WHEN LIFE DEALS ACES: THE ASSOCIATION BETWEEN ADVERSE CHILDHOOD EXPERIENCES (ACES) AND REPRODUCTIVE, PRENATAL, AND PERINATAL HEALTH OUTCOMES AMONG WOMEN

by

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ABSTRACT

TASHA LEIMOMI GILL, MPH. When life deals ACEs: The association between adverse childhood experiences (ACEs) and reproductive, prenatal, and perinatal health outcomes among women. (Under the direction of DR. LARISSA R. BRUNNER HUBER)

Nearly 65% of adults report experiencing at least one adverse childhood experience (ACEs). Women are more likely to report experiencing 4 or more ACEs. While the association between ACEs and adverse physical and mental health outcomes in adulthood is well supported, few studies have examined the impact of ACEs on reproductive, prenatal, and perinatal health. Women with a history of ACEs have increased odds of unintended pregnancy, pregnancy complications, and delivering infants with low birth weight and preterm birth. This dissertation aimed to assess the associations between ACEs and contraceptive use, early initiation of prenatal care (PNC), and delivering a small for gestational age (SGA) infant.

Three separate population-based studies were conducted to investigate these associations using Add Health Public-Use Data, a subset of publicly available data from the full National Longitudinal Study of Adolescent Health dataset. The first study assessed the association between ACEs and contraceptive use. The second study evaluated the association between ACEs and early initiation of PNC. The third study examined the ACEs-SGA association as well as examined race/ethnicity as an effect modifier of this association. Logistic regression and multivariate logistic regression were used to calculate the unadjusted and adjusted odds ratios (ORs) and 95% confidence intervals (CIs), respectively. Stratified analysis by race/ethnicity was conducted on the ACEs-SGA association. Given the complex sampling design of Add Health Public-Use Data, all analyses were performed using SAS survey procedures (version 9.4, SAS Institute Inc. Cary, NC).

Across all studies, ACEs were associated with adverse health outcomes. In the first study,

women with a family history of suicidal behavior had statistically significant decreased odds of contraceptive use (AOR=0.69, 95% CI: 0.51-0.96). Findings from the second study demonstrated that women who experienced parental alcoholism had 82% statistically significant decreased odds of early initiation of PNC (AOR=0.18, 95% CI: 0.06-0.55). In the third study on ACEs and birth outcomes, women who experienced parental alcoholism had statistically significant increased odds of delivering an SGA infant (AOR=4.11, 95% CI: 1.09-15.52). When stratified by race/ethnicity, among Non-Hispanic White women, those who experienced parental alcoholism had 7-fold statistically significant increased odds of delivering an SGA infant (AOR=7.39, 95% CI: 1.44-37.88). Among Non-Hispanic Black/Hispanic/Other women, those who experienced parental alcoholism had 1.6-fold increased odds of delivering an SGA infant (AOR=1.55, 95% CI: 0.22-10.84).

This dissertation addresses existing gaps in the literature on the impact of ACEs on women's reproductive, prenatal, and perinatal health. Study results highlight the importance of integrating mental health and reproductive health care services. By implementing trauma-informed care practices such as ACEs screening during reproductive health and PNC visits, healthcare providers may provide additional support for this high-risk population of women. In addition, healthcare providers should underscore the importance of PNC during preconception reproductive health counseling as these visits may serve as an opportunity to engage these women before a pregnancy. By doing so, early PNC may reduce and prevent SGA births.

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Finally, to my husband, Peter Gill: Thank you for standing alongside me throughout the ups, downs, and steady paths of life. You are my best investment.

"A'ohe hana nui ke alu 'ia."

No task is too big when done together by all.

- Mary Kawena Pukui, ‘Ōlelo No‘eau, No. 142

DEDICATION

I dedicate this dissertation to my son, Paxton Nainoa Gill. May the vibrant spark of your childhood always shine brightly, and may you continue to share it with those around you.

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LIST OF ABBREVIATIONS

ACE	Adverse Childhood Experience
AIAN	American Indian/Alaska Native
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
COMPASS	Collaborative Care Model for Perinatal Depression Support Services
CI	Confidence Interval
DOHaD	Developmental Origins of Health and Disease
HRSA	Health Resources and Services Administration
H	Hypothesis
LBW	Low birth weight
ADD Health	National Longitudinal Study of Adolescent Health
NHW	Non-Hispanic White
NHB/H/O	Non-Hispanic Black/Hispanic/Other
OR	Odds Ratio
AOR	Adjusted Odds Ratio
PRAMs	Pregnancy Risk Assessment Monitoring System
PNC	Prenatal care
PTB	Preterm birth
aPR	Adjusted Prevalence Ratio
SGA	Small for gestational age
STACY	Stress, Trauma, and the Childbearing Year
UN	United Nations
US	United States of America

CHAPTER 1: INTRODUCTION

Adverse childhood experiences (ACEs) are defined as exposure to stressful life events under the age of 18 years (1). Four main categories of ACEs are widely recognized today: household dysfunction, psychological, physical, and sexual abuse (2). More than half of all US adults report experiencing at least one ACE (3, 4). Compared to men, women have a higher prevalence of experiencing more than one ACE (2, 4). Approximately 50-85% of women who are pregnant or have given birth report experiencing at least one ACE, with nearly 20% reporting 4 or more ACEs (5-7). Women with ACEs are more likely to experience adverse sexual and reproductive health outcomes, pregnancy complications, and adverse birth outcomes (5, 8). Moreover, ACEs scores are positively associated with offspring ACEs scores, suggesting the intergenerational transmission of ACE exposure risk (9). For the first time, Healthy People 2030 included reducing the number of young adults reporting experiencing 3 or more ACEs as a developmental objective, demonstrating its importance as a national public health issue (10).

