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Original Clinical Investigations

Effect of Maternal Adverse Childhood Experiences (ACEs) and Maternal Resiliency on Early Childhood Outcomes on Vaccination Adherence and Emergency Department Visits

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Introduction

Adverse Childhood Experiences (ACEs) are traumatic events that occurred to an individual during ages 0-17 years. The 1998 Adverse Childhood Experiences (ACE) suggested higher ACE scores contributed to negative future health outcomes. The tool is now used to screen at-risk populations for the development of chronic health conditions. Protective factors, such as resilience, were later studied and found to offset the negative health impacts of traumatic childhood events. The 7Cs questionnaire was a tool developed to measure resilience in adolescents and demonstrated better health outcomes despite the presence of higher ACE scores. This pilot study evaluated whether higher maternal ACEs would result in more frequent pediatric ED visits and less vaccination adherence and whether higher 7Cs would be protective.

Methods

This IRB approved study recruited pregnant women and new mothers in a tertiary NJ urban hospital, between their second trimester and their child's one month well visit at the pediatric clinic. All subjects completed the Adverse Childhood Events (ACEs) survey, 7Cs resilience tool, and a Maternal Health questionnaire at the time of recruitment. A review of children's electronic medical records was conducted at 2-, 4-, 6-, and 12-months to evaluate pediatric outcomes, adherence to AAP recommended vaccine schedule and emergency department visits.

Results

Total of 34 women were enrolled, their and their children's medical and demographic data collected. There was no difference in higher ACE scores and number of ED visits for the babies (OR 0.9645 [CI 0.7643 - 1.2172]), with no effect seen with higher resilience scores and number of ED visits (OR 0.8477 [0.6192 – 1.1604]). Increase in ACE scores resulted in reduction in vaccination adherence (OR 0.3555 [CI 0.1417 – 0.8923]). Increase in resilience scores decreased vaccination adherence by 44% (OR 0.5578 [CI 0.4164 - 0.7471]).

Conclusion

There was no significant relationship between ACE or resilience scores and pediatric ED visits. A higher ACE score and lower levels of resilience were associated with decreased child vaccine adherence rate. ACE scores relate to higher traumatic childhoods, suggest poorer outcomes in offspring. Women with higher ACE scores could benefit from closer interventions and resources from obstetricians, and closer follow up of their children by the pediatricians.

INTRODUCTION

Since the 1998 publication of the Adverse Childhood Experiences (ACE) Study by Felitti et al.,[1] it has been understood that early exposure to adversities has future implications on adult health. Adverse childhood experiences are adversities such as abuse (i.e., physical, emotional, sexual), neglect, and family dysfunction (i.e., domestic violence, parental separation, and substance abuse in the household) that are experienced in childhood.[2,3] The original study utilized a 17-item questionnaire about childhood experiences and investigated a population of older, non-His-

panic adults in a primary care setting. The study's findings demonstrated that adult patients who had experienced events in four or more adverse experience categories had a 4 to 12 times higher risk of engaging in risky behaviors, including alcoholism, depression, or suicide attempts as adults.[4] Patients also had a two to four time increased risk of smoking and a higher likelihood of having more than 50 sexual partners.[4] Ultimately, the results showed that the higher number of exposures to adversities were associated with higher risks of negative health outcomes and engaging in risky health behaviors.

Although the original ACE study utilized a longer questionnaire with a patient population of primarily older, non-Hispanic adults, subsequent studies have expanded the survey to populations of interest, such as obstetric patients.

Due to the highly influenced nature of pregnancy by factors such as inadequate social support and external maternal stressors leading to an adverse pregnancy outcome, the ACE questionnaire has been used to identify early trauma that may also affect the pregnancy course.[1,3] A study of 301 pregnant women in the American South found that 67% of the women were exposed to at least one ACE, while 19% of participants had been exposed to 4 or more ACEs.[3] Another study conducted by researchers at San Francisco General Hospital administered the ACE questionnaire along with a PTSD checklist and Edinburgh Postnatal depression scale. The study correlated higher total ACEs, especially childhood maltreatment, with higher levels of PTSD and depressive symptoms during pregnancy.[1] Both studies reinforce the utility of screening for ACEs in a pregnant population to identify pregnancies at risk of poor health outcomes.

