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Association Between Adverse Childhood Experience Scores and Sexually Transmitted Infections in Pregnant and Postpartum People

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Adverse childhood experiences (ACEs) are associated with numerous adverse health outcomes, including risky sexual behaviors and sexually transmitted infections (STIs) in non-pregnant individuals. However, limited data exist on the relationship between high ACE scores (≥ 4) and STIs during pregnancy. This study evaluated the association between high ACE scores and STI positivity among 855 pregnant and postpartum individuals. Using logistic regression, we assessed STI diagnoses (lower genital tract infections, HIV, syphilis, HSV, and hepatitis C) relative to ACE scores. Results indicated that high ACE scores were associated with increased odds of lower genital tract infection during pregnancy in univariate analysis but not in adjusted models. Additionally, no significant association was found between high ACE scores and overall STI positivity or hepatitis C infection. While high ACE scores were prevalent in the cohort (37%), further research is needed to determine if ACE scores can be used in screening for STIs during pregnancy.

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Adverse childhood experiences (ACEs) are potentially traumatic events experienced by an individual before the age of 18 (Felitti et al., 1998). These can include different forms of neglect, abuse, and household challenges such as mental illness, substance use, or incarceration of a family member. ACE scores are determined by administering a questionnaire with ten questions regarding exposure to abuse, neglect, or adverse events before the age of 18. Each positive response receives a point, which is tallied to determine an individual's total ACE score (Petruccelli et al., 2019). Unfortunately, nearly two-thirds of adults in the United States report at least one ACE, and approximately one in six reports four or more ACEs (Merrick, 2019; Swedo, 2023). Previous studies have established that reporting four or more ACEs is associated with adverse health outcomes, including mental illness, alcohol and illicit substance use, stroke, diabetes, and obesity (Felitti et al., 1998; Hughes et al., 2017; Petruccelli et al., 2019).

Additionally, a high ACE score (≥ 4) has been associated with higher odds of risky sexual behaviors in non-pregnant people. Those reporting a high ACE score were 4.3 times (95% CI 3.425 - 5.327, $p < 0.001$) more likely to report sexual activity before age 16 (Felitti et al., 1998; Wood et al., 2022). A history of childhood sexual abuse has been associated with engaging in transactional sex (OR 2.71, 95% CI 2.17 – 3.38) (Cohen et al., 2000). High ACE scores and engagement in risky sexual behaviors have been associated with higher rates of sexually transmitted infections (STIs) in non-pregnant people. Previous studies have reported that a high ACE score had 1.36 to 7.1 times higher odds of STI(s) (Felitti et al., 1998; London et al., 2017; Loxton et al., 2021; Wood et al., 2022). Limited data are available regarding the relationship between high ACE scores and STIs in pregnant people. For postpartum people, exposure to ≥ 1 ACE was not significantly associated with STI diagnosis (adjusted OR = 1.43 95%, CI = 0.42, 4.84) (Thomas et al., 2021). Another small observational study of pregnant people ($n = 52$) did not find a significant association between high ACE and STI diagnosed during pregnancy (29.7% vs 24.4%, $p = 0.415$) (Jasthi et al., 2023).

STIs during pregnancy are associated with adverse pregnancy outcomes, including low birth weight, preterm birth, and infant death (He et al., 2020; Heumann et al., 2017; Johnson et al., 2011; Lin et al., 2018; Panel on Treatment of HIV During Pregnancy and Prevention of Perinatal Transmission, 2022; Tang et al., 2020; Van Gerwen et al., 2021). Identification and treatment of STIs during pregnancy improves pregnancy outcomes, and delayed treatment may result in preterm birth (Brandenburger & Ambrosino, 2021). The American College of Obstetricians and Gynecologists and the Center for Disease Control and Prevention have established guidelines for STI screening during pregnancy (Davidson et al., 2021; Prevention, 2021). In pregnancy, universal screening is recommended for HIV, hepatitis B, hepatitis C, and syphilis. Additionally, screening for gonorrhea and chlamydia is recommended for those < 25 years old and those > 25 years old at high risk for STI acquisition.

