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Associations of Adverse Childhood Experiences With Pregnancy and Infant Health

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Abstract

Introduction: Adverse childhood experiences are associated with a host of negative outcomes; however, few have studied cumulative adverse childhood experiences in the context of pregnancy and infant health. This study examines state-level prevalence of adverse childhood experiences and associations with pregnancy- and infant health–related indicators.

Methods: The study used 2016–2018 Pregnancy Risk Assessment Monitoring System population-based data from 5 states. Analyses were conducted for individual states and grouped states using similar adverse childhood experience items. Thirteen adverse childhood experience measures were included across 3 domains: abuse, neglect, and household challenges. Adverse childhood experience scores were calculated for the number of adverse childhood experiences experienced (0, 1, 2, ≥3) on the basis of available state measures. Fourteen pregnancy- and infant health–related indicators were examined, including unwanted pregnancy, adequate prenatal care, experiences during pregnancy (e.g., smoking, abuse, depression), gestational diabetes, hypertensive disorders of pregnancy, birth outcomes (e.g., preterm birth), and breastfeeding. Adjusting for demographics, parity, health insurance status, and educational attainment, prevalence ratios and 95% CIs were calculated to examine the associations between pregnancy- and infant health–related indicators and adverse childhood experience scores.

Results: Over 50% of respondents reported at least 1 adverse childhood experience and 13%–31% reported ≥3 adverse childhood experiences, depending on the state. Significant associations

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SUPPLEMENTAL MATERIAL

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were identified in all adjusted models between adverse childhood experiences and unwanted pregnancy, smoking, physical abuse, and depression during pregnancy.

Conclusions: Adverse childhood experiences are associated with risk factors that impact pregnancy and infant health. Preventing and mitigating adverse childhood experiences is an important strategy to improve pregnancy- and infant health–related indicators.

INTRODUCTION

Pregnancy- and infant health–related (PIH) indicators are important markers of the overall health of a society.[1] These conditions may manifest during pregnancy or up to 1 year later, including hypertensive disorders of pregnancy, gestational diabetes, preterm birth, low birth weight, and postpartum depression. These serious public health issues contribute to premature mortality and increased healthcare costs.[2-5]

Among other risk factors,[6-8] stress has been identified as a key contributor to some poor pregnancy, postpartum, and neonatal health indicators, particularly among racial and ethnic minority groups.[8,9] A promising area for improving the understanding of negative PIH indicators–and subsequently, prevention efforts–is the growing science connecting experiences of childhood trauma and toxic stress to later health and well-being.

Adverse childhood experiences (ACEs) are preventable, potentially traumatic events that occur in childhood, including neglect; experiencing or witnessing violence; and growing up in a household with substance use, mental health problems, or instability because of parental separation, divorce, or incarceration.[10,11] ACEs are common[12,13]: between 2015 and 2017, 61% of adults from 25 U.S. states reported ≥1 ACE, and 16% reported experiencing ≥4 ACEs.[13] ACEs' impacts on health and life opportunities increase as the number of ACEs increases and may persist for years.[10,14,15] ACEs can cause a toxic stress response that derails optimal development by changing gene expression, brain architecture, immune function, and coping strategies affecting educational attainment, health behaviors, physical and mental health, life opportunities, socioeconomic position, and life expectancy.[10,14-16]

Lesser known is how experiencing childhood trauma impacts pregnancy and birth outcomes. Studies report the associations between experiencing chronic stress or abuse in childhood with preterm delivery or low birth weight,[17-21] but fewer studies have looked at cumulative ACEs in the context of PIH indicators.[22-24] Cumulative ACEs are important to examine in the context of PIH outcomes because increasing ACEs often show a dose–response relationship with negative health outcomes.[25] High ACEs have been associated with increased odds of pregnancy loss,[26] unwanted pregnancy,[27,28] negative prenatal mental health,[29-32] intimate partner violence during pregnancy,[31] substance use in pregnancy,[32-34] gestational hypertension,[35] preterm birth,[21,24,35,36] neonatal intensive care unit hospitalization,[37] and low birth weight,[26,37] but most studies have been limited to small, unrepresentative samples and have not included a robust set of outcomes.[22-24,38] Furthermore, few studies provide the population-based prevalence of ACEs among recently pregnant individuals at the state level.

The study seeks to understand the prevalence of ACEs among individuals with recent birth and associations between cumulative ACEs and key PIH indicators at a population level. The study uses a life-course perspective to examine the associations between cumulative adversity and the entire pregnancy and birth experience, from the wantedness of pregnancy to pregnancy-associated health conditions and behaviors to birth outcomes and breastfeeding. This information may highlight upstream risk factors and provide potential targets for decision makers seeking to prevent poor PIH outcomes.

METHODS

The Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing population-based surveillance system designed to monitor select behaviors and experiences that occur before, during, and shortly after pregnancy among individuals who deliver live-born infants in participating U.S. states, cities, and territories.[39] Monthly, all participating sites select a stratified random sample of 75–300 participants from birth certificate records. PRAMS sites use a standardized protocol for data collection, including mailing up to 3 self-administered surveys to sampled participants 2–6 months after delivery and contacting those who do not respond to mailings for telephone interviews. Survey results are linked to participants' birth certificates. Data are weighted annually to account for sample design, nonresponse, and noncoverage, thus representing the population of people with live births in each site for the year. Additional details on PRAMS methodology are described elsewhere.[39] PRAMS has approval from IRBs at the Centers for Disease Control and Prevention and participating sites.

Study Sample

The study used data from 5 PRAMS sites (Kansas [n=1,971], Michigan [n=5,565], North Dakota [n=1,476], Rhode Island [n=3,350], and South Dakota [n=2,148]) that included questions on ACEs experienced by postpartum individuals in their childhood. Sites achieved an overall weighted response rate of ≥55% for each year of survey data included between 2016 and 2018 (Appendix Table 1, available online).

Measures

The PRAMS questionnaire includes core, standard, and site-specific questions. Core questions are the same for all PRAMS sites. Standard questions are optional for sites to include but are identical. Site-specific questions are developed by participating sites independently. ACEs questions were site specific and were not uniform across all the 5 sites (Appendix Table 1, available online). Sites with similar questions were grouped for analyses into 2 combined data sets: North Dakota/South Dakota and Kansas/Michigan/Rhode Island. North Dakota and South Dakota questions were similar to Behavioral Risk Factor Surveillance System ACEs module questions[40] and assessed abuse (physical, emotional, sexual), neglect (physical, emotional), and household challenges (witnessed intimate partner violence, household substance use, household mental illness, parental separation/divorce, incarceration of a family member) experienced before the age of 18 years. Kansas, Michigan, and Rhode Island questions were adapted from the National Survey of Children's Health[41] and included neglect (emotional) and household challenges (parental separation/

divorce, household substance use, parental incarceration, food insecurity, housing instability, living in foster care) experienced before the age of 13 years.

For each site, a composite ACE score was created for the number of ACEs experienced during the participant's childhood for individuals with complete ACEs data on the basis of available indicators. Composite scores were grouped into 0, 1, 2, and ≥3 ACEs on the basis of the general distribution of ACE frequency in the study population and for comparability within this analysis and across other studies. Sensitivity analyses examining other groupings of cumulative scores (0–1, 2, ≥3; 0, 1, 2, 3, ≥4) evaluated the impact of ACE score categorization on strength of associations. In each of the 2 combined data sets, only ACE variables that were available and identical for all grouped sites (North Dakota/South Dakota, n=10; Kansas/Michigan/Rhode Island, n=7) were included in the ACE score calculation for combined analyses.