Measurement of ACEs

ACEs are often measured using self-reported retrospective questionnaires (2). In the landmark CDC-Kaiser ACE study, ACEs were measured using a 17-item survey adapted from the Conflicts Tactics Scale, National Health Interview Survey, and Wyatt measures of child sexual abuse (2, 11). The CDC-Kaiser ACE study was the first of its kind to apply an epidemiological approach to measure the cumulative long-term impact of childhood adversity on health outcomes in later adulthood. Since then, data on ACEs have been collected in clinical settings as well as using national cross-sectional and longitudinal surveys such as the Behavioral Risk Factor Surveillance System (BRFSS), National Survey of Children's Health (NSCH), and National Longitudinal Study of Adolescent to Adult Health (Add Health) (12). Despite the lack

of standardization of ACE measures, the associations between ACE exposure and adverse health outcomes in adulthood are well supported in the literature (12).

Risk Factors for ACEs

While there is no single cause for ACEs, several risk factors may increase an individual's risk of experiencing ACEs in their lifetime. Although ACEs are common in the US population, there are significant disparities in their distribution. There are significant racial differences in exposure to ACEs. Non-Hispanic Black and Hispanic children have higher prevalence rates of ACE exposure than their Non-Hispanic White counterparts (13-15). In a study of 133 perinatal women with mental illness, Non-Hispanic Black women were more likely to experience ACEs, specifically sexual and physical abuse, and witnessing violence than White women (16).

Beyond race, several risk factors are associated with the disproportionate exposure of ACEs. Individuals with low income and less education are at higher risk of experiencing ACEs (16-18). Individuals with ACEs are also more likely to report lower socioeconomic status and psychosocial assets (19, 20). Individuals with low educational attainment are more likely to report experiencing ACEs than those with a high school education or higher (21). In addition, neighborhoods with community violence and disorder are associated with a greater prevalence of ACEs among their residents (18, 22). Relatedly, peer victimization and rejection are also associated with ACEs (18).

In addition, parents with ACEs are more likely to have children who report experiencing ACEs, demonstrating the intergenerational transmission of ACEs (23-26). In particular, individuals with one or more ACEs may have an increased risk for experiencing intimate partner violence, depression, substance abuse and suicide, which in turn could contribute to risk of ACE exposure in their children (23, 27-29). Lastly, ACEs tend to be experienced in clusters, such that

individuals who report experiencing one ACE are more likely to report experiencing other forms of ACEs (30).

Health Consequences of ACEs

ACEs may lead to long-term physical and mental health outcomes in an individual's life course and across generations (2, 5, 31, 32). Exposure to ACEs is linked to morbidity and premature mortality in adulthood (2, 33). ACEs are associated with increased risks of chronic diseases such as obesity, asthma, diabetes, cancers, and cardiovascular disease (2, 30, 34-36). ACEs are also associated with poor mental health outcomes such as depression Moreover, individuals with ACEs may be more vulnerable to risky health behaviors. ACEs are associated with smoking, alcohol use, and high-risk sexual behavior (1, 8, 29). In addition to increased risk behaviors and adverse health outcomes in adulthood, parents with a history of ACEs must consider the impact of ACEs on their health during the preconception and perinatal periods as well as the health of their offspring.

Prior studies have demonstrated the profound impact of ACEs on reproductive health. Women who experience ACEs have an increased risk for unwanted pregnancies (37). In addition, women with ACEs have an increased risk of having their first pregnancy at a younger age compared to women without ACEs, a known risk factor for infant health (38, 39). Exposure to ACEs is also associated with mental health conditions during pregnancy such as increased prenatal stress, depression and anxiety (28, 40). The impact of ACEs on health outcomes extends to offspring as well. Women who experience ACEs have increased risk for adverse birth outcomes such as low birth weight and preterm birth (5, 41). ACEs are also linked to fetal death through a strong dose-response relationship whereby the more ACEs experienced by a woman, the greater the likelihood for fetal death (42). Furthermore, ACEs are associated with risk for

infant biological and social development delays within the first 12 months of age (43).

Preconception Outcome: Contraceptive Use

Despite the heightened risk for unwanted pregnancies and adverse reproductive health outcomes among women with a history of ACEs, studies assessing the association between ACEs and preventive measures such as contraceptive use are scarce. Contraceptive use is an effective and reliable method for preventing unwanted or unintended pregnancies (44-46). In the US, 65% of women reported currently using contraceptives (47). Contraceptive use allows for women to exercise their reproductive choice, which can improve maternal and infant health by allowing for planned pregnancies and adequate birth spacing (48, 49). Accordingly, this preventive measure can reduce the risk of complications during pregnancy and childbirth (50). Furthermore, contraceptive use reduces the demand for abortion, particularly for unsafe procedures that can lead to serious and potentially fatal outcomes (50). In addition, contraceptive use plays a vital role in preventing illness and premature death in women (50) (54). Contraceptive use is associated with decreased risk for menstrual disorders and gynecological cancers (50-54).