Subsequent investigations around childhood adversity began focusing on its potential impact on more specific health outcomes. For example, a study investigated associations between childhood maltreatment and health care use and cost in a random sample of 1225 women who were members of a health maintenance organization.[5] Results showed that women who reported significant childhood sexual abuse were nearly twice more likely to visit the ED than women without a history of sexual abuse. The study concluded that childhood maltreatment was significantly associated with increased adult medical costs and visits for women who experienced childhood maltreatment. Another study at a large suburban pediatric primary care practice investigated the association between maternal ACE scores and offspring health.[6] The study showed that maternal ACEs were significantly associated with missed well-child visits. These studies highlight that ACEs can affect health outcomes outside the individual who experienced the adversity.

More recently, ACE research has expanded to find solutions to mitigate the many risks associated with early childhood adversity. Studies have shown that an individual's sense of resiliency may counter the negative health risks of childhood adversity. One study co-administered the Benevolent Childhood Experiences (BCE) scale to assess resiliency risks, along with the ACE questionnaire. Resiliency skills were determined by the number of positive experiences, such as positive attachments with caregivers, strong relationships with peers and teachers, and the individual's positive sense of self. This study suggested that higher resiliency skills, which were fostered by positive experiences, were inversely correlated with lower depression, PTSD, perceived stress, and stressful life event scores.[7] A different study conducted at two Kaiser Permanente Northern California medical centers investigated associations between protective factors, such as resilience, and influence on prenatal and behavioral health in pregnant patients with positive ACE scores.[8] This study found a strong association between maternal health outcomes in pregnancy and low levels of resilience and suggested that higher levels of resilience reduced the risk of poor pregnancy health outcomes associated with high ACEs.

Several studies have investigated the impact of maternal ACE scores on child health outcomes. However, there are few studies investigating the influence of both maternal ACE scores and maternal resiliency on infant health outcomes.