The study obtained information on participant age, race/ethnicity, education level, parity, plurality, marital status, adequacy of prenatal care (either Kotelchuck or Kessner index scored 'adequate'),[42,43] and neonatal indicators (small for gestational age [birth weight <10th percentile for gestational age], large for gestational age [birth weight >90th percentile for gestational age], low birth weight [<2,500 grams], preterm birth [<37 weeks gestation]) from the linked birth-certificate data. Participants who reported Hispanic ethnicity of any race were categorized as Hispanic. Participants who did not report Hispanic ethnicity were categorized as non-Hispanic White, non-Hispanic Black, non-Hispanic American Indian/Alaska Native, or non-Hispanic another race on the basis of reported race. The another race category included participants reporting Asian or Pacific Islander racial identity or multiple races owing to small sample size. Health insurance coverage for prenatal care (private, Medicaid, other, none) was from the PRAMS questionnaire, as were indicators for unwanted pregnancy, cigarette smoking during the last 3 months of pregnancy, experience of physical abuse during pregnancy, gestational diabetes, hypertensive disorders of pregnancy (HDP) (gestational hypertension/pre-eclampsia/eclampsia), depression during pregnancy, and ever breastfeeding.[44,45]

Statistical Analysis

Missing data were addressed through pairwise deletion; the percentage of missing data for variables of interest was low, ranging from 0 to 12.7% missing. Descriptive and bivariate analyses were conducted for combined groups (Kansas/Michigan/Rhode Island; North Dakota/South Dakota) and individual sites. Prevalence and 95% CIs were calculated for respondent characteristics and individual/cumulative ACEs as well as pregnancy-related behaviors, experiences, health risks, and birth indicators among participants experiencing ≥3 versus those experiencing 0 ACEs, testing for differences using chi-square tests. Poisson regression with robust SEs was conducted for combined groups to generate adjusted prevalence ratios examining the associations between ACE score (1, 2, ≥3) and PIH indicators, with 0 ACEs as the ref. To examine the direct impacts of ACEs on PIH indicators (Appendix Figure 1, available online), model covariates included participant age, race/ethnicity, marital status, parity, health insurance status (as a proxy for income), and educational attainment. On the basis of a priori knowledge, substantial differences in

the associations between ACEs and membership in a racial/ethnic minority group were anticipated for many of the indicators explored. To confirm this, effect modification was investigated by testing for interaction between ACE score and race/ethnicity for each examined outcome and examining stratified results. Unfortunately, given the small sample size of select minority groups in study states (e.g., non-Hispanic Black participants in North Dakota/South Dakota; non-Hispanic American Indian/Alaska Native participants in Kansas/Michigan/Rhode Island), the estimates generated were unstable (as determined by a relative CI width >130% and relative SE ≥30%) and could not be presented in this analysis.[46,47] All analyses accounted for complex survey design using SAS, Version 9.4, and R, Version 4.2.0.[48,49]

RESULTS

In total, 14,510 participants were included. Table 1 provides the weighted percentages of demographic characteristics for combined and individual sites. Across sites, most respondents were non-Hispanic White, were aged 25–34 years, were married, were privately insured, and completed more than a high school education. Approximately 60% of the participants were multiparous, and the majority had singleton infants.

Table 2 provides the weighted prevalence of ACEs for the combined and individual site participants. On the basis of combined data for 10 ACEs assessed by both South Dakota and North Dakota, parental separation or divorce was the most common ACE (40.8%; 95% CI=38.8%, 42.7%). A quarter of participants reported experiencing emotional abuse (24.5%; 95% CI=22.8%, 26.2%), exposure to substance use (28.8%; 95% CI=27.0%, 30.6%), or mental illness (25.4%; 95% CI=23.6%, 27.1%) in their home. Six in 10 North Dakota/South Dakota respondents (60.6%; 95% CI=58.6%, 62.5%) reported experiencing at least 1 of the 10 assessed ACEs, and more than a quarter (29.1%; 95% CI=27.3%, 30.9%) experienced ≥3 ACEs.

On the basis of combined data for the 7 ACEs assessed by Kansas, Michigan, and Rhode Island, parental separation or divorce was the most common ACE (34.8%; 95% CI=33.5%, 36.2%); 17.7% (95% CI=16.5%, 18.8%) of participants reported exposure to substance use in their home, and 14.7% (95% CI=13.7%, 15.8%) reported housing instability. One half (49.6%; 95% CI=48.2%, 51.0%) of the Kansas/Michigan/Rhode Island participants experienced 1 or more of the 7 assessed ACEs, and 13.6% (95% CI=12.6%, 14.7%) experienced ≥3 ACEs.

When comparing PIH indicators for participants experiencing ≥3 ACEs versus those experiencing 0 ACEs, most bivariate analysis findings were similar across combined site groupings (Tables 3 and 4). A significantly higher proportion of participants with ≥3 ACEs reported unwanted pregnancy, physical abuse during pregnancy, smoking during pregnancy, depression during pregnancy, and HDP than of participants without ACEs. A significantly lower proportion of participants with ≥3 ACEs reported adequate prenatal care and ever breastfeeding than of participants without ACEs. There was variation in some indicators among individual sites; however, findings for pregnancy-related behaviors and experiences (e.g., smoking, physical abuse, and depression during pregnancy) were consistent across

individual and combined sites. Pregnancies with small for gestational age infants did not demonstrate significant associations with increased ACEs in combined or individual sites. Mixed results were observed for preterm birth, low birth weight, and large-for-gestational-age infants across combined and individual sites.

Table 5 presents the adjusted associations between pregnancy and birth indicators by ACE score. Participants with 1, 2, or ≥3 ACEs in both combined groups had 1.3–3.5 times higher prevalence of depression during pregnancy and 1.9–4.2 times higher prevalence of smoking during pregnancy than participants without ACEs. Participants with ≥2 ACEs in North Dakota/South Dakota and participants with ≥1 ACE in Kansas/Michigan/Rhode Island had 1.4–2.2 times higher prevalence of reporting an unwanted pregnancy and 2.2–7.9 times higher prevalence of experiencing abuse during pregnancy than participants without ACEs. Participants who experienced ≥3 ACEs in Kansas/Michigan/Rhode Island had 1.4 times higher prevalence of reporting HDP during pregnancy than participants without ACEs. Participants reporting 2 ACEs in North Dakota/South Dakota had 1.6 times higher prevalence of small-for-gestational-age infants than participants without ACEs. Sensitivity analyses did not find any significant differences in the strength of associations when examining other groupings of cumulative ACE scores.

DISCUSSION

This study uses large population-based samples to examine the associations between ACEs and PIH indicators. ACEs were highly prevalent; over 50% of participants with a recent live birth reported ≥1 ACEs, and 12.5%–30.6% reported ≥3 ACEs. Experiencing ≥3 ACEs was associated with several negative PIH indicators; consistent with previous studies, individuals who reported exposure to ACEs experienced an increased prevalence of unwanted pregnancy,[50] abuse during pregnancy,[51] prenatal depression,[29] and smoking during pregnancy.[31,52-55] For the most part, associations between higher ACE scores and negative PIH indicators were consistent across combined state groups, despite state-based differences in ACE indicators.

Associations between cumulative ACEs and pregnancy-related conditions and neonatal outcomes were mixed. High ACEs were only significantly associated with small- or large-for-gestational-age infants and gestational hypertension in 1 combined state group. This is not inconsistent with existing literature, where associations between ACEs and pregnancy and infant biological outcomes have been more modest[35,56] than associations with behavioral outcomes.[31,52] Unlike 2 smaller studies showing higher odds of spontaneous preterm birth among individuals experiencing ≥2 ACEs,[24,26] no evidence of direct associations between experiencing ACEs and preterm birth was found. However, the study found significant associations between participants' ACEs and several known risk factors for preterm birth—including smoking during pregnancy, gestational depression, and abuse during pregnancy—suggesting that the relationship between ACEs and preterm birth may occur more indirectly through mediators.[23]

ACEs' impact can be felt across one's lifetime and reverberate across future generations. Child abuse, neglect, and other adversities show intergenerational continuity–the cycle

of violence.[57-59] Indeed, parental ACE scores are a strong predictor of children's ACE scores,[60,61] and ACEs can be experienced in utero before a child is born.[62] The intersections between ACEs and PIH highlight a potentially powerful nexus for early prevention to improve PIH and reduce intergenerational transmission of ACEs.

This study found associations between increased ACEs and PIH indicators across the reproductive spectrum, from wantedness of pregnancy to pregnancy-associated health behaviors. Previous studies have shown that the relationship between ACEs and negative PIH is moderated by high levels of resilience[31] or positive influences in childhood,[29] suggesting that efforts to build resilience in childhood[63] and beyond may mitigate the negative impacts of ACEs on individuals who have already experienced them. Studies have shown that individuals with high ACEs have improved pregnancy and birth outcomes if they have a strong support system in place.[64] For those who have experienced ACEs, providing needed mental and behavioral health care, facilitating concrete and social supports, and promoting resilience are important strategies to buffer against the negative impacts of ACEs.

This study adds to the growing body of literature suggesting that ACEs be included as part of a larger, comprehensive trauma-informed approach to reproductive care.[32] Within the reproductive healthcare setting, inquiring about ACEs and social determinants of health, particularly in the context of concurrent stressors,[32] may help providers identify individuals with barriers to care and mitigate increased risk for reproductive and pregnancy complications. Such strategies include referring survivors of ACEs to effective services and support, particularly mental and behavioral health care, and encouraging help seeking in clinical settings before, during, and after pregnancy.