Prenatal Outcome: Prenatal Care

Prenatal care (PNC) refers to health care provided to a woman during pregnancy (54). In the US, PNC is recommended to begin in the first trimester of pregnancy and continues until birth, with the frequency of PNC visits increasing over time; although, the frequency of PNC visits may depend on the patient's needs (55). In 2021, approximately 89% of women reported receiving PNC in the first trimester of pregnancy (52). However, women who were uninsured, multiparous, or had income within 100% of the federal poverty level were more likely to receive late PNC or no PNC (56). In addition, women with unplanned pregnancies have 2.5 times

increased odds of receiving late PNC and 3 times increased odds of receiving no PNC (Late: 95% CI: 1.63-3.87; No PNC: 95% CI: 1.49-3.12) (56). PNC visits can help detect and manage pregnancy complications from ectopic pregnancies, gestational diabetes, and preeclampsia (57, 58). Moreover, timely PNC is also associated with a shorter length of days of maternal hospitalization and lower likelihood of becoming overweight or underweight postpartum (59).

Perinatal Outcome: Small for Gestational Age

In the US, approximately 11% of infants are born as small for gestational age (SGA) (60). SGA is defined as birth weight within the 10^{th} percentile of the referent population based on the infant's gestational age (61, 62). While SGA is often used as a proxy for fetal growth restriction and may indicate potential health issues, not all SGA infants experience fetal growth restriction (63). Risk factors for SGA include maternal history of chronic diseases, infection, malnutrition, substance use, and genetic disorders (63, 64). In addition, there are longstanding racial disparities among SGA infants (65, 66). Among extremely low-risk mothers, African American mothers had 2.64 times increased risk of delivering an SGA infant compared to White mothers (95% CI: 2.51-2.78) (65). Existing research suggests that SGA infants may face increased risk of short- and long-term adverse outcomes. In particular, SGA infants may experience respiratory distress syndrome, late-onset sepsis, difficulties with thermoregulation, and an increased risk of mortality (63, 67). Moreover, SGA infants have an increased risk of development delays and metabolic diseases later in life (63, 68-70).

Literature Review

Previous literature has explored the impact of ACEs on maternal and child health outcomes. A review of relevant peer-reviewed literature on maternal ACEs and preconception, prenatal, and perinatal health outcomes is provided.

Preconception: Studies Examining ACEs and Contraceptive Use

To our knowledge, two studies had assessed the association between ACEs and contraceptive use. However, their findings are inconsistent. In a prospective longitudinal study conducted among 460 women receiving care at prenatal clinics in Michigan and Tennessee, women who experienced ACEs had statistically significant decreased odds of postpartum contraceptive use (AOR=0.57; 95% CI: 038-0.86) and had 1.5 times increased odds of using less efficacious forms of contraception (AOR=1.50; 95% CI=1.02-2.21) (71). While study findings were from a racially diverse sample of women, contraceptive use was assessed during the postpartum period and did not assess preconception contraceptive use. Furthermore, women with a history of ACEs who are pregnant and receiving prenatal care may differ from those who are not yet pregnant, have no intentions of getting pregnant, or do not have access to prenatal care. Although this study controlled for sociodemographic characteristics, including race/ethnicity, researchers had not controlled for confounders such as maternal education level and employment, which are associated with maternal ACEs and contraceptive use (2, 33, 72, 73).

In the second study of a population-based sample of women residing in Honduras (N=810), Huber-Krum, Miedema (74) found no association between ACEs and contraceptive use (AOR=0.98, 95% CI: 0.64-1.49). In particular, women who experienced sexual abuse as an ACE had statistically significant decreased odds of using contraception (OR=0.56; 95%CI: 0.34-0.91) (74). In this same study, women with at least one ACE had decreased odds of using provider-dependent contraceptives (AOR=0.39, 95% CI: 0.24-0.63) (74). However, there may be other sociocultural and environmental differences in this international study, which limit the generalizability of this study's findings to the US population.

Prenatal: Studies Examining ACEs and PNC

Few studies have assessed ACEs and its association with PNC. One study conducted a post-hoc analysis using data from the Stress Trauma and the Childbearing Year (STACY) project, which assessed women with Post-Traumatic Stress Disorder (PTSD) who were receiving PNC in Michigan (N=467) (75). Findings from this study demonstrated that women who experienced childhood maltreatment had nearly 3-fold statistically significant increased odds of adequate PNC (AOR=2.89, 95% CI: 1.41-5.90) (75). In the STACY study, the exposure variable, childhood maltreatment, was defined as abuse or physical neglect under the age of 16 years and was measured using the Life Stressor Checklist-Revised (LSC-R) (75). While the LSC-R included items such as experiences of physical and sexual abuse, it also had various events such as witnessing a serious accident that were experienced throughout one's entire life and were not limited to events of childhood (76). In addition, childhood maltreatment was restricted to abuse or neglect and did not include additional potentially traumatic events during childhood such as ACEs.