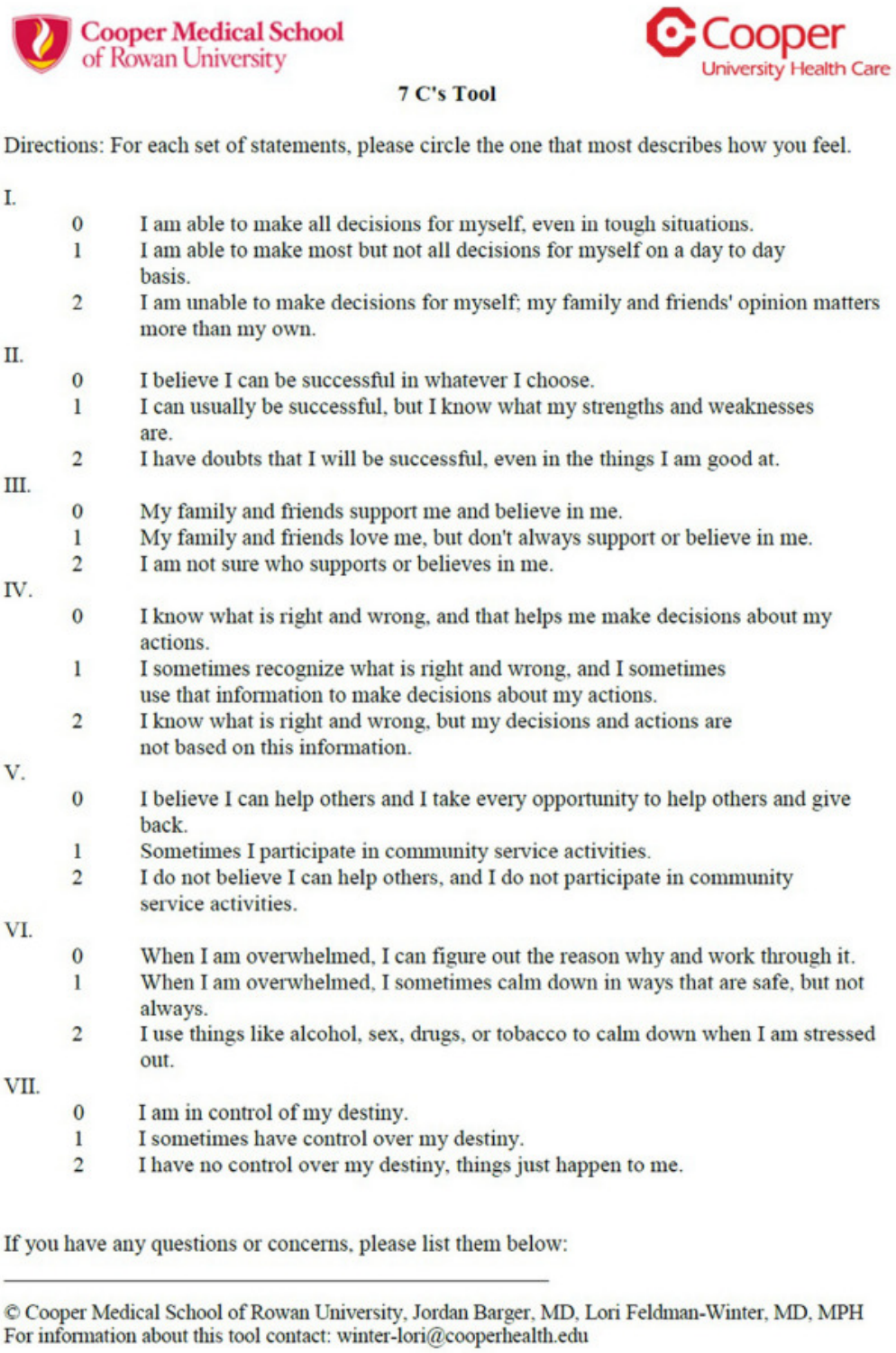
Our study aimed to understand if maternal ACEs and maternal resiliency affect their offspring's health within the first year of life. We measured maternal ACEs via ACE Questionnaire and measured maternal levels of resilience with the 7C's Tool **(Figure 1).** The pediatric outcomes selected were attending primary care visits to receive vaccines based on the CDC vaccination schedule and the number of visits to the emergency department. We chose to analyze whether higher ACEs predicted more frequent pediatric ED visits and less vaccination adherence and whether higher levels of maternal resilience resulted in fewer pediatric ED visits and better vaccination adherence.

METHODS

Using a longitudinal prospective study design, 33 mother-infant pairs were recruited in the outpatient setting of an urban tertiary hospital in New Jersey. In this IRB approved study (protocol 20-025), women presenting to the hospital's obstetric clinic or pediatric clinic who were 18 years or older, English-speaking, and currently pregnant past their first trimester or were less than two months post-delivery were eligible to be included in the study. Mothers who consented to the study were administered three survey materials to document maternal childhood experiences and maternal health. We used the Adverse Childhood Experience (ACE) questionnaire to measure maternal childhood adversity and the 7C's Tool to measure maternal resiliency.

The ACE questionnaire we utilized was modeled after the ACE questionnaire created by the Kaiser Permanente Medical Group and consisted of 10 statements in categories of abuse, neglect, or household dysfunction. Participants were given the questionnaire and asked to indicate if they experienced any of these statements before the age of 18. Participants designated "1" if the experience occurred or "0" if the experience did not occur. The participant's total ACE score was then calculated by summing all the "1" on their questionnaire.

The 7C's Tool is an internally validated questionnaire created by researchers at Cooper University Hospital to



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7 C's Tool

Directions: For each set of statements, please circle the one that most describes how you feel.

I.
- 0 I am able to make all decisions for myself, even in tough situations.
- 1 I am able to make most but not all decisions for myself on a day to day basis.
- 2 I am unable to make decisions for myself; my family and friends' opinion matters more than my own.