Poor PIH indicators are a serious public health issue with far-reaching consequences. ACEs may be a contributing factor to these indicators, but they are preventable. By adopting and promoting appropriate, evidence-based policies, social norms, programmatic strategies, and approaches that prevent ACEs, indicators may be improved for current and future generations. These strategies include addressing underlying social determinants such as housing, food, and economic insecurity; neighborhood safety; and access to quality health care and education. This may involve legislative support for policies that address socioeconomic conditions and adult stressors that can put people at risk of pregnancy complications.[13,31]

Limitations

This study is not without limitations. First, the study was limited to 5 Midwestern and Northeastern states that self-selected to include ACEs measures on their PRAMS surveys. As such, results are not generalizable beyond participating states. Second, because measures were based on self-report, the extent of overreporting or underreporting of ACEs is unknown. In addition, the included ACE measures did not measure the severity, frequency, or duration of adverse experiences. ACE items from Kansas, Michigan, and Rhode Island were limited to nonviolent experiences in the first 13 years of life and likely underrepresent the true prevalence of ACEs. Moreover, the ACEs measured were a select subset of potentially traumatic childhood experiences and do not fully capture the full range of negative experiences that may happen to children. For example, ACEs of

racism[65] and discrimination are particularly salient for racial and ethnic minority groups—with demonstrated impacts on pregnancy and neonatal health—but these ACEs were not assessed by these states. Fourth, on the basis of the instability of estimates for participants from certain racial and ethnic minority groups in the study population, stratified results were unable to be presented. Exploring the contributions of ACEs to disparities among racial and ethnic minority groups may help to identify prevention strategies that decrease inequities in PIH indicators. Owing to inequities in structural determinants of health, because of both current and historical factors (e.g., racism, economic policy), ACEs often disproportionately affect members of racial and ethnic minority groups.[66] Further analyses using additional data years are planned to explore the differences in the prevalence of ACEs and associations with PIH indicators by race and ethnicity. Finally, PRAMS only captures live births and select pregnancy risk behaviors, limiting the ability to examine the associations between ACEs and other pregnancy outcomes and behaviors (e.g., stillbirth, substance use). Further research would enable a better understanding of how the types and characteristics of ACEs impact PIH indicators. Despite these limitations, the findings from this study have important implications for the way clinicians, researchers, policy makers, and the public understand the intersections between exposure to adversity and PIH.

CONCLUSIONS

ACEs are significantly associated with a host of PIH indicators, including unwanted pregnancy, smoking, physical abuse, and depression during pregnancy. Preventing and mitigating ACEs may be an important strategy to improve PIH.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Crear-Perry J, Correa-de-Araujo R, Lewis Johnson T, McLemore MR, Neilson E, Wallace M. Social and structural determinants of health inequities in maternal health. J Womens Health (Larchmt). 2021;30(2):230–235. 10.1089/jwh.2020.8882. [PubMed: 33181043]
2. Kapur A, Hod M. Maternal health and non-communicable disease prevention: an investment case for the post COVID-19 world and need for better health economic data. Int J Gynaecol Obstet. 2020;150(2):151–158. 10.1002/ijgo.13198. [PubMed: 32401348]

3. Moran PS, Wuytack F, Turner M, et al. Economic burden of maternal morbidity - a systematic review of cost-of-illness studies. PLoS One. 2020;15(1):e0227377. 10.1371/journal.pone.0227377. [PubMed: 31945775]
4. Gon G, Leite A, Calvert C, Woodd S, Graham WJ, Filippi V. The frequency of maternal morbidity: a systematic review of systematic reviews. Int J Gynaecol Obstet. 2018;141(suppl 1):20–38. 10.1002/ijgo.12468.
5. Petersen EE, Davis NL, Goodman D, et al. Vital signs: pregnancy-related deaths, United States, 2011–2015, and strategies for prevention, 13 states, 2013–2017. MMWR Morb Mortal Wkly Rep. 2019;68(18):423–429. 10.15585/mmwr.mm6818e1. [PubMed: 31071074]
6. Almeida J, Bécares L, Erbetta K, Bettegowda VR, Ahluwalia IB. Racial/ethnic inequities in low birth weight and preterm birth: the role of multiple forms of stress. Matern Child Health J. 2018;22(8):1154–1163. 10.1007/s10995-018-2500-7. [PubMed: 29442278]
7. Goldenberg RL, Cliver SP, Mulvihill FX, et al. Medical, psychosocial, and behavioral risk factors do not explain the increased risk for low birth weight among black women. Am J Obstet Gynecol. 1996;175(5):1317–1324. 10.1016/s0002-9378(96)70048-0. [PubMed: 8942508]
8. Almeida LM, Caldas J, Ayres-de-Campos D, Salcedo-Barrientos D, Dias S. Maternal healthcare in migrants: a systematic review. Matern Child Health J. 2013;17(8):1346–1354. 10.1007/s10995-012-1149-x. [PubMed: 23334357]
9. Lu MC, Halfon N. Racial and ethnic disparities in birth outcomes: a life-course perspective. Matern Child Health J. 2003;7(1):13–30. 10.1023/a:1022537516969. [PubMed: 12710797]
10. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. Am J Prev Med. 1998;14(4):245–258. 10.1016/s0749-3797(98)00017-8. [PubMed: 9635069]
11. Finkelhor D, Shattuck A, Turner H, Hamby S. Improving the adverse childhood experiences study scale. JAMA Pediatr. 2013;167(1):70–75. 10.1001/jamapediatrics.2013.420. [PubMed: 23403625]
12. Bethell CD, Davis MB, Gombojav N, Stumbo S and Powers K, Issue Brief: adverse childhood experiences among U.S. children, Child and Adolescent Health Measurement Initiative, 2017, Johns Hopkins Bloomberg School of Public Health; Baltimore, MD https://www.cahmi.org/docs/default-source/resources/issue-brief-adverse-childhood-experiences-among-us-children-(2017).pdfhttps://www.publicschoolsfirstnc.org/wp-content/uploads/2018/08/ACEs-Fact-Sheet.pdf,pdf. Published October 2017. Accessed January 21, 2021.
13. Merrick MT, Ford DC, Ports KA, et al. Vital Signs: estimated proportion of adult health problems attributable to adverse childhood experiences and implications for prevention – 25 States, 2015–2017. MMWR Morb Mortal Wkly Rep. 2019;68(44):999–1005. 10.15585/mmwr.mm6844e1. [PubMed: 31697656]
14. Metzler M, Merrick MT, Klevens J, Ports KA, Ford DC. Adverse childhood experiences and life opportunities: shifting the narrative. Child Youth Serv Rev. 2017;72:141–149. 10.1016/j.childyouth.2016.10.021.
15. Shonkoff JP. Capitalizing on advances in science to reduce the health consequences of early childhood adversity. JAMA Pediatr. 2016;170(10):1003–1007. 10.1001/jamapediatrics.2016.1559. [PubMed: 27548291]
16. Brown DW, Anda RF, Tiemeier H, et al. Adverse childhood experiences and the risk of premature mortality. Am J Prev Med. 2009;37(5):389–396. 10.1016/j.amepre.2009.06.021. [PubMed: 19840693]
17. Margerison-Zilko CE, Strutz KL, Li Y, Holzman C. Stressors across the life-course and preterm delivery: evidence from a pregnancy cohort. Matern Child Health J. 2017;21(3):648–658. 10.1007/s10995-016-2151-5. [PubMed: 27443654]
18. Bublitz M, De La Monte S, Martin S, Larson L, Bourjeily G. Childhood maltreatment and inflammation among pregnant women with gestational diabetes mellitus: a pilot study. Obstet Med. 2017;10(3):120–124. 10.1177/1753495×17701320. [PubMed: 29051779]
19. Grimstad H, Schei B. Pregnancy and delivery for women with a history of child sexual abuse. Child Abuse Negl. 1999;23(1):81–90. 10.1016/s0145-2134(98)00113-6. [PubMed: 10075195]