Another cross-sectional study used data from 5 states of the 2016-2018 Pregnancy Risk Assessment Monitoring System (PRAMS) found no association between women who experienced ACEs and adequate PNC (77). However, findings from this study were limited to data from 5 states in the Midwest and Northeast, which may limit the generalizability to the broader population of pregnant women in the US (77). Additionally, there was variability in the ACEs questions based on site-specific questionnaires, such that certain states included questions such as abuse and incarceration of a family member. In contrast, other states included parental incarceration and food insecurity. Moreover, three of the five states included ACEs questions that were limited to nonviolent events under the age of 14, which may underestimate ACEs in

this population.

Perinatal: Studies Examining ACEs and SGA

Findings from previous studies examining the impact of ACEs on delivering an SGA infant are inconsistent. The first study found no association between ACEs and pregnancy risk or reproductive health risk, both of which included SGA (78). This study had a relatively small sample size composed of 389 women receiving or seeking service from Women, Infants, and Children (WIC) offices in the Midwest (78). In addition, nearly half of the study participants were 18-21 years at their first pregnancy, had a high school degree or less, were never married, and were not employed outside the home. Thus, the lack of diversity and representativeness may limit the generalizability of the study findings to other populations.

In contrast, other studies have demonstrated that women with a history of ACEs had increased odds of delivering an SGA infant (77, 79). In a cohort study of 1,149 pregnant or postpartum women participating in the Collaborative Care Model for Perinatal Depression Support Services (COMPASS) who were receiving mental health care in the Northwest, women with four or more ACEs had 1.2 times increased odds of SGA; however, this finding was not statistically significant (95% CI: 0.64-2.25) (79). Of note, this study did not conduct a multivariate analysis due to the small cell counts, which prevented any adjustment for confounders. Nevertheless, congruent results were found in the population-based PRAMS study, which found that among women in North and South Dakota, women who experienced two ACEs had 1.6 times higher prevalence of delivering an SGA infant compared to women who did not experience ACEs (N=3,624; 95% CI: 1.025-2.60) (77). However, in this same study, among women in Kansas, Michigan, and Rhode Island, there was no significant difference in the association between women with ACEs and SGA (77). The aforementioned limitations in

geographic areas and the use of site-specific PRAMS questionnaires contributed to the limited generalizability of the study results. In addition, despite efforts to assess for effect modification of race/ethnicity in this sample, it is essential to note that race/ethnicity was not stratified in this analysis due to unstable population estimates.

Theoretical Framework and Conceptual Model

This dissertation is grounded within the life-course epidemiology perspective. Life-course epidemiology examines the influence of early life factors on health outcomes in adulthood and across generations (80-82). Life-course epidemiology utilizes an interdisciplinary approach to understanding the biological, social, environmental, and ecological risks and determinants of health in a population that occurs across the lifespan (80, 82). Moreover, the primary goal of life-course epidemiology is to examine the complex processes of exposure-disease relationships by assessing the timing of risk at various life stages as well as the cumulative risks over time (83).

The study of early life determinants on later reproductive and maternal and child health was first examined through the fetal origins hypothesis, later known as the Developmental Origins of Health and Disease (DOHaD) hypothesis (81, 84-86). The DOHaD developed from Barker's hypothesis (84). In accordance with life-course epidemiology, the DOHaD posits that early life experiences can have profound effects on fetal development, which can lead to subsequent risk for morbidity later in life. The DOHaD also assumes a temporal component whereby maternal factors contributing to the intrauterine environment of the fetus predict subsequent fetal development. While the DOHaD as a mid-range theory has evolved from the nutrition and chronic disease literature, DOHaD can be applied to multiple situations (86). The DOHaD has been empirically tested in animals and humans.

Several theoretical models within life-course epidemiology further elucidate the relationships between early life exposures and subsequent health outcomes. For this dissertation, we utilized the accumulation of risk model with risk clustering to investigate the influence of maternal ACEs on maternal health behaviors during the preconception, prenatal, and postnatal periods (80, 81, 87). The accumulation of risk model posits that cumulative exposures over time will increase risk for subsequent adverse health outcomes (80, 81). Exposures of risk may include stress events such as illness, injury, environmental conditions, and health behaviors (80). Specifically, the accumulation of risk model with correlated exposures or risk clustering assumes that the exposures occur in socially patterned clusters, such that one exposure may be correlated to other exposures, increasing risk for adverse health outcomes. This model was initially applied to the concept of neighborhood poverty, whereas environmental risk due to residing in a poor neighborhood may increase the risk of exposure to poor nutrition, limited physical activity, and adverse health behaviors (80). The accumulation of risk model with risk clustering was applied to reproductive health (Figure 1) (81). In this example, low socioeconomic position was associated with poor growth, parental divorce, and poor diet, which cumulatively increased the risk for earlier menopause.

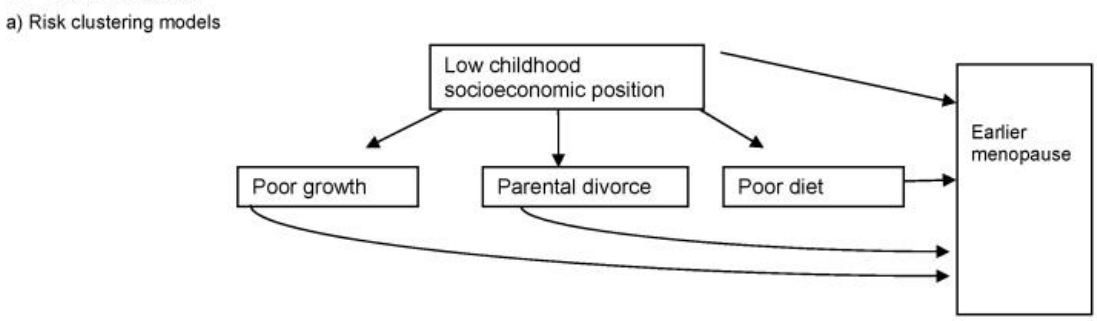

Figure 1. Accumulation of risk with correlated insults (risk clustering) model (81).