II.
- 0 I believe I can be successful in whatever I choose.
- 1 I can usually be successful, but I know what my strengths and weaknesses are.
- 2 I have doubts that I will be successful, even in the things I am good at.

III.
- 0 My family and friends support me and believe in me.
- 1 My family and friends love me, but don't always support or believe in me.
- 2 I am not sure who supports or believes in me.

IV.
- 0 I know what is right and wrong, and that helps me make decisions about my actions.
- 1 I sometimes recognize what is right and wrong, and I sometimes use that information to make decisions about my actions.
- 2 I know what is right and wrong, but my decisions and actions are not based on this information.

V.
- 0 I believe I can help others and I take every opportunity to help others and give back.
- 1 Sometimes I participate in community service activities.
- 2 I do not believe I can help others, and I do not participate in community service activities.

VI.
- 0 When I am overwhelmed, I can figure out the reason why and work through it.
- 1 When I am overwhelmed, I sometimes calm down in ways that are safe, but not always.
- 2 I use things like alcohol, sex, drugs, or tobacco to calm down when I am stressed out.

VII.
- 0 I am in control of my destiny.
- 1 I sometimes have control over my destiny.
- 2 I have no control over my destiny, things just happen to me.

If you have any questions or concerns, please list them below:

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For information about this tool contact: winter-lori@cooperhealth.edu

Figure 1. 7C's Tool Questionnaire

screen for resilience in populations between the ages 13-21.[9] It's other purpose was to help guide physician counseling against risky behaviors associated with ACEs. This tool was modeled after Dr. Kenneth Ginsburg's 7Cs Model of Positive Development, which described seven components of resilience – competence, confidence, character, connection, caring, coping, and control— in adolescents. When administered in adolescent patients, lower resilience was correlated with higher ACE scores as well as violent behavior, drug use, depression, and suicidality.[2, 9] Both studies demonstrated that positive and negative childhood exposures contribute to long-term functioning in independent manners. Therefore, the presence or absence of childhood adversity or favorable childhood experiences does not preclude the other.

Mean Maternal Age, Years	27.2
Maternal Race/ Ethnicity	**Total, n (%)**
Black	19 (57.6)
Hispanic	10 (30.3)
White	4 (12.1)

Table 1. Demographics (N=33)

In our study, we administered the 7Cs Tool, which consisted of seven sets of statements, each corresponding to one of the seven components of resilience. Participants chose one of three statements within each set that best describes how they felt. Each of the three statements were assigned a point of either a 0, 1, and 2 (Figure 1). Following the methods of the original study, statements that reflected lower levels of resilience would earn scores of 1 or 2; therefore, lower participant resiliency would be demonstrated through higher scores on the 7Cs Tool. The design of the original 7Cs Tool intentionally associated higher levels of resiliency with lower scores to counteract potential social desirability bias which guides participants to earn higher scores. Participant's total score was the sum of all points assigned with their chosen statements. A higher total score indicated low resilience levels, and a lower total score indicated high resilience levels.

After administrating survey materials, chart-review was conducted on the infants during their 2, 4, 6, and 12-month well visits. All mothers gave consent for the study team to contact them by phone to collect study outcomes if they decided to transfer their infants' care to a different hospital.

The number of ED visits was analyzed as a continuous variable as a function of the ACE and resilience scores (linear regression). The resilience and ACE scores were analyzed as continuous predictors, with the odds ratio reflecting the change in the probability of the binary outcomes (ED visit, vaccination adherence) per unit change in the scores. The primary outcomes were analyzed using Generalized Estimating Equations appropriate for repeated measures overtime. Odds ratios with 95% confidence intervals for the relationships of ACE and 7C with the clinical outcomes were presented. Based on the nature of the outcomes, we do not expect to pass normality test. In addition, statistical tests for normality are prone to sample size error. Therefore, QQ plot of residuals was used to assess normality.