While current guidelines include screening for a variety of STIs based on individual history and risk, people with STIs during pregnancy may be missed using traditional screening paradigms. By evaluating the relationship between STIs and high ACE scores, an alternative method to identify pregnant individuals at risk of STIs may be elucidated. Currently, it is unclear if ACE scores can be used as a tool to determine which pregnant people are at risk for an STI. More information is needed to determine the potential relationship between high ACE scores and STI infections in pregnancy. Our primary aim was to evaluate the association between high ACE scores and STIs during pregnancy. Our secondary aims included identifying factors associated with lower genital tract infection (gonorrhea, chlamydia, and trichomonas positive), any STI positivity (lower genital tract infection, HIV, syphilis, and herpes simplex virus (HSV) positive), and hepatitis C infection (chronic or resolved) during pregnancy or in postpartum people.

Method

Patients were not involved in this retrospective cohort study, and personal health information was not collected as part of our protocol. This study was a retrospective cohort study of pregnant and postpartum people within one year of delivery. The study included 855 participants recruited between 2015 and 2019 as part of an IRB-approved behavioral health study of pregnant and postpartum people. A secondary analysis was conducted in which all participants were pregnant or postpartum and receiving care with our Women's

Behavioral Health Services. Participants were universally screened. We examined ACE scores and STI positivity in a population of pregnant people undergoing mental health screening. In the initial data collection, behavioral health specialists collected mental health outcomes, screening, and ACE scores. We obtained IRB approval to collect additional variables related to STI in this cohort.

Descriptive variables collected for participants included age, self-reported race and ethnicity, insurance status, relationship status (single versus partnered), income, and education. Behavioral health specialists collected adverse childhood experience scores, depression scores (Patient Health Questionnaire, PHQ9) , anxiety scores (General Anxiety Disorder – 7 item, GAD-7), and mania scores (Altman Self-Rating Mania Scale, ASRM). STI diagnoses were determined through a chart review of the participants' current or recent pregnancies. A high ACE score was defined as greater than or equal to 4. We used bivariate analyses to compare percentages of individuals with high vs. low ACE scores. We used logistic regression to determine if factors, including high ACE, were associated with lower genital tract infection (gonorrhea, chlamydia, and trichomonas positive), any STI positivity (lower genital tract infection, HIV, syphilis, and HSV positive), and hepatitis C infection (chronic and resolved). Individuals with data available on the outcome of interest were included in the analyses, reducing the overall sample size.

Results

Demographic results for the sample are listed below in Table 1. The median ACE score was 2 (interquartile range, IQR of 1-5). Over one-third of participants had a high ACE score (300/808, 37%). Most participants reside in the three counties surrounding our academic medical center in Charleston, South Carolina (n = 570, 80%). Most participants had commercial insurance, and 44% had Medicaid or were uninsured. Most participants identified as non-Hispanic (95%) ethnicity; 71% identified as white and 28% as Black. The median age of participants was 29 (IQR 25-33). Less than half of participants (43%) had a low household annual income (< $25,000).

Table 1

Demographic Information of Participants

Variable	***n* (%)**
Latina/Hispanic Ethnicity	
Yes	43 (5%)
No	822 (95%)
Missing	33
Race	
White	589 (71%)
Black	229 (28%)
Other	14 (1.7%)
Missing	23
Age (Median 29, IQR 25-33)	
< 25	184 (22%)
≥ 25	661 (78%)
Missing	13
ACE Score	
Low ACE (≤ 4)	508 (63%)
High ACE (≥ 4)	300 (37%)
Missing	47
Tricountry Resident	
Yes	570 (80%)
No	141 (20%)
Missing	144

Variable	*n* (%)
Medicaid or No Insurance	
Yes	372 (44%)
No	483 (57%)
Relationship Status	
Single	122 (15%)
Partnered	706 (85%)
Missing	30
Education	
Some college or more	383 (49%)
High school or less	403 (51%)
Missing	72
Income	
< $25,000	331 (43%)
> $25,000	443 (57%)
Missing	84
Tobacco Use	
Yes	125 (33%)
No	256 (67%)
Missing	477

Note. Other: Asian, Native Hawaiian and Pacific Islander, and Native American Tricountry Resident: Charleston, Berkeley, and Dorchester Counties in South Carolina. IQR, Interquartile range; ACE, Adverse Childhood Experience

HSV was most often reported as positive during pregnancy, with a large number of missing results reported. The remaining STI results are below in Table 2, and missing data was noted for participants across each diagnosis. In

general, missing data was common regarding STI results in pregnancy, ranging from 213 to 833 missing values depending on the diagnosis.