This dissertation hypothesized that ACEs were associated with reproductive health

behaviors such as contraceptive use and prenatal care utilization, which cumulatively may increase the risk for SGA (Figure 2; see H_1 and H_2, respectively). Our research also hypothesized that ACEs were associated with increased odds of SGA. In addition, given the disproportionate risk for specific population groups, we assume that the transmission of risk will be higher for certain races/ethnicities such that race/ethnicity will act as an effect modifier of the exposure-disease relationship (Figure 2, see $H_{3.1}$ and $H_{3.2}$).

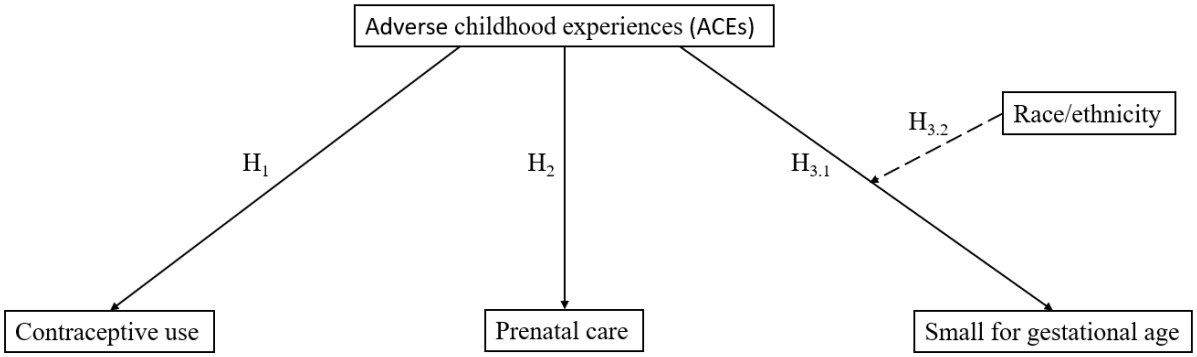

Figure 2. Conceptual model of the association between ACEs and contraceptive use, prenatal care, and small for gestational age with race/ethnicity as a potential effect modifier adapted from the accumulation of risk with risk clustering model (81); H_0=hypothesis.

Previous studies on ACEs have applied the chains of risk model to describe the intergenerational transmission of risk from mother to infant (88). The chains of risk model assumes that one exposure may increase risk for subsequent exposures (80). For instance, Cheng, Park (88) state that maternal ACEs are associated with an increased risk for adverse health outcomes in the infant, which is then linked to poor health in childhood. However, this model assumes a linear progression of risks. In contrast, the accumulation of risk with the risk clustering model provides a more nuanced approach that accounts for the multifaceted nature of ACEs and its related health outcomes. While there is limited literature on the application of the accumulation of risk with risk clustering model to ACEs, this application demonstrates the

complex interrelatedness of factors such as contraceptive use decisions and initiation of PNC, and birth outcomes such as SGA. Importantly, this model accounts for the cumulative exposure of these factors across the life course (80, 87).

Research Aims and Hypotheses

The overall purpose of this dissertation study was to assess the impact of ACEs on maternal reproductive and infant health outcomes. This study sought to assess the association between ACEs and health outcomes during the preconception, prenatal, and perinatal periods. In addition, this research examined racial differences in the intergenerational transmission of ACEs on adverse infant birth outcomes, specifically SGA. By conducting these three studies on the preconception, prenatal, and perinatal periods, we aimed to gain a more comprehensive understanding of the impact of ACEs on pregnancy and birth.

This research aimed to answer the following three research questions: 1) What is the association between ACEs and contraceptive use? 2) What is the relationship between ACEs and early initiation of PNC? and 3) What is the association between ACEs and SGA and does this association differ by race/ethnicity?

Thus, the specific aims of this research were:

Study 1 Aim: To examine the association between ACEs and contraceptive use among women aged 24 – 32 years using waves I-IV of the Add Health Public-Use Data. The intended journal for this manuscript is Contraception (Impact factor=2.335) due to its mission to disseminate research on reproductive health, with specific emphasis on contraceptive use.

Hypothesis 1.1: ACEs are associated with decreased odds of contraceptive use.

Study 2 Aim: To assess the relationship between ACEs and early initiation of PNC

among women ages 32 - 42 using waves I-V of the Add Health Public-Use Data. The intended journal for this manuscript is Women's Health Issues (Impact Factor=3.027) because of its emphasis on women's health care and history of publishing research articles on ACEs and prenatal health behaviors.

Hypothesis 2.1: Women with ACEs have decreased odds of receiving early initiation of PNC.