RESULTS

A total of 33 mother-infant pairs were enrolled and followed for this study eight of the mother-infant pairs were lost to follow-up at the time of data analysis.

The average age of mothers at their time of enrollment was 27.2 (Table 1). Maternal Race/Ethnicity data was gathered from the electronic health system, EPIC. Of the 33 mothers, 19 identified as Black, ten identified as Hispanic, and four identified as White.

Out of the 33 mothers enrolled, seven mothers had a total ACE score of "0" (Table 2.1). Eight mothers had a total score of "1". Four mothers had a score of "2" and another four mothers had a total score of "3". Ten mothers had a total score of "4" or more. The average score on the ACE questionnaire for the mothers enrolled was 2.6 [range 0-9].

On the 7C's Tool questionnaire, 11 mothers earned a total score of "0" (Table 2.2). Seven mothers earned a score of "1". Three mothers earned a total score of "2". Four mothers earned a total score of "3". Eight mothers had a score of "4" or more. The average score on the 7Cs Tool was 2.4 [range 0-13].

31% of the children enrolled in the study had 1 or more ED visits reported within their first year of life. There was no statistically significant relationship between higher maternal ACE scores and the number of pediatric ED visits (p=1.000) (Table 3.2).

The number of pediatric ED visits increased 0.29 visits for each unit increase in the 7Cs Tool score, (95% confidence interval 0.1411-0.4347, p = 0.0001) (Table 3.1).

Of the children who presented for their well visits, 92% of infants followed the CDC recommended vaccine schedule, while 8% of infants were following the CDC catch-up schedule. For each one-point increase in the maternal ACE score, there was a 65% reduction in the probability of vaccination adherence (OR 0.3555, 95% CI 0.1417 – 0.8923, p = 0.0276). For each one-point increase in the 7Cs Tool scores, there was a decrease of 44% in the probability of vaccination adherence (OR 0.5578, 95% CI 0.4164 - 0.7471, p <0.0001).

DISCUSSION

When comparing maternal ACEs and resilience scores to the frequency of pediatric ED visits, there was no statistically significant relationship between higher ACE or 7Cs Tool scores and the probability of an ED visit. However, every one-point increase in maternal ACE scores showed a decrease in CDC vaccination adherence by 65% (Table 4). Additionally, each unit increase in 7Cs Tool scores, indicating a decrease in resilience, showed a decrease in CDC vaccination adherence by 44% (Table 4). Our findings suggests that higher maternal exposure to childhood traumatic events and lower levels of resilience are associated with less child-vaccination adherence.

Previous studies had solely focused on higher ACE scores which were showed to decrease the number of well child visits within the first two years of life.[6] Similar studies had

Adverse Childhood Experiences Questionnaire	Total, n (%)
0	7 (21.2)
1	8 (24.2)
2	4 (12.1)
3	4 (12.1)
≥4	10 (30.3)

Table 2.1. ACE Score

7 C's Tool	Total, n (%)
0	11 (33.3)
1	7 (21.2)
2	3 (9.1)
3	4 (12.1)
≥4	8 (24.2)

Table 2.2. Resilience Score

Parameter	Estimate	Standard Error	95% Confidence Limits		Z	*p*
			LL	*UL*		
Total ACE Score	0	0.0576	-0.1130	0.1130	0.000	1.0000
Total Resilience Score	0.2879	0.0749	0.1411	0.4347	3.84	0.0001

Table 3.1. Number of ED Visits

Interpretation: The number of ED visits increased 0.29 for each unit increase in total resilience

Total ACE Score	Chi-Square	*p*	Mean Estimate	Mean Confidence Limits		Odds Ratio	Standard Error	Alpha	Odds Ratio Confidence Limits	
				LL	*UL*				*LL*	*UL*
	0.09	0.761	0.491	0.4332	0.5490	0.9645	0.1145	0.05	0.7643	1.2172
Total Resilience Score	**Chi-Square**	***p***	**Mean Estimate**	**Mean Confidence Limits**		**Odds Ratio**	**Standard Error**	**Alpha**	**Odds Ratio Confidence Limits**	
				LL	*UL*				*LL*	*UL*
	1.06	0.3023	0.4588	0.3824	0.5371	0.8477	0.1358	0.05	0.6192	1.1604