Table 2

Sexually Transmitted Infection Prevalence

Variable	Yes, *n* (%)	No, *n* (%)	Missing, *n*
HSV + During Pregnancy	95 (53%)	126 (47%)	676
HIV + at Initial Visit	7 (1.1%)	633 (98.9%)	215
HCV Ab + During Pregnancy	22 (10%)	212 (90%)	643
Chronic HCV Infection	12 (55%)	10 (45%)	833
Syphilis Infection	3 (0.5%)	642 (99.5%)	213
Chlamydia Infection	23 (4%)	578 (96%)	277
Gonorrhea Infection	4 (0.7%)	577 (99.3%)	278
Trichomonas Infection	17 (8%)	227 (92%)	628
Lower Genital Tract Infection	41 (7%)	537 (93%)	277

Note. Chronic HCV: chronic hepatitis c virus infection; positive hepatitis C antibody and detectable viral load. Lower genital tract infection: chlamydia, gonorrhea, or trichomonas positive at initial prenatal visit. HSV, herpes simplex virus; HIV, human immunodeficiency virus; HCV, hepatitis C virus

Lower genital tract infection was more often diagnosed during pregnancy in those with a high ACE score compared to those without (54% vs. 37%, p = 0.04). Additionally, lower genital tract infection was diagnosed more frequently for those with Medicaid or no insurance (76% vs. 53%, p = 0.005), tobacco use (54% vs. 31%, p = 0.018), single relationship status (36% vs. 15%, p = 0.0004), and income < $25,000 (97% vs. 45%, p < 0.0001) (Table 3). In the univariate logistic regression analysis, a high ACE score was associated with increased odds of lower genital tract infection (unadjusted OR 2.034 CI 1.040 – 3.979, p = 0.038), but this finding was not statistically significant in the adjusted analysis (aOR 1.296 CI 0.484-3.468, p = 0.606) (Table 4). Factors associated with lower genital tract infection in the adjusted analysis were age <

25 years old (aOR 2.858 CI 1.054-7.753, $p = 0.029$) and income < $25,000 (aOR 11.361 CI 1.249-103.354, $p = 0.031$). Medicaid or no insurance was associated with lower odds of lower genital tract infection (aOR 0.256 CI 0.075-0.876, $p = 0.029$).

Those with a high ACE score were not more often diagnosed with any STI positivity (44% vs 37%, $p = 0.152$). Any STI positivity was diagnosed more often in those with Medicaid or no insurance (71% vs. 50%, $p < 0.0001$), age < 25 years old (35% vs. 21%, $p = 0.001$), tobacco use (44% vs. 30%, $p = 0.039$), income < $25,000 (67% vs 43%, $p < 0.0001$), and single relationship status (28% vs 13%, $p < 0.0001$). STI positivity was less often diagnosed among those with some college education or more (30% vs. 48%, $p = 0.001$) and those residing in the Tricounty area (76% vs. 84%, $p = 0.043$) (Table 3). None of these factors were significantly associated with STI positivity in adjusted analyses. On univariate and adjusted logistic regression analysis, high ACE score was not associated with increased odds of STI positivity (uaOR 1.341 CI 0.897 – 2.005, $p = 0.153$ and aOR 1.100 CI 0.578-2.095, $p = 0.77$) (Table 4).