Study 3 Aim: To assess the association between ACEs and SGA among women ages 24 - 32 years using waves I-IV of the Add Health Public-Use Data, and to evaluate whether the ACEs-SGA association differs by race/ethnicity. The intended journal for this manuscript is the Journal of Midwifery and Women's Health (Impact Factor=1.048) due to its focus on perinatal care and clinical practice.

Hypothesis 3.1: ACEs are positively associated with SGA.

Hypothesis 3.2: Race is an effect modifier of the association between having ACEs and delivering an infant with SGA.

Rationale and Significance

Importance and Rationale

Few studies have taken a comprehensive approach at assessing the impact of ACEs on maternal and infant health outcomes during the preconception, prenatal, and perinatal periods. Unintended pregnancy increases the risk of pregnancy-related maternal complications such as pre-eclampsia and postpartum hemorrhage (89). Women with unwanted pregnancies have an increased risk of not receiving timely PNC and, subsequently, adverse birth outcomes (90, 91). However, existing studies on women with ACEs and its association with sexual and reproductive health outcomes have primarily focused on unwanted or unintended pregnancies and high-risk

sexual behaviors (8, 37). Given the increased risk of adverse risk behaviors and reproductive health outcomes among women with ACEs, research investigating contraceptive use in this population addresses a critical gap in the literature by assessing more upstream preventive reproductive measures. Research on the association between ACEs and contraceptive use provides a greater understanding of how ACEs may influence women's reproductive choices in adulthood. Furthermore, findings from this study may inform necessary screening and public health programming to improve preconception contraceptive counseling and later health during pregnancy and postpartum.

Research on the association between ACEs and PNC is sparse. While utilization of PNC increased to 77.6% in 2019, disparities in initiating PNC remain (92)(80). The association between ACEs and adverse health outcomes during the perinatal period is well established; however, many of these studies included cohorts of women receiving PNC. There may be a cohort of women with ACEs who did not receive PNC or had delayed timing of PNC due to sociodemographic barriers such as income and insurance. Thus, research investigating ACEs and PNC using a population-based sample improves our understanding of the impact of ACEs on maternal behaviors during pregnancy.

Lastly, research exploring the association between ACEs and delivering an SGA infant may broaden our understanding of the long-term effects of ACEs on fetal development. While previous literature has demonstrated the association between ACEs and low birth weight (LBW) and preterm birth (PTB), few studies have assessed the association between ACEs and delivering an SGA infant (32, 41, 93-95). While LBW is more established in the ACEs literature, LBW fails to account for the infant's gestational age. In addition, SGA may identify infants who are born term but have abnormal growth patterns. SGA, as an outcome, provides more insight into

assessing an infant's size in relation to their development (63). Moreover, racial differences in the distribution of ACEs and SGA births warrant further research (14, 66, 96). By assessing the role of ACEs on SGA infants and the role of race/ethnicity as an effect modifier on this association, findings from this study may guide preventive approaches to reduce the incidence of infants born with SGA. Collectively, these three studies provide a comprehensive understanding of the maternal and infant health outcomes associated with women who experienced ACEs across the life course. This comprehensive approach has significant implications for ACEs-informed public health policies and programming.

Significance and Scientific Contribution

The potential association between ACEs and adverse reproductive, prenatal, and perinatal health outcomes is concerning and poses a significant challenge to public health research on women and infant health (32, 42, 78). This dissertation addresses the Health Resources and Services Administration (HRSA) Maternal and Child Health Bureau Strategic Research Issues Goals: #2) Promote the Health and Well-Being of Women of Childbearing Age, and #3) Promote the Healthy Development and Well-Being of Infants, Children, Adolescents, and Young Adults (97). Research on the impact of ACEs on preconception, prenatal, and perinatal health contributes to the limited but growing literature that lies at the intersection of violence prevention and maternal and child health. Specifically, this dissertation explores the influence of ACEs on women's reproductive, prenatal, and perinatal health outcomes in adulthood.

First, contraceptive use can save billions in healthcare costs by preventing unintended pregnancy. In the US, unintended pregnancies carry a significant financial burden. In 2010, healthcare expenditures attributed to unintended pregnancies totaled $41 billion (98). Further, findings on the association between ACEs and contraceptive use among women address Healthy

People 2030 objectives to reduce the proportion of unintended pregnancies and increase the proportion of women at risk for unintended pregnancy who use effective birth control (10).

Second, research on ACEs and their association with PNC addresses Healthy People 2030's objective to increase the proportion of pregnant women who receive early and adequate PNC (10). Research on the impact of ACEs on PNC may further inform the scientific knowledge base on potential barriers to access to timely PNC during the first trimester of pregnancy among a high-risk population of women.

Third, our study on ACEs and SGA provides insights into the intergenerational transmission of ACEs. By examining racial differences in the association between ACEs and SGA, this study addresses the United Nations (UN) Sustainable Development Goal 3: Ensure healthy lives and promote well-being for all at all ages (99). Specifically, this research on SGA addresses Goal 3 Target 3.2 to end preventable deaths of newborns and children under 5 years of age (99). Infants born with SGA have increased risk for infant mortality and morbidity (60, 63, 67, 69). This study can potentially inform clinical practice by identifying infant health risk through screening of ACEs among pregnant women.