20. Gillespie SL, Christian LM, Alston AD, Salsberry PJ. Childhood stress and birth timing among African American women: cortisol as biological mediator. Psychoneuroendocrinology. 2017;84:32–41. 10.1016/j.psyneuen.2017.06.009. [PubMed: 28651102]
21. Hardcastle K, Ford K, Bellis MA. Maternal adverse childhood experiences and their association with preterm birth: secondary analysis of data from universal health visiting. BMC Pregnancy Childbirth. 2022;22(1):129. 10.1186/s12884-022-04454-z. [PubMed: 35172776]
22. McDonnell CG, Valentino K. Intergenerational effects of childhood trauma: evaluating pathways among maternal ACEs, perinatal depressive symptoms, and infant outcomes. Child Maltreat. 2016;21(4):317–326. 10.1177/1077559516659556. [PubMed: 27457410]
23. Smith MV, Gotman N, Yonkers KA. Early childhood adversity and pregnancy outcomes. Matern Child Health J. 2016;20(4):790–798. 10.1007/s10995-015-1909-5. [PubMed: 26762511]
24. Christiaens I, Hegadoren K, Olson DM. Adverse childhood experiences are associated with spontaneous preterm birth: a case-control study. BMC Med. 2015;13(1):124. 10.1186/s12916-015-0353-0. [PubMed: 26063042]
25. Sacks V, Murphey D. The prevalence of adverse childhood experiences, nationally, by state, and by race or ethnicity. Bethesda, MD: Child Trends; 2018. https://www.childtrends.org/publications/prevalence-adverse-childhood-experiences-nationally-state-race-ethnicity#:~:text=Children%20of%20different%20races%20and,of%20Asian%20non%2DHispanic%20children. Published February 12, 2018. Accessed January 21, 2021.
26. Mersky JP, Lee CP. Adverse childhood experiences and poor birth outcomes in a diverse, low-income sample. BMC Pregnancy Childbirth. 2019;19(1):387. 10.1186/s12884-019-2560-8. [PubMed: 31660899]
27. Testa A, Jackson DB, Ganson KT, Nagata JM. Maternal adverse childhood experiences and pregnancy intentions. Ann Epidemiol. 2021;64:47–52. 10.1016/j.annepidem.2021.09.011. [PubMed: 34547446]
28. Young-Wolff KC, Wei J, Varnado N, Rios N, Staunton M, Watson C. Adverse childhood experiences and pregnancy intentions among pregnant women seeking prenatal care. Womens Health Issues. 2021;31(2):100–106. 10.1016/j.whi.2020.08.012. [PubMed: 33032888]
29. Chung EK, Mathew L, Elo IT, Coyne JC, Culhane JF. Depressive symptoms in disadvantaged women receiving prenatal care: the influence of adverse and positive childhood experiences. Ambul Pediatr. 2008;8(2):109–116. 10.1016/j.ambp.2007.12.003. [PubMed: 18355740]
30. Atzl VM, Narayan AJ, Rivera LM, Lieberman AF. Adverse childhood experiences and prenatal mental health: type of ACEs and age of maltreatment onset. J Fam Psychol. 2019;33(3):304–314. 10.1037/fam0000510. [PubMed: 30802085]
31. Young-Wolff KC, Alabaster A, McCaw B, et al. Adverse childhood experiences and mental and behavioral health conditions during pregnancy: the role of resilience. J Womens Health (Larchmt). 2019;28(4):452–461. 10.1089/jwh.2018.7108. [PubMed: 30183473]
32. Racine N, Byles H, Killam T, Ereyi-Osas W, Madigan S. Asking about childhood adversity in the prenatal care setting: cross-sectional associations with maternal health and mental health outcomes. Matern Child Health J. 2022;26(5):994–1004. 10.1007/s10995-021-03301-5. [PubMed: 34837600]
33. Racine N, McDonald S, Chaput K, Tough S, Madigan S. Maternal substance use in pregnancy: differential prediction by childhood adversity subtypes. Prev Med. 2020;141:106303. 10.1016/j.ypmed.2020.106303. [PubMed: 33121963]
34. Racine N, McDonald S, Chaput K, Tough S, Madigan S. Pathways from maternal adverse childhood experiences to substance use in pregnancy: findings from the all our families cohort. J Womens Health (Larchmt). 2021;30(12):1795–1803. 10.1089/jwh.2020.8632. [PubMed: 33524303]
35. Miller ES, Fleming O, Ekpe EE, Grobman WA, Heard-Garris N. Association between adverse childhood experiences and adverse pregnancy outcomes. Obstet Gynecol. 2021;138(5):770–776. 10.1097/AOG.0000000000004570. [PubMed: 34619717]
36. Sulaiman S, Premji SS, Tavangar F, Yim IS, Lebold M. MiGHT. Total adverse childhood experiences and preterm birth: A systematic review. Matern Child Health J. 2021;25(10):1581–1594. 10.1007/s10995-021-03176-6. [PubMed: 34036452]

37. Ciciolla L, Shreffler KM, Tiemeyer S. Maternal childhood adversity as a risk for perinatal complications and NICU hospitalization. J Pediatr Psychol. 2021;46(7):801–813. 10.1093/jpepsy/jsab027. [PubMed: 34304270]
38. Mersky JP, Janczewski CE, Topitzes J. Rethinking the measurement of adversity. Child Maltreat. 2017;22(1):58–68. 10.1177/1077559516679513. [PubMed: 27920222]
39. Shulman HB, D'Angelo DV, Harrison L, Smith RA, Warner L. The Pregnancy Risk Assessment Monitoring System (PRAMS): overview of design and methodology. Am J Public Health. 2018;108(10):1305–1313. 10.2105/AJPH.2018.304563. [PubMed: 30138070]
40. Behavioral risk factor surveillance system survey ACE data. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. 2022 https://www.cdc.gov/violenceprevention/aces/ace-brfss.html. Updated April 3, 2020. Accessed September 9, 2021.
41. U.S. Census Bureau. 2020 National Survey of Children's Health: methodology report. Suitland-Silver Hill, MD: U.S. Census Bureau; 2021. https://www2.census.gov/programs-surveys/nsch/technical-documentation/methodology/2020-NSCH-Methodology-Report.pdf. Published September 30, 2021. Accessed December 2, 2021.
42. Kotelchuck M. The adequacy of prenatal care utilization index: its U.S. distribution and association with low birthweight. Am J Public Health. 1994;84(9):1486–1489. 10.2105/ajph.84.9.1486. [PubMed: 8092377]
43. Kessner D, Singer J, Kalk C, Schlesinger E. Infant Death: an Analysis by Maternal Risk and Health Care. Chapter 2. Washington, DC: Institute of Medicine and National Academy of Scientists, 1973.
44. Birth certificate variables. Atlanta, GA: Centers for Disease Control and Prevention. https://www.cdc.gov/prams/pdf/pramsresearchdatasetcode-book_3-2012.pdf. Published March 23, 2012. Accessed January 4, 2023.
45. PRAMS Phase 8 topic reference document. Centers for Disease Control and Prevention. https://www.cdc.gov/prams/pdf/questionnaire/Phase-8-Topics-Reference_508tagged.pdf. Published May 8, 2018. Accessed December 2, 2021.
46. Parker J, Talih M, Malec D, et al. , National Center for Health Statistics data presentation standards for proportions, Vital Health Stat 2, 175, 2017, 1–22, https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf, Published August 2017. Accessed August 24, 2022.
47. Reliability of estimates. National Center for Health Statistics; 2021. Centers for Disease Control and Prevention. https://wwwn.cdc.gov/nchs/nhanes/tutorials/ReliabilityOfEstimates.aspx. Updated December 2021. Accessed August 24, 2022.
48. SAS [computer program]. Version 9.4. Cary, NC: SAS Institute Inc; 2017.
49. R Language. Environment for Statistical Computing [computer program]. Version 4.2.0. Vienna, Austria: R Foundation for Statistical Computing, 2022.
50. Dietz PM, Spitz AM, Anda RF, et al. Unintended pregnancy among adult women exposed to abuse or household dysfunction during their childhood. JAMA. 1999;282(14):1359–1364. 10.1001/jama.282.14.1359. [PubMed: 10527183]
51. Mahenge B, Stöckl H, Mizinduko M, Mazalale J, Jahn A. Adverse childhood experiences and intimate partner violence during pregnancy and their association to postpartum depression. J Affect Disord. 2018;229:159–163. 10.1016/j.jad.2017.12.036. [PubMed: 29310065]
52. Chung EK, Nurmohamed L, Mathew L, Elo IT, Coyne JC, Culhane JF. Risky health behaviors among mothers-to-be: the impact of adverse childhood experiences. Acad Pediatr. 2010;10(4):245–251. 10.1016/j.acap.2010.04.003. [PubMed: 20599179]
53. Ångerud K, Annerbäck EM, Tydén T, Boddeti S, Kristiansson P. Adverse childhood experiences and depressive symptomatology among pregnant women. Acta Obstet Gynecol Scand. 2018;97(6):701–708. 10.1111/aogs.13327. [PubMed: 29431859]
54. Samia P, Premji S, Tavangar F, et al. Adverse childhood experiences and changing levels of psychosocial distress scores across pregnancy in Kenyan women. Int J Environ Res Public Health. 2020;17(10):3401. 10.3390/ijerph17103401. [PubMed: 32414141]
55. Racine N, Zumwalt K, McDonald S, Tough S, Madigan S. Perinatal depression: the role of maternal adverse childhood experiences and social support. J Affect Disord. 2020;263:576–581. 10.1016/j.jad.2019.11.030. [PubMed: 31759669]