Table 3

Lower Genital Tract Infection and Any STI Positivity

Variable	**Lower Genital Tract Infection (*n* = 41)**	**No Lower Genital Tract Infection (*n* = 537)**	***p*-value**
High ACE (*n* = 208)	20/37 (54%)	188/513 (37%)	0.04
Medicaid or No Insurance (*n* = 314)	31/41 (76%)	283/537 (53%)	0.005
Black Race (*n* = 152)	8/40 (20%)	144/522 (28%)	0.297
White Race (*n* = 402)	32/40 (80%)	370/522 (71%)	0.222
Latina/Hispanic Ethnicity (*n* = 31)	0/41 (0%)	31/537 (6%)	0.109
Tricounty Resident (*n* = 475)	30/41 (73%)	445/533 (83%)	0.092
Age < 25 (*n* = 141)	23/39 (59%)	118/535 (22%)	< 0.001
Tobacco Use (*n* = 99)	15/28 (54%)	84/267 (31%)	0.018
Single (*n* = 90)	14/39 (36%)	76/524 (15%)	0.0004
Some College or More (*n* = 239)	3/34 (9%)	236/505 (47%)	< 0.001
Income < $25,000 (*n* = 259)	33/34 (97%)	226/498 (45%)	< 0.001
Variable	**STI Positivity *n* (%)**	**No STI Positivity *n* (%)**	***p*-value**
High ACE (≥ 4) (*n* = 215)	55/126 (44%)	160/437 (37%)	0.152
Medicaid or No Insurance (*n* = 324)	93/132 (71%)	231/460 (50%)	< 0.0001
White Race (*n* = 411)	100/128 (78%)	311/447 (70%)	0.0589
Latina/Hispanic Ethnicity (*n* = 31)	6/126 (4%)	26/440 (6%)	0.398
Tricounty Resident (*n* = 483)	99/130 (76%)	384/458 (84%)	0.0434

Variable	Lower Genital Tract Infection (*n* = 41)	No Lower Genital Tract Infection (*n* = 537)	*p*-value
Age < 25 (*n* = 143)	46/130 (35%)	97/458 (21%)	0.0009
Tobacco Use (*n* = 101)	31/71 (44%)	70/230 (30%)	0.039
Single (*n* = 96)	36/127 (28%)	60/450 (13%)	< 0.0001
Some College or More (*n* = 243)	36/119 (30%)	207/432 (48%)	0.0006
Income < $25,000 (*n* = 264)	79/118 (67%)	185/427 (43%)	< 0.0001

Note. Lower genital tract infection and any STI positivity on bivariate analysis. Lower genital tract infection: Chlamydia, gonorrhea, and trichomonas positive at initial prenatal visit. Tricounty Resident: Charleston, Berkeley, and Dorchester Counties in South Carolina. Any STI positivity: lower genital tract infection, HIV, syphilis, or HSV positive at any time during pregnancy.
Significant at $p < .05$. Highly significant at $p < .0001$.

Table 4

Logistic Regression Analysis for Factors Associated with Lower Genital Tract Infection and Any STI Positivity

Variable	**uaOR (95% CI) Lower genital tract infection**	***p*-value**	**aOR (95% CI) Lower genital tract infection**	***p*-value**
High ACE	2.034 (1.040, 3.979)	0.038	1.296 (0.484, 3.468)	0.606
Medicaid or No Insurance	2.782 (1.337, 5.788)	0.0045	0.256 (0.075, 0.876)	0.0299
White Race	1.643 (0.740, 3.648)	0.222	1.738 (0.664, 4.551)	0.26
Tricounty Resident	0.539 (0.261, 1.117)	0.096	1.680 (0.521, 5.418)	0.3851
Age < 25	5.080 (2.600, 9.927)	< 0.0001	2.858 (1.054, 7.753)	0.0392
Tobacco Use	2.514 (1.145, 5.519)	0.022	1.754 (0.592, 5.200)	0.3108
Single	3.301 (1.643, 6.634)	0.0008	1.515 (0.540, 4.251)	0.4297
Some College or More	0.110 (0.033, 0.366)	0.0003	0.164 (0.019, 1.395)	0.0979
Income < $25,000	39.717 (5.390, 292.661)	0.0003	11.361(1.249, 103.354)	0.0310
Variable	**uaOR (95% CI) Any STI**	***p*-value**	**aOR (95% CI) Any STI**	***p*-value**
High ACE Score	1.341 (0.897, 2.005)	0.1527	1.100 (0.578, 2.095)	0.77
Medicaid or No Insurance	2.364 (1.559, 3.584)	< 0.0001	0.942 (0.421, 2.104)	0.88
White Race	1.561 (0.981, 2.486)	0.0604	1.142 (0.572, 2.280)	0.71
Tricounty Resident	0.615 (0.383, 0.988)	0.0445	0.678 (0.332, 1.388)	0.29
Age < 25	2.038 (1.334, 3.113)	0.001	1.465 (0.732, 2.930)	0.28