Women with a history of ACEs experience unique challenges during their reproductive years. This research addresses existing gaps in the scientific literature with implications for preconception, prenatal, and perinatal health programming. Moreover, the economic and public health implications of these study findings are profound. The economic burden of ACEs alone is an estimated $251 billion annually (100). By providing ACEs-informed interventions, we may reduce the significant economic burden of ACEs and associated adverse reproductive health outcomes on the healthcare system. Moreover, research on this topic may inform public health efforts and clinical practices to reduce and prevent maternal and infant morbidity and mortality.

Therefore, the short-term goal of this research study is to improve our understanding of the intergenerational effects of ACE exposure on maternal and infant health outcomes during the preconception, prenatal and perinatal periods. This research aims to improve maternal and child health by identifying the impact of ACEs as a necessary screening tool for early intervention.

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CHAPTER 2: THE ASSOCIATION BETWEEN ADVERSE CHILDHOOD EXPERIENCES AND CONTRACEPTIVE USE AMONG WOMEN IN THE US

Abstract

Background: Women who experienced ACEs have increased odds of engaging in risky sexual behaviors and unintended pregnancy. However, to our knowledge, no prior studies have assessed ACEs and their association with preventive reproductive health practices such as contraceptive use in a nationally representative sample. Thus, the purpose of this study was to examine the association between ACEs and contraceptive use among women in the US.

Methods: Data from waves I-IV of the National Longitudinal Study of Adolescent Health (Add Health) Public-Use data were analyzed. Women aged 24-32 years (N=2,460) were selected. The outcome variable, contraceptive use, was defined in two ways: contraceptive use (yes/no) and type of contraceptive method (coital dependent method/non-coital dependent method/no contraceptive use). The exposure variables were ACEs. All information was self-reported by the participants. Multivariate logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) of the association between ACEs and contraceptive use. Survey-weighted multinomial logistic regression was used to estimate ORs and 95% CIs of the ACEs-type of contraceptive method association.

Results: Approximately 53% of the women in this study reported contraceptive use and 52% reported experiencing at least one ACE. Women with a family history of suicidal behavior had statistically significance decreased odds of contraceptive use after adjustment for educational attainment (AOR= 0.69, 95% CI: 0.51-0.96). Women with a family history of suicidal behavior had decreased odds of using coital and non-coital dependent methods (Coital: AOR=0.74, 95% CI: 0.46-1.20 and Non-coital: AOR=0.75, 95% CI: 0.53-1.06, respectively).

Conclusions: Early contraceptive counseling and additional support may be needed for women

with a family history of suicidal behavior. Further research investigating the broader implications of ACEs on contraceptive use among a larger, diverse population is warranted.

Introduction

In the US, more than half of adults report experiencing at least one adverse childhood experience (ACE) (1-3). Approximately 50-85% of women who have been pregnant or given birth have experienced at least one ACE, with nearly 20% reporting four or more ACEs (4-6). For the first time, Healthy People 2030 has designated the reduction of the prevalence of young adults reporting three or more ACEs as a developmental objective, underscoring its significance as a critical public health concern (7). Women who experience ACEs have an increased risk of adverse sexual and reproductive health outcomes, complications during pregnancy, and adverse birth outcomes (4, 8).

While existing studies on the association between ACEs and sexual and reproductive health outcomes have primarily focused on unwanted or unintended pregnancies and high-risk sexual behaviors, few studies have examined contraceptive use in this population (8, 9). Contraceptives are an effective and reliable method of preventing pregnancy (10, 11) and contribute significantly to reducing morbidity and mortality in women (12) by preventing unwanted pregnancies, increasing birth spacing, decreasing the risk of menstrual disorders, and reducing ectopic pregnancies and gynecological cancers (13-15).

As previously mentioned, literature on the ACEs-contraceptive use association is sparse. To date, only two studies have investigated this association. One study focused on this association among postpartum women (16), while the other evaluated a group of women who had not recently given birth (17) The study of postpartum women included 460 women visiting prenatal care clinics in Detroit, Michigan and Nashville, Tennessee, and found that women with ACEs had statistically significant decreased odds of contraceptive use during the 12 months

postpartum (AOR=0.57; 95% CI: 038-0.86) (16). In this same study, women with ACEs had 1.5 times increased odds of using less efficacious forms of contraception (AOR=1.50; 95% CI=1.02-2.21). To our knowledge, the only other study that assessed the ACEs-contraceptive use association was conducted in Honduras among 810 women aged 18-24 years. This study found no association between women who experienced any ACE and contraceptive use (AOR=0.98, 95% CI: 0.64-1.49) (17). However, women who experienced any ACE had statistically significant decreased odds of using contraceptive methods that require a healthcare provider, such as sterilization and intrauterine devices, compared to women who did not experience ACEs (AOR=0.39, 95% CI: 0.24-0.63). While these studies had relatively large sample sizes, the generalizability of these studies may be limited. In particular, the first study included postpartum women receiving prenatal care in Michigan and Tennessee, which may limit the generalizability of the study findings to the broader population. Additionally, significant differences in reproductive policies between the US and Honduras may inhibit the ability to extrapolate the findings to US women (18).