Table 3.2. ED Visit

Interpretation: No significant relationship between total ACE score, total resilience score, and ED visits

only determined relationships between ACEs and postnatal outcomes, with limited exploration of resilience scores. The compounded effect of higher ACE scores and low levels of resilience showed two avenues for decreasing vaccination adherence, which is a primary focus of early pediatric visits. Our preliminary data suggest that pregnant patients and new mothers could benefit from ACE and resilience screening by helping obstetricians and pediatricians identify mother and child dyads at risk of non-adherence to vaccination schedules. By administering ACE and resilience questionnaires to mothers during routine maternal prenatal visits or well-child visits, health care professionals could incorporate interventions to prevent potential adherence issues. Future directions for this research would be to understand the utility of the 7C's Tool as a guide for providers to address low resiliency levels. For example, mothers identified to have low levels of resiliency in the connection component may benefit from provider-tailored care to help foster connections by identifying support systems, connecting her to support groups, and providing referrals to additional mental health resources. Likewise, lower levels of resilience in the control or competence component could alert

Total ACE Score	Chi-Square	*p*	Mean Estimate	Mean Confidence Limits		Odds Ratio	Standard Error	Alpha	Odds Ratio Confidence Limits	
				LL	*UL*				*LL*	*UL*
	4.85	0.0276	0.2623	0.1241	0.4715	0.3555	0.1669	0.05	0.1417	0.8923
Total Resilience Score	**Chi-Square**	***p***	**Mean Estimate**	**Mean Confidence Limits**		**Odds Ratio**	**Standard Error**	**Alpha**	**Odds Ratio Confidence Limits**	
				LL	*UL*				*LL*	*UL*
	15.33	<.0001	0.3581	0.2940	0.4276	0.5578	0.0832	0.05	0.4164	0.7471

Table 4. Adherence to CDC Vaccine Recommendations

Interpretation: The probability of following the CDC recommendation for vaccination decreased 65% (odds ratio = 0.3555) with each unit increase in total ACE Score and decreased 44% (odds ratio = 0.5578) with each unit increase in total resilience score.

providers to spend more time providing health education and clarifying questions around vaccination. In addition, providers could suggest different options for vaccination schedules, such as grouping vaccines together to decrease the number of visits. As our study continues with enrollment, we hope to provide a clearer understanding of the relationship between maternal ACES and resilience on pediatric health outcomes.

A significant limitation of the study includes our small sample size at the time of data analysis. This project is still in enrollment and data collecting phases. Our goal sample size is 120 infant-mother pairs. Based on a repeated measures design, and accounting for the typical 20% loss-to-follow-up rate, a sample size of 120 will provide >90% power to detect an odds ratio of 2 or greater for each standard deviation above the mean of the ACE scale (1-10) assuming a mean of 3.7 and a standard deviation of 2.7 and a response proportion of 0.50.

This study was also limited by the tools within our populations to which they were administered. The ACE questionnaire in conjunction with the 7C's Tool had only previously been utilized in patient populations between 13 to 21 years old. However, the 7C's Tool was selected for this study because it had been validated as a tool for identifying positive behaviors and outlooks in the presence of identified risks (i.e. ACE questionnaire). Moreover, at the time of the study, we assessed vaccination schedule adherence in the middle of the COVID-19 pandemic. In addition to the general climate of childhood vaccination hesitancy, factors such as social distancing and COVID-19 vaccination hesitancy could have influenced adherence to CDC-recommended childhood vaccination schedule and number of emergency room visits during the time of this study. Additionally, the study was solely completed at an urban tertiary hospital in New Jersey, limiting the external validity of the results. Future studies should focus on expanding the administration of these tools within a larger area to better reflect a wider population of interest, and increasing participant enrollment.

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