0.57	0.09	0.29
Urban vs. Rural	Odds ratio	1.4	1.4	1.5	1.2
	95% CI	1.1–1.9	1.0–1.8	1.0–2.2	0.7–2.2
	p-value	0.005	0.03	0.04	0.46
Moved between vs. Rural	Odds ratio	1.0	1.5	1.7	1.2
	95% CI	0.7–1.5	1.1–2.1	1.0–2.8	0.5–2.9
	p-value	0.85	0.02	0.05	0.65

above had five times lower odds to report a 4+ ACE score (OR = 0.2, 95% CI: 0.1–0.3). In terms of the residential urbanity before age 18, individuals who lived in urban areas had 1.4 (95% CI: 1.1–1.9), 1.4 (95% CI: 1.0–1.8), and 1.5 (95% CI: 1.0–1.8) higher odds of reporting 1, 2, and 3 ACEs than those who lived in rural areas, respectively.

3.3. Impacts of including data from self-reported dishonest respondents

Sensitivity analysis demonstrated that dishonesty was associated with both region and ACE scores (Tables 5 and 6). Among the four regions, the South had the highest percentage of respondents who self-reported dishonesty during the surveys. Those who reported responding to the study surveys honestly had 20% lower odds of having ACE scores of 1 and 2 than their peers who reported making dishonest survey responses, while sociodemographics were kept constant. These quantitative analyses demonstrated that samples of those who reported dishonest survey responses biased the prevalence estimation and risk analysis of ACEs; hence, they were excluded from the study.

4. Discussion

This study using a nationally representative school-based sample demonstrated that the prevalence of ACEs varied among the four major census regions in the United States (Northeast, Midwest, South, and West). Specifically, the regional differences of *emotional abuse*, *physical abuse*, and *incarcerated member in household* were significant. The Northeast had the highest prevalence of four specific ACEs (*emotional abuse*, *sexual abuse*, *substance abuse in household*, and *emotional neglect*), and the South had the lowest prevalence of six (*emotional abuse*, *physical abuse*, *sexual abuse*, *substance abuse in household*, *mental illness in household*, and *physical neglect*). The prevalence of ACE scores also varied regionally. Overall, ACEs were found to be most prevalent in the Northeast and least prevalent in the South. Compared to the Northeast, individuals in the South had half the odds of reporting ACE scores of four or above.

The regional variations found in this study differed from findings from other ACE prevalence studies. For example, using data from the 2016 National Survey of Children's Health (NSCH), Bethell et al. (2017b) showed that, among the four regions, prevalence of 2+ ACEs for children ages 0–17 was highest in the South (where all but two of the 17 states had higher prevalence of 2+ACEs than the national average) and lowest in the Northeast (where all but one of the nine states had lower prevalence of 2+ ACEs than the national average). These significant regional trend differences found in this study may be attributed to the fact that the NSCH assesses a set of ACEs significantly different from those assessed in this study and does not include items related to abuse or neglect. Another possible explanation is the difference in survey participants: NSCH data was provided by parents and guardians of children ages varying from birth to17 years, whereas Add Health data was self-reported by young adults retrospectively. Another study that used Behavioral Risk Factor Surveillance System (BRFSS) ACE data from 34 states found that the South had the lowest mean ACE score, whereas the mean ACE score and prevalence of four of eight individual ACEs were highest in the West compared to the other three regions (Giano et al., 2020). Although the types of ACEs assessed in the BRFSS ACE module largely overlap with those in Add Health, the data used in Giano et al. (2020) did not include all U.S. states and the proportion of states sampled in each region varied from the South (45.4%), West (20.6%), Midwest (20.1%), to Northeast (13.7%).

One possible reason for a lower exposure to ACEs in the South than in the other regions may be the presence of protective factors that strengthen families. Research suggests that five protective factors,

Table 5
Percentages of self-reportedly honest respondents in each U.S. region*.

Self-reported response honesty	Northeast	Midwest	South	West	Overall	*p*-value
Honest	84.7	86.4	82.2	86.2	84.5	0.05
Dishonest	15.3	13.6	17.8	13.8	15.5	

Note: *These estimations were based on all samples in Add Health (including the samples that were excluded for dishonesty).

Table 6
Relative risk estimations of ACE scores with respect to self-reported response honesty.