56. Stanhope KK, Cammack AL, Perreira KM, et al. Adverse childhood experiences and lifetime adverse maternal outcomes (gestational diabetes and hypertensive disorders of pregnancy) in the Hispanic Community Health Study/Study of Latinos. Ann Epidemiol. 2020;50:1–6. 10.1016/j.annepidem.2020.08.004. [PubMed: 32791197]
57. Narayan AJ, Kalstabakken AW, Labella MH, Nerenberg LS, Monn AR, Masten AS. Intergenerational continuity of adverse childhood experiences in homeless families: unpacking exposure to maltreatment versus family dysfunction. Am J Orthopsychiatry. 2017;87(1):3–14. 10.1037/ort0000133. [PubMed: 26752439]
58. Schofield TJ, Donnellan MB, Merrick MT, Ports KA, Klevens J, Leeb R. Intergenerational continuity in adverse childhood experiences and rural community environments. Am J Public Health. 2018;108(9):1148–1152. 10.2105/AJPH.2018.304598. [PubMed: 30089003]
59. Schofield TJ, Lee RD, Merrick MT. Safe, stable, nurturing relationships as a moderator of intergenerational continuity of child maltreatment: a meta-analysis. J Adolesc Health. 2013;53(4 suppl):S32–S38. 10.1016/j.jadohealth.2013.05.004.
60. Randell KA, O'Malley D, Dowd MD. Association of parental adverse childhood experiences and current child adversity. JAMA Pediatr. 2015;169(8):786–787. 10.1001/jamapediatrics.2015.0269. [PubMed: 26030177]
61. Negriff S. Expanding our understanding of intergenerational exposure to adversity. Child Youth Serv Rev. 2020;118:105369. 10.1016/j.childyouth.2020.105369. [PubMed: 33132471]
62. Gentner MB, Leppert MLO. Environmental influences on health and development: nutrition, substance exposure, and adverse childhood experiences. Dev Med Child Neurol. 2019;61(9):1008–1014. 10.1111/dmcn.14149. [PubMed: 30671935]
63. Ellis WR, Dietz WH. A new framework for addressing adverse childhood and community experiences: the building community resilience model. Acad Pediatr. 2017;17(7S):S86–S93. 10.1016/j.acap.2016.12.011. [PubMed: 28865665]
64. Racine N, Madigan S, Plamondon A, Hetherington E, McDonald S, Tough S. Maternal adverse childhood experiences and antepartum risks: the moderating role of social support. Arch Womens Ment Health. 2018;21(6):663–670. 10.1007/s00737-018-0826-1. [PubMed: 29594369]
65. Trent M, Dooley DG, Dougé J. Section on Adolescent Health, Council on Community Pediatrics, Committee on Adolescence. The impact of racism on child and adolescent health. Pediatrics.. 2019;144(2):e20191765. 10.1542/peds.2019-1765. [PubMed: 31358665]
66. Maguire-Jack K, Lanier P, Lombardi B. Investigating racial differences in clusters of adverse childhood experiences. Am J Orthopsychiatry. 2020;90(1):106–114. 10.1037/ort0000405 [PubMed: 30816722]

Table 1.

Demographics of PRAMS Participants in 5 States, 2016–2018

Characteristics	Combined[a] North Dakota and South Dakota (Unweighted *n*=3,624), unweighted *n* [weighted %] (95% CI)	North Dakota (Unweighted *n*=1,476), unweighted *n* [weighted %] (95% CI)	South Dakota (Unweighted *n*=2,148), unweighted *n* [weighted %] (95% CI)	Combined[a] Kansas, Michigan, and Rhode Island (unweighted *n*=10,886), unweighted *n* [weighted %] (95% CI)	Kansas (Unweighted *n*=1,971), unweighted *n* [weighted %] (95% CI)	Michigan (Unweighted *n*=5,565), unweighted *n* [weighted %] (95% CI)	Rhode Island (Unweighted *n*=3,350), unweighted *n* [weighted %] (95% CI)
Age, years							
<20	233 [4.4] (3.7, 5.1)	98 [3.4] (2.4, 4.4)	135 [5.3] (4.2, 6.3)	586 [4.9] (4.3, 5.5)	104 [6.2] (4.6, 7.7)	341 [4.7] (4.0, 5.3)	141 [4.4] (3.6, 5.2)
20–24	756 [19.5] (17.9, 21.1)	312 [19.7] (17.1, 22.2)	444 [19.4] (17.4, 21.3)	1,999 [19.7] (18.6, 20.9)	359 [21.7] (19.2, 24.2)	1,195 [19.7] (18.4, 21.1)	445 [15.2] (13.7, 16.7)
25–34	2,211 [64.1] (62.2, 65.9)	889 [64.5] (61.5, 67.5)	1,322 [63.8] (61.3, 66.0)	6,450 [59.7] (58.3, 61.1)	1,208 [58.0] (55.1, 60.9)	3,212 [60.0] (58.4, 61.7)	2,030 [59.7] (57.8, 61.5)
≥35	424 [12.0] (10.7, 13.3)	177 [12.4] (10.4, 14.5)	247 [11.6] (10.1, 13.2)	1,851 [15.7] (14.7, 16.7)	300 [14.1] (12.2, 16.0)	817 [15.6] (14.4, 16.8)	734 [20.7] (19.2, 22.2)
Race/ethnicity							
White, non-Hispanic	1,650 [72.3] (71.1, 73.6)	763 [73.0] (70.5, 75.6)	887 [71.7] (71.3, 72.1)	5,640 [67.5] (66.4, 68.6)	1,479 [74.5] (71.8, 77.1)	2,376 [67.1] (65.8, 68.4)	1,785 [56.0] (54.1, 57.9)
Black, non-Hispanic	200 [4.0] (3.3, 4.7)	46 [4.7] (3.3, 6.1)	154 [3.4] (3.0, 3.8)	2,981 [15.5] (15.2, 15.8)	136 [6.2] (4.8, 7.6)	2,610 [18.3] (18.0, 18.6)	235 [6.0] (5.1, 6.9)
American Indian/ Alaska Native, non-Hispanic	1,015 [10.9] (10.5, 11.3)	498 [8.5] (8.2, 8.9)	517 [13.0] (12.4, 13.7)	52 [0.4] (0.2, 0.6)	10 [0.5] (0.1, 0.8)	25 [0.3] (0.1, 0.6)	17 [0.6] (0.3, 0.9)
Another race (non-Hispanic)	396 [7.4] (6.4, 8.3)	78 [8.0] (6.1, 9.9)	318 [6.9] (6.2, 7.5)	814 [7.8] (7.0, 8.5)	137 [6.4] (5.0, 7.7)	316 [7.8] (6.8, 8.7)	361 [10.9] (9.7, 12.1)
Hispanic	322 [5.4] (4.6, 6.2)	70 [5.8] (4.2, 7.3)	252 [5.0] (4.6, 5.5)	1,343 [8.9] (8.1, 9.7)	208 [12.5] (10.4, 14.7)	223 [6.5] (5.6, 7.5)	912 [26.5] (24.8, 28.2)
Education							
Less than high school	128 [2.8] (2.2, 3.4)	13 [1.2] (0.4, 2.0)	115 [4.3] (3.4, 5.3)	172 [1.5] (1.1, 1.9)	26 [2.2] (1.1, 3.2)	46 [1.2] (0.8, 1.6)	100 [3.4] (2.7, 4.2)
High school	835 [25.4] (23.5, 27.3)	317 [24.3] (21.3, 27.2)	518 [26.5] (24.1, 28.8)	2,652 [28.3] (26.9, 29.6)	472 [28.4] (25.6, 31.3)	1,533 [28.6] (27.0, 30.3)	647 [23.9] (22.1, 25.7)
More than high school	2,167 [71.8] (69.9, 73.7)	977 [74.6] (71.6, 77.5)	1,190 [69.2] (66.8, 71.6)	6,708 [70.2] (68.8, 71.6)	1,301 [69.4] (66.5, 72.3)	3,305 [70.2] (68.5, 71.8)	2,102 [72.7] (70.8, 74.5)
Parity							
Nulliparous	1,159 [34.2] (32.3, 36.0)	483 [34.8] (31.8, 37.7)	676 [33.6] (31.3, 36.0)	4,125 [36.0] (34.7, 37.4)	717 [34.6] (31.8, 37.3)	2,059 [36.0] (34.4, 37.6)	1,349 [40.1] (38.2, 41.9)