Variable	uaOR (95% CI) Any STI	*p*-value	aOR (95% CI) Any STI	*p*-value
Tobacco Use	1.772 (1.026, 3.061)	0.0403	1.340 (0.671, 2.677)	0.41
Single	2.571 (1.604, 4.123)	< 0.0001	1.778 (0.857, 3.690)	0.12
Some College or More	0.471 (0.305, 0.728)	0.0007	0.831 (0.368, 1.879)	0.66
Income < $25,000	2.650 (1.726, 4.068)	< 0.0001	1.802 (0.749, 4.335)	0.19

Note. Lower genital tract infection and any STI positivity on bivariate analysis. Lower genital tract infection: Chlamydia, gonorrhea, and trichomonas positive at initial prenatal visit. Tricounty Resident: Charleston, Berkeley, and Dorchester Counties in South Carolina. Any STI positivity: lower genital tract infection, HIV, syphilis, or HSV positive at any time during pregnancy.
Significant at $p < .05$. Highly significant at $p < .0001$.

Hepatitis C, either resolved or chronic, was diagnosed in 10.4% (22/212) of participants. Hepatitis C was diagnosed more often with Medicaid or no insurance (95% vs. 67%, $p = 0.006$), income < $25,000 (94% vs 60%, $p = 0.007$), and those reporting tobacco use (76% vs. 41%, $p = 0.006$). In the adjusted analyses, tobacco use was the only factor associated with hepatitis C infection (aOR 8.8 CI 1.7 – 45.4, $p = 0.009$).

Discussion

Adverse childhood experiences were common in our population of pregnant and postpartum people, with 37% reporting four or more ACEs. A high ACE score was associated with an increased risk of lower genital tract infection during pregnancy on bivariate analysis, but the association was not statistically significant in adjusted analyses. High ACE scores were not significantly associated with any STI positivity or hepatitis C during pregnancy. Our findings are similar to those of a recent study that evaluated the association between high ACE scores and adverse pregnancy outcomes, including STIs during pregnancy (Jasthi et al., 2023).

Currently, there is insufficient evidence to support the use of ACE scores as a tool for identifying people at risk for an STI during pregnancy. Based on our results, ACE score is not significantly associated with STI diagnosis during

pregnancy, limiting its possible use as a screening tool for STIs. Further research is needed to determine if ACE scores can be adopted to identify people at risk for an STI diagnosis. Future studies could include a retrospective larger sample size with fewer missing data or prospective studies obtaining a baseline ACE score in pregnancy and following for new STI diagnosis. The Centers currently recommend STI screening strategies for individuals under the age of 25 for Disease Control, and our study further supports this as a means of identifying higher-risk individuals (Prevention, 2021).

While our study included over 800 participants, missing data reduced our sample size when assessing lower genital tract infection, STI positivity, and hepatitis. Our sample collection started before recommendations for universal screening for hepatitis C infection in each pregnancy. The smaller sample size available for adjusted analyses likely contributed to the lack of statistically significant associations between high ACE scores and sexually transmitted infections and hepatitis in pregnancy.

Conclusion

Adverse childhood events have been associated with reporting risky behaviors, including condomless sex, transactional sex, and a higher number of lifetime partners (Cohen et al., 2000; Felitti et al., 1998; Thomas et al., 2021). This translates to an increased risk of STI acquisition outside of pregnancy. Based on our analyses and the limited literature published, this association has not been found in pregnancy. More studies are needed to fully elucidate the relationship between STIs in pregnancy and high ACE scores to determine if ACE scores can be utilized in risk-based screening strategies.

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