Self-reported response honesty	Relative risk estimations	Comparisons of ACE scores				
		0	1	2	3	4+
Honest vs. Dishonest	Odds ratio	1.0	0.8	0.8	0.7	1.1
	95% CI		0.7–1.0	0.6–1.0	0.5–1.1	0.7–1.7
	p-value		0.02	0.05	0.12	0.69

including (1) parental resilience, (2) social connections, (3) knowledge of parenting and child development, (4) concrete support in times of need, and (5) social and emotional competence of children, increase the capacity of families to cope with stress and can in turn reduce the incidence of child maltreatment (Harper Browne, 2014). There is also evidence suggesting that having safe, stable, and nurturing relationships with caring adults during childhood moderates the long-term health impact of exposure to four or more ACEs (Crouch et al., 2019b). The South has a higher proportion of residents living in rural areas compared to other regions, and lower parental stress as well as more social connections within families and communities had been reported by rural residents than their urban counterparts (Radcliff et al., 2018). In addition, a qualitative study of southern West Virginia found cultural attributes of strong family ties, a sense of place (defined as identification with a specific community), and strong spiritual faith in God to be important to study participants from this southern state (Coyne et al., 2006). Although socioeconomic disadvantage is more pervasive in the southern U.S. than in the northern region (Kolak et al., 2020), social and cultural conditions in the South may be important protective factors against socioeconomic and other stressors that can lead to household dysfunction and child maltreatment. Further research is needed to elucidate how various social and cultural factors contribute to ACE prevalence in different regions and to further explore the reasons for the regional variations seen in the present study.

All sociodemographic factors considered in this study were found to have strong associations with ACE scores and therefore were modeled as covariates in the risk analysis of ACEs. In particular, female sex, need for social welfare, lack of post-secondary education attainment, and childhood urban residence were associated with increased odds of having multiple ACEs. Past studies had also shown a higher exposure to ACEs among females than males (Campbell et al., 2016; Giano et al., 2020; Gilbert et al., 2015; Merrick et al., 2018; Winstanley et al., 2020). Economic stress, which was reflected by the need for public support in this study, and low education attainment have been consistently shown to be associated with increased ACE scores (Campbell et al., 2016; Crouch et al., 2019a; Giano et al., 2020; Gilbert et al., 2015). With regards to the association of residential urbanity with ACE exposure, past research using NSCH data has shown an association between childhood rural residence and increased exposure to ACEs (Calthorpe & Pantell, 2021; Crouch et al., 2019a). The aforementioned difference in ACE measures and sampling method between NSCH and Add Health may explain the different findings with respect to childhood residential urbanity.

Our sensitivity analysis on self-reported dishonesty reflected that samples of those who reported dishonest survey responses biased the quantitative analyses performed in this study and therefore were excluded. Our study found that self-reported dishonesty was associated with higher odds of having ACE scores of 1 and 2. Considering the sensitive nature of ACE survey questions, the likelihood of underreporting ACEs among research participants should be considered. Understanding and addressing survey honesty would be a worthy area to further research on ACEs.

5. Conclusions

Existing population health studies have explored the geographic patterns of health disparities, providing insights into potential sources of disparities, such as environmental, social, cultural, and economic factors, as well as informing public health policies and resource allocation (Acharya & Tabb, 2021; Goldhagen et al., 2005; Kolak et al., 2020). For example, the REGARDS study has been instrumental in defining the Stroke Belt of the U.S. and allowed better allocation of resources to address the public health concern of high rates of stroke-related deaths in that region (Howard et al., 2005). Similarly, a better understanding of regional differences in the prevalence of ACEs and their impact on the development of chronic diseases and mental health conditions may allow for improved precision in resource allocation to regions in addition to policy making and designing of prevention and interventional programs.

Preventing ACEs and mitigating their impacts have been an area of study by many researchers, including the Centers for Disease Control and Prevention (CDC, 2019). Strategies such as strengthening economic support to families, improving household financial security, and creating work policies and environments that are amenable to working families are recommended (Fortson et al., 2016). Other strategies include promoting social norms that guard against violence such as campaigns educating the public about adversity, resources to reduce community and household domestic violence, and parenting skills, as well as ensuring a strong start for children with approaches such as early childhood home visitation, universal Transitional Kindergarten, and widespread high-quality and affordable childcare (Niolon et al., 2017). Finally, treatment interventions to identify and treat substance use and mental illness in the home and early screening for ACEs by primary care providers can be effective ways to reduce ACEs and prevent future harm. Further work in adapting these ACE-related interventions based on specific regional needs and evaluating them in the regional context could advance population health effort in addressing childhood adversity.

The limitations of this study should be taken into consideration. First, we included only nine of the 10 ACEs defined in the CDC-Kaiser ACE Study and omitted other important childhood adversities such as low socioeconomic status, bullying, and discrimination (Finkelhor, 2018). Second, the school-based samples missed those who were not in schools and thus could underrepresent vulnerable populations. It is also noteworthy that our Add Health sample reflects an adolescent-age cohort in the late 1990's. Future research could examine the temporal stability of our findings as well as temporal trends in the regional variations of ACEs.

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Author statement

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Ethical statement

The study was approved by the University of California, Riverside Institutional Review Board. Participants of the dataset used in this study (Add Health) provided written informed consent for participation in accordance with the University of North Carolina School of Public Health Institutional Review Board guidelines.

Declaration of competing interest

None.

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