Characteristics	Combined[a] North Dakota and South Dakota (Unweighted *n*=3,624), unweighted *n* [weighted %] (95% CI)	North Dakota (Unweighted *n*=1,476), unweighted *n* [weighted %] (95% CI)	South Dakota (Unweighted *n*=2,148), unweighted *n* [weighted %] (95% CI)	Combined[a] Kansas, Michigan, and Rhode Island (unweighted *n*=10,886), unweighted *n* [weighted %] (95% CI)	Kansas (Unweighted *n*=1,971), unweighted *n* [weighted %] (95% CI)	Michigan (Unweighted *n*=5,565), unweighted *n* [weighted %] (95% CI)	Rhode Island (Unweighted *n*=3,350), unweighted *n* [weighted %] (95% CI)
Multiparous	2,465 [65.8] (64.0, 67.7)	993 [65.2] (62.3, 68.2)	1,472 [66.4] (64.0, 68.7)	6,701 [64.0] (62.6, 65.3)	1,254 [65.4] (62.7, 68.2)	3,054 [64.0] (62.4, 65.6)	1,943 [59.9] (58.1, 61.8)
Plurality							
Singleton	3,557 [98.3] (97.9, 98.8)	1,453 [98.8] (98.2, 99.4)	2,104 [97.9] (97.2, 98.5)	10,345 [98.2] (97.9, 98.4)	1,827 [98.7] (98.3, 99.0)	5,363 [98.1] (97.7, 98.4)	3,155 [98.2] (97.8, 98.5)
Twin	65 [1.6] (1.1, 2.0)	23 [1.2] (0.6,1.8)	42 [2.0] (1.4, 2.2)	527 [1.8] (1.5, 2.1)	143 [1.3] (1.0, 1.7)	197 [1.9] (1.6, 2.3)	187 [1.8] (1.4, 2.2)
Other multiple	2 [0.1] (0.0, 0.2)	0 –	2 [0.1] (0.0, 0.1)	14 [0.0] (0.0, 0.1)	1 [0.0] (0.0, 0.0)	5 [0.0] (0.0, 0.1)	8 [0.0] (0.0, 0.1)
Marital status							
Married	2,021 [64.8] (63.0, 66.6)	815 [65.2] (62.3, 68.2)	1,206 [64.5] (62.3, 66.7)	5,931 [60.5] (59.2, 61.8)	1,329 [64.1] (61.2, 66.9)	2,639 [60.1] (58.6, 61.7)	1,963 [55.8] (53.9, 57.7)
Not married	1,603 [35.2] (33.4, 37.0)	661 [34.8] (31.8, 37.7)	942 [35.5] (33.3, 37.7)	4,927 [39.5] (38.2, 40.8)	642 [35.9] (33.1, 38.8)	2,922 [39.9] (38.3, 41.4)	1,363 [44.2] (42.3, 46.1)
Insurance coverage for prenatal care							
Private	1,702 [65.4] (63.6, 67.2)	716 [66.2] (63.2, 69.3)	986 [64.7] (62.6, 66.8)	5,525 [59.7] (58.3, 61.1)	1,188 [63.7] (60.8, 66.7)	2,612 [59.1] (57.4, 60.8)	1,725 [57.3] (55.3, 59.3)
Medicaid	588 [13.8] (12.4, 15.2)	290 [15.2] (12.8, 17.6)	298 [12.4] (10.9, 14.0)	3,343 [29.1] (27.8, 30.4)	244 [13.2] (11.1, 15.4)	2,248 [32.4] (30.8, 33.9)	851 [29.2] (27.4, 31.1)
Other (military, IHS/tribal)	608 [9.8] (8.8, 10.8)	261 [10.4] (8.6, 12.2)	347 [9.3] (8.4, 10.1)	246 [2.1] (1.7, 2.4)	102 [5.9] (4.4, 7.3)	62 [1.2] (0.8, 1.6)	82 [2.7] (2.1, 3.4)
None	420 [11.0] (9.7, 12.3)	107 [8.2] (6.3, 10.0)	313 [13.7] (11.9, 15.4)	931 [9.1] (8.3, 10.0)	300 [17.2] (14.8, 19.6)	319 [7.3] (6.3, 8.3)	312 [10.7] (9.5, 12.0)

[a]ACE questions were not uniform across all the 5 states included in the analysis. States with identical questions were combined (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) to increase study power. In the combined data sets, only variables that were available and identical for all grouped states (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) were included in the ACE score calculation for combined analyses. ACE, adverse childhood experience; IHS, Indian Health Service; PRAMS, Pregnancy Risk Assessment Monitoring System.

Table 2.

Prevalence of ACEs Among Pregnancy Risk Assessment Monitoring System Participants, 2016–2018

ACEs[a]	Combined[b] North Dakota and South Dakota (unweighted *n*=3,624), unweighted *n* [weighted %[c]] (95% CI)	North Dakota (Unweighted *n*=1,476) unweighted *n* [weighted %[c]] (95% CI)	South Dakota (Unweighted *n*=2,148) Unweighted *n* [weighted %[c]] (95% CI)	Combined[b] Kansas, Michigan, and Rhode Island (Unweighted *n*=10,886) Unweighted *n* [weighted %[c]] (95% CI)	Kansas (Unweighted *n*=1,971) Unweighted *n* [weighted %[c]] (95% CI)	Michigan (Unweighted *n*=5,565) Unweighted *n* [weighted %[c]] (95% CI)	Rhode Island (Unweighted *n*=3,350) Unweighted *n* [weighted %[c]] (95% CI)
Abuse							
Emotional abuse	911 [24.5] (22.8, 26.2)	372 [23.7] (21.0, 26.4)	539 [25.2] (23.0, 27.4)				
Physical abuse	637 [16.2] (14.7, 17.6)	254 [14.9] (12.7, 17.1)	383 [17.3] (15.4, 19.2)				
Sexual abuse	523 [12.4] (11.1, 13.7)	209 [11.9] (9.9, 13.9)	314 [12.8] (11.2, 14.5)				
Neglect							
Physical neglect	288 [6.6] (5.6, 7.6)	111 [5.7] (4.3, 7.2)	177 [7.4] (6.1, 8.7)				
Emotional neglect[d]	623 [15.3] (13.9, 16.7)	231 [13.4] (11.3, 15.5)	392 [17.0] (15.2, 18.8)	936 [8.5] (7.7, 9.3)	173 [9.6] (7.8, 11.4)	492 [8.3] (7.3, 9.3)	271 [8.6] (7.5, 9.7)
Household challenges							
Witnessed intimate partner violence	547 [12.7] (11.4, 14.0)	230 [12.6] (10.6, 14.6)	317 [12.8] (11.2, 14.4)				
Substance abuse	1,135 [28.8] (27.0, 30.6)	475 [28.1] (25.3, 30.9)	660 [29.4] (27.2, 31.6)	1,715 [17.7] (16.5, 18.8)	378 [19.6] (17.2, 22.0)	863 [17.5] (16.1, 18.8)	474 [15.3] (13.9, 16.7)
Mental illness	891 [25.4] (23.6, 27.1)	363 [24.8] (22.1, 27.5)	528 [25.9] (23.7, 28.1)				
Parental separation or divorce	1,620 [40.8] (38.8, 42.7)	655 [39.2] (36.2, 42.3)	965 [42.2] (39.8, 44.6)	3,705 [34.8] (33.5, 36.2)	690 [34.6] (31.9, 37.4)	1,848 [34.7] (33.1, 36.4)	1,167 [36.2] (34.4, 38.1)
Incarcerated household member	454 [10.0] (8.9, 11.2)	162 [8.5] (6.8, 10.2)	292 [11.4] (10.0, 12.9)	1,255 [12.8] (11.8, 13.8)	256 [13.3] (11.3, 15.3)	703 [12.9] (11.7, 14.2)	296 [10.0] (8.8, 11.2)
Food insecurity				923 [8.3] (7.5, 9.1)	175 [9.0] (7.3, 10.7)	475 [8.2] (7.2, 9.1)	273 [8.5] (7.4, 9.6)
Housing instability				1,519 [14.7] (13.7, 15.8)	295 [15.7] (13.5, 17.9)	813 [14.7] (13.4, 15.9)	411 [13.4] (12.1, 14.8)
Lived in foster care				586 [4.8] (4.2, 5.3)	97 [4.9] (3.6, 6.1)	338 [4.7] (4.0, 5.4)	151 [5.1] (4.2, 6.0)
Number of ACEs[e]							
0	1,200 [39.4] (37.5, 41.4)	495 [40.5] (37.3, 43.6)	705 [38.4] (36.0, 40.9)	5,089 [50.4] (49.0, 51.8)	955 [49.5] (46.6, 52.4)	2,475 [50.5] (48.8, 52.3)	1,659 [50.8] (48.8, 52.7)

ACEs[a]	Combined[b] North Dakota and South Dakota (unweighted *n*=3,624), unweighted *n* [weighted %[c]] (95% CI)	North Dakota (Unweighted *n*=1,476) unweighted *n* [weighted %[c]] (95% CI)	South Dakota (Unweighted *n*=2,148) Unweighted *n* [weighted %[c]] (95% CI)	Combined[b] Kansas, Michigan, and Rhode Island (Unweighted *n*=10,886) Unweighted *n* [weighted %[c]] (95% CI)	Kansas (Unweighted *n*=1,971) Unweighted *n* [weighted %[c]] (95% CI)	Michigan (Unweighted *n*=5,565) Unweighted *n* [weighted %[c]] (95% CI)	Rhode Island (Unweighted *n*=3,350) Unweighted *n* [weighted %[c]] (95% CI)
1	708 [20.5] (18.9, 22.2)	303 [21.8] (19.1, 24.4)	405 [19.4] (17.4, 21.4)	2,679 [24.4] (23.1, 25.6)	445 [24.0] (21.4, 26.6)	1,394 [24.3] (22.8, 25.8)	840 [25.9] (24.2, 27.6)
≥1	2,223 [60.6] (58.6, 62.5)	913 [59.5] (56.4, 62.6)	1,310 [61.6] (59.1, 64.0)	5,227 [49.6] (48.2, 51.0)	959 [50.5] (47.6, 53.4)	2,712 [49.5] (47.7, 51.2)	1,556 [49.3] (47.3, 51.2)
2	399 [11.0] (9.7, 12.2)	156 [10.3] (8.5, 12.2)	243 [11.6] (9.9, 13.2)	1,167 [11.6] (10.7, 12.5)	222 [11.1] (9.3, 13.0)	609 [11.8] (10.6, 12.9)	336 [10.8] (9.6, 12.1)
≥3	1,116 [29.1] (27.3, 30.9)	454 [27.4] (24.6, 30.3)	662 [30.6] (28.3, 32.9)	1,381 [13.6] (12.6, 14.7)	292 [15.3] (13.2, 17.5)	709 [13.4] (12.2, 14.6)	380 [12.5] (11.2, 13.9)

[a]Blank cell indicates that the ACE was not assessed on that state's PRAMS survey.

[b]ACE questions were not uniform across all the 5 states included in the analysis. States with identical questions were combined (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) to increase study power. In the combined data sets, only variables that were available and identical for all grouped states (North Dakota, South Dakota *n*=10; Kansas, Michigan, Rhode Island *n*=7) were included in the ACE score calculation for combined analyses.

[c]Weighted percentages.

[d]Emotional neglect questions differed between states. North Dakota and South Dakota asked, *Did you 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?* Kansas, Michigan, and Rhode Island asked respondents whether the following experience occurred before the age of 13 years: *Most of the time, I had an adult who believed in me and who I could count on to help me.* This was reverse coded to calculate emotional neglect.

[e]ACE count data only calculated for participants with complete data on all ACEs. ACE, adverse childhood experience; PRAMS, Pregnancy Risk Assessment Monitoring System.

Table 3.

Health Outcome Prevalence by ACEs in North Dakota and South Dakota, Pregnancy Risk Assessment Monitoring System, 2016–2018

	Combined[a] North Dakota and South Dakota			North Dakota			South Dakota		
Outcome	**≥3 ACEs[b]**	**0 ACEs**	***p*-value[c]**	**≥3 ACEs[b]**	**0 ACEs**	***p*-value[c]**	**≥3 ACEs[b]**	**0 ACEs**	***p*-value[c]**
Unwanted pregnancy, %[d] (95% CI)	10.7 (8.1, 13.2)	4.2 (2.7, 5.7)	**<0.0001**	10.0 (6.0, 14.0)	5.5 (2.7, 8.2)	0.07	11.3 (7.9, 14.6)	3.1 (1.7, 4.5)	**<0.0001**
PNC									
Adequate PNC by Kotelchuck or Kessner index, %[b] (95% CI[c])	74.4 (71.4, 77.4)	83.3 (80.9, 85.7)	**<0.0001**	74.1 (69.1, 79.0)	80.7 (76.7, 84.8)	**0.045**	74.7 (71.0, 78.3)	85.8 (83.1, 88.4)	**<0.0001**
Pregnancy-related behaviors and experiences									
Physical abuse during pregnancy, %[b] (95% CI[c])	9.0 (7.0, 11.0)	0.6 (0.2, 1.0)	**<0.0001**	7.9 (5.1, 10.8)	0.4 (0.0, 0.8)	**<0.0001**	9.9 (7.2, 12.6)	0.8 (0.1, 1.4)	**<0.0001**
Smoking during the last 3 months of pregnancy, %[b] (95% CI[c])	24.3 (21.2, 27.5)	3.9 (2.5, 5.3)	**<0.0001**	27.5 (22.1, 33.0)	5.9 (3.4, 8.5)	**<0.0001**	21.7 (18.0, 25.4)	1.9 (0.7, 3.1)	**<0.0001**
Depression during pregnancy, %[b] (95% CI[c])	29.4 (26.0, 32.7)	6.0 (4.3, 7.6)	**<0.0001**	28.3 (22.8, 33.8)	7.1 (4.5, 9.8)	**<0.0001**	30.2 (26.0, 34.4)	4.8 (2.9, 6.7)	**<0.0001**
Pregnancy-related conditions									
Gestational diabetes, %[b] (95% CI[c])	10.3 (8.1, 12.4)	8.6 (6.9, 10.3)	0.25	9.3 (5.7, 12.9)	7.4 (4.9, 9.9)	0.41	11.1 (8.4, 13.7)	9.7 (7.4, 12.1)	0.47
Gestational hypertension, pre-eclampsia, or eclampsia, %[b] (95% CI[c])	13.6 (11.1, 16.1)	9.9 (8.0, 11.9)	**0.02**	10.8 (7.2, 14.3)	9.7 (6.7, 12.6)	0.64	16.0 (12.5, 19.4)	10.2 (7.7, 12. 7)	**0.009**
Birth outcomes									
Small for gestational age, %[b] (95% CI[c])	8.4 (6.3, 10.6)	7.7 (6.0, 9.5)	0.62	8.8 (5.2, 12.3)	5.0 (2.7, 7.3)	0.09	8.2 (5.8, 10.8)	10.4 (7.8, 13.0)	0.24
Large for gestational age, %[b] (95% CI[c])	12.4 (9.9, 14.9)	9.3 (7.4, 11.1)	**0.049**	14.3 (9.8, 18.7)	9.0 (6.2, 11.8)	**0.049**	10.9 (8.1, 13.7)	9.5 (7.1, 11.9)	0.47
Low birth weight, %[b] (95% CI[c])	5.8 (4.2, 7.4)	5.3 (3.9, 6.7)	0.65	5.3 (2.8, 7.7)	4.7 (2.6, 6.7)	0.73	6.2 (4.1, 8.3)	5.9 (4.1, 7.7)	0.82
Preterm (gestational age <37 weeks), %[b] (95% CI[c])	9.0 (7.0, 11.0)	7.7 (6.1, 9.4)	0.35	8.5 (5.4, 11.5)	7.1 (4.5, 9.6)	0.49	9.4 (6.8, 12.1)	8.4 (6.2, 10.5)	0.55
Breastfeeding									
Ever breastfed, %[b] (95% CI[c])	85.7 (83.1, 88.4)	92.0 (90.3, 93.8)	**0.0001**	83.2 (78.7, 87.8)	91.6 (88.7, 94.4)	**0.003**	87.8 (84.9, 90.8)	92.5 (90.4, 94.6)	**0.01**

Note: Boldface indicates statistical significance ($p<0.05$).

[a] ACEs questions were not uniform across all the 5 states included in the analysis. States with identical questions were combined (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) to increase study power. In the combined data sets, only variables that were available and identical for all grouped states (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) were included in the ACE score calculation for combined analyses.

[b] ACE count data only calculated for participants with complete data on all ACEs.

[c] *p* derived from chi-square test.

[d] Weighted percentages. ACE, adverse childhood experience; PNC, prenatal care.

Table 4.

Health Outcome Prevalence by ACEs in Kansas, Michigan, and Rhode Island, Pregnancy Risk Assessment Monitoring System, 2016–2018

Outcomes	Combined[a] Kansas, Michigan, and Rhode Island			Kansas			Michigan			Rhode Island		
	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]
Unwanted pregnancy, %[d] (95% CI)	12.0 (9.3, 14.8)	4.3 (3.5, 5.1)	**<0.0001**	13.7 (7.7, 19.7)	4.2 (2.5, 5.9)	**0.004**	11.6 (8.2, 15.0)	4.3 (3.3, 5.3)	**<0.0001**	12.0 (7.9, 16.2)	4.4 (3.2, 5.6)	**0.0007**
PNC												
Adequate PNC by Kotelchuck or Kessner index, %[b] (95% CI[C])	77.8 (74.5, 81.1)	85.4 (84.1, 86.8)	**<0.0001**	80.4 (74.1, 86.7)	90.7 (88.2, 93.2)	**0.004**	78.2 (74.2, 82.3)	85.8 (84.1, 87.5)	**0.0009**	65.3 (60.2, 70.9)	69.3 (66.9, 71.8)	0.22
Pregnancy-related behaviors and experiences												
Physical abuse during pregnancy, %[b] (95% CI[C])	7.1 (5.0, 9.2)	1.2 (0.8, 1.6)	**<0.0001**	5.9 (2.3, 9.5)	1.1 (0.3, 1.8)	**0.01**	7.6 (4.9, 10.2)	1.2 (0.7, 1.7)	**<0.0001**	5.8 (3.1, 8.4)	1.0 (0.5, 1.6)	**0.0007**
Smoking during the last 3 months of pregnancy, %[b] (95% CI[C])	22.3 (18.8, 25.8)	4.4 (3.5, 5.2)	**<0.0001**	21.3 (14.8, 27.7)	4.5 (2.5, 5.9)	**<0.0001**	22.9 (18.6, 27.3)	4.5 (3.5, 5.5)	**<0.0001**	18.3 (13.8, 22.7)	3.2 (2.2, 4.2)	**<0.0001**
Depression during pregnancy, %[b] (95% CI[C])	29.7 (26.0, 33.4)	9.4 (8.2, 10.6)	**<0.0001**	33.7 (26.3, 41.0)	10.1 (7.7, 12.6)	**<0.0001**	28.7 (24.2, 33.3)	9.3 (7.8, 10.7)	**<0.0001**	29.0 (23.5, 32.7)	9.5 (7.9, 11.1)	**<0.0001**
Pregnancy-related conditions												
Gestational diabetes, %[b] (95% CI[C])	9.0 (6.7, 11.3)	9.0 (7.9, 10.1)	0.99	7.4 (3.9, 10.9)	8.3 (6.1, 10.5)	0.67	9.4 (6.5, 12.3)	9.1 (7.7, 10.5)	0.85	8.9 (5.5, 12.2)	9.5 (8.0, 11.1)	0.73
Gestational hypertension, pre-eclampsia, or eclampsia, %[b] (95% CI[C])	16.3 (13.4, 19.1)	11.4 (10.1, 12.6)	**0.003**	21.0 (14.7, 27.2)	11.2 (8.8, 13.6)	**0.005**	15.7 (12.2, 19.3)	11.7 (10.2, 13.2)	**0.04**	9.1 (6.0, 12.2)	8.3 (6.9, 9.7)	0.64
Birth outcomes												
Small for gestational age, %[b] (95% CI[C])	9.0 (6.9, 11.0)	8.8 (7.7, 9.8)	0.86	10.7 (6.0, 15.5)	8.2 (6.1, 10.3)	0.34	8.5 (6.1, 10.9)	8.7 (7.5, 10.0)	0.84	9.7 (6.7, 12.7)	10.3 (8.8, 11.8)	0.72
Large for gestational age, %[b] (95% CI[C])	9.4 (7.0, 11.9)	10.8 (9.5, 12.1)	0.33	9.2 (4.6, 13.7)	13.8 (10.9, 16.6)	0.10	9.4 (6.3, 12.4)	10.1 (8.6, 11.7)	0.68	10.8 (7.1, 14.5)	11.6 (9.8, 13.3)	0.71
Low birth weight, %[b] (95% CI[C])	8.7 (7.5, 9.8)	6.5 (6.1, 6.9)	**0.002**	7.4 (6.0, 8.9)	5.7 (5.2, 6.2)	**0.03**	9.1 (7.6, 10.7)	6.7 (6.2, 7.2)	**0.007**	6.8 (5.8, 7.8)	6.2 (5.9, 6.6)	0.33

Outcomes	Combined[a] Kansas, Michigan, and Rhode Island			Kansas			Michigan			Rhode Island		
	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]	3+ ACEs[b]	0 ACEs	*p*-value[c]
Preterm (gestational age <37 weeks), %[b] (95% CI[c])	11.2 (9.0, 13.3)	7.5 (6.7, 8.3)	**0.002**	10.1 (6.1, 14.1)	6.7 (5.4, 8.0)	0.11	11.6 (8.9, 14.2)	7.8 (6.8, 8.8)	**0.01**	9.4 (6.7, 12.1)	6.5 (5.6, 7.4)	**0.048**
Breastfeeding												
Ever breastfed, %[b] (95% CI[c])	85.1 (82.2, 88.0)	88.3 (87.1, 89.6)	0.05	88.8 (83.6, 93.9)	90.2 (87.6, 92.7)	0.61	84.2 (80.5, 87.9)	87.7 (86.1, 89.3)	0.09	85.4 (81.1, 89.7)	90.7 (89.1, 92.3)	**0.03**

Note: Boldface indicates statistical significance ($p<0.05$).

[a] ACEs questions were not uniform across all 5 states included in the analysis. States with identical questions were combined (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) to increase study power. In the combined data sets, only variables that were available and identical for all grouped states (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) were included in the ACE score calculation for combined analyses.

[b] ACE count data only calculated for participants with complete data on all ACEs.

[c] *p* derived from chi-square test.

[d] Weighted percentages. ACE, adverse childhood experience; PNC, prenatal care.

Table 5.

Adjusted Associations Between Outcomes and Adverse Childhood Experiences, Pregnancy Risk Assessment Monitoring System, 2016–2018

Outcomes	Combined[a] North Dakota and South Dakota Adjusted prevalence ratio (95% CI)[b] Adverse Childhood Experiences Score[c]				Combined[a] Kansas, Michigan, and Rhode Island Adjusted prevalence ratio (95% CI)[b] Adverse Childhood Experiences Score[c]			
	Unweighted n	1	2	≥3	Unweighted n	1	2	≥3
Unwanted pregnancy[d]	2,284	1.3 (0.8, 2.2)	2.2 (1.2, 3.8)	2.0 (1.2, 3.3)	7,027	1.4 (1.04, 2.0)	1.9 (1.3, 2.8)	2.1 (1.5, 3.0)
PNC								
Adequate PNC by Kotelchuck or Kessner Index	3,583	1.0 (0.9, 1.01)	0.9 (0.87, 0.99)	1.0 (0.95, 1.1)	10,450	1.0 (0.95, 1.01)	1.0 (0.97, 1.1)	1.0 (0.9, 1.02)
Pregnancy-related behaviors and experiences								
Physical abuse during pregnancy	3,564	2.3 (0.9, 5.8)	3.6 (1.4, 9.1)	7.9 (3.6, 17.3)	10,420	2.2 (1.3, 3.6)	2.3 (1.3, 3.9)	3.6 (2.2, 5.8)
Smoking during the last 3 months of pregnancy	3,564	2.5 (1.5, 4.1)	2.6 (1.5, 4.4)	4.2 (2.7, 6.6)	10,362	1.9 (1.4, 2.6)	2.6 (1.9, 3.6)	2.9 (2.2, 4.0)
Depression during pregnancy	3,513	1.8 (1.2, 2.6)	2.5 (1.7, 3.7)	3.5 (2.5, 4.8)	10,350	1.3 (1.0, 1.6)	1.6 (1.3, 2.1)	2.3 (1.8, 2.8)
Pregnancy-related conditions								
Gestational diabetes	3,539	1.3 (0.9, 1.8)	1.2 (0.8, 1.8)	1.3 (0.9, 1.9)	10,375	1.0 (0.8, 1.3)	1.0 (0.7, 1.4)	1.2 (0.8, 1.6)
Gestational hypertension, pre-eclampsia, or eclampsia	3,525	0.9 (0.6, 1.3)	1.2 (0.8, 1.8)	1.3 (0.97, 1.8)	10,382	1.1 (0.9, 1.3)	1.2 (0.9, 1.5)	1.4 (1.1, 1.8)
Neonatal outcomes								
Small for gestational age	3,498	1.3 (0.8, 1.9)	1.6 (1.02, 2.6)	1.2 (0.8, 1.7)	9,904	1.0 (0.8, 1.3)	1.0 (0.7, 1.4)	0.9 (0.7, 1.2)
Large for gestational age	3,498	1.2 (0.9, 1.7)	1.2 (0.8, 1.9)	1.2 (0.9, 1.7)	9,904	1.3 (1.03, 1.6)	1.0 (0.7, 1.3)	1.0 (0.8, 1.4)
Low birth weight (<2,500 g)	3,581	0.7 (0.4, 1.2)	1.0 (0.5, 1.8)	0.9 (0.6, 1.4)	10,443	1.1 (0.9, 1.2)	1.0 (0.9, 1.3)	1.1 (0.9, 1.3)
Preterm (gestational age <37 weeks)	3,578	1.0 (0.6, 1.4)	0.8 (0.5, 1.4)	1.0 (0.7, 1.4)	10,444	1.0 (0.8, 1.2)	1.0 (0.8, 1.4)	1.3 (1.0, 1.7)
Breastfeeding								
Ever breastfed	3,473	1.0 (0.98, 1.05)	1.0 (0.95, 1.05)	1.0 (0.97, 1.05)	10,162	1.0 (0.99, 1.1)	1.0 (0.99, 1.1)	1.0 (0.99, 1.1)

[a] ACE questions were not uniform across all the 5 states included in the analysis. States with identical questions were combined (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) to increase study power.

[b] Model covariates include participant age, race/ethnicity, marital status, parity, education, and insurance status (as a proxy for income). The ref is 0 ACEs.

[c] In the respective combined data sets, only variables that were available for all grouped states (North Dakota, South Dakota; Kansas, Michigan, Rhode Island) were included in the ACE score calculation for combined analyses.

[d] Respondents who were unsure whether the pregnancy was wanted were excluded from the analysis. ACE, adverse childhood experience; PNC, prenatal care.