Healthy People 2030 aims to decrease the proportion of unintended pregnancies and increase the proportion of women at risk for unintended pregnancy who use effective birth control (19). While contraceptive use is an established method for preventing pregnancy, a woman's decision to use contraceptives is complex and influenced by many factors, including cultural norms, social determinants of health, social network, and access (20-23). Given the association between ACEs and increased risky sexual behaviors, lower educational attainment, and barriers to accessing health care, understanding the ACEs-contraceptive use association may provide an important opportunity for reducing unintended pregnancies and improving reproductive health outcomes among women with ACEs. (24-28). This study aimed to assess the

association between ACEs and contraceptive use among women ages 24-32 years using population-based data from the National Longitudinal Study of Adolescent Health (Add Health).

Methods

This secondary data analysis used data from the National Longitudinal Study of Adolescent Health (Add Health), a nationally representative sample of non-institutionalized adolescents in the US (29). Add Health collects data on health behaviors, access to health services, and health outcomes from a cohort of adolescents that were followed into adulthood. The first wave of data collection was conducted among 7^{th} to 12^{th} graders in public and private schools in 1994-1995 using a multi-stage stratified cluster sampling design (29, 30). The wave I in-home sample is foundational for all subsequent waves. Therefore, participants in waves II-V were derived from the original wave I sample. Eligible participants from wave I were interviewed in their homes by trained interviewers during each wave of data collection (29). During the in-home interview, interviewers read the questions out loud and entered participant responses. For sensitive questions such as sexual history and ACEs, participants reported their answers directly into the laptop using the audio computer-assisted self-interviewing (audio-CASI) method (31, 32).

In total, 20,745 adolescents were recruited and completed the in-home interview for wave I with a response rate of 80%. In wave II, conducted in 1996, the original wave I participants were in grades 8-12 (N=14,738) with a response rate of 88.6%. Wave III was conducted in 2001-2002 when the wave I participants were ages 18-26 years (N=15,197) with a response rate of 77.4%. This wave of the study focused on collecting data during the transition from post-secondary education to adulthood. Wave IV was conducted in 2008 when the wave I participants were ages 24-32 years (N=15,701) with a response rate of 80.3%. Lastly, wave V was conducted

in 2016-2018 when the wave I participants were ages 32-42 years (N=12,300) with a response rate of 71.8%. The Add Health Public-Use Data is a subset of the full dataset. The Add Health Public-Use Data includes de-identified information from one-third of the participants that were randomly selected to be representative of the full data. While Add Health Public-Use data waves I-V asked questions about sexual and reproductive health histories, ACEs questions were asked in Waves I-IV and contraceptive use questions were asked in Wave IV. Thus, this study used data from Add Health Public-Use Data waves I-IV.

For this analysis, participants who did not identify as female were excluded from the study (n=3,148) (Figure 1). Given that the outcome measure was derived from wave IV, women who did not participate in wave IV were also excluded from this study (n=596). Women who were pregnant at the time of data collection were excluded (n=189). Women who had missing information or reported "other" contraceptive use (n=11) were excluded from the analysis, as were women who had incomplete information on age (n=2), race/ethnicity (n=8), insurance (n=24), and marital status (n=66). Thus, 2,460 women remained.

Measurement of Contraceptive Use

The outcome variable was contraceptive use, which was defined in two ways. First, contraceptive use was defined as a dichotomous outcome of contraceptive use and no contraceptive use. Second, contraceptive use was defined by type of contraceptive method and categorized as coital dependent methods, non-coital dependent methods, and no contraceptive use. Contraceptive use was obtained from wave IV data. While wave V included questions on contraceptive use, the questions were primarily focused on pre-pregnancy contraceptive use and frequency of contraceptive use; they did not have the exact type of contraceptive method a woman used. In addition, although contraceptive use was included in wave III, we used wave IV

data to measure contraceptive use because this would provide the most recent contraceptive use during peak reproductive years. In particular, data collection for wave IV occurred when participants were within reproductive age, between the ages of 24 and 32 years (33-35).

Specifically, contraceptive use was assessed using the following question during wave IV: “In the past 12 months, did you or your partner(s) use any of these methods for birth control or disease prevention (check all that apply).” Women who self-reported using any type of contraceptive method were considered to have the outcome and use contraception. In contrast, women who did not report using any of the listed contraceptive methods were considered not to use contraception. Again, we further considered the type of contraceptive method by classifying method according to the following three categories: no contraceptive use, coital dependent methods, and non-coital dependent methods (36). Coital dependent methods include male and female condoms, rhythm method or natural family planning, withdrawal or pulling out, foam, jelly, film, or cream, and emergency contraception. Non-coital dependent methods include female sterilization, male sterilization, contraceptive implant, Levonorgestrel or hormonal IUD, copper-bearing IUD, other IUD, shots, birth control pills, contraceptive patches, and contraceptive rings.

Measurement of ACEs

The exposure variables were ACEs. This study assessed eight measures of ACEs (37). ACEs were assessed by exposure to any ACE, experience of selected individual ACE measures, and a cumulative ACE score (17, 37). The cumulative ACE score was measured by the presence of 0, 1, 2, or 3 or more ACEs (38-41). The eight measures of ACEs included in this study were physical abuse, sexual abuse, neglect, emotional abuse, parental death, parental incarceration, parental alcoholism, and a family history of suicidal behavior (Table 1).

Measurement of Confounders

Potential confounders of the ACEs-contraceptive use association were selected from the literature and included age in wave IV, race/ethnicity, educational attainment, marital status, employment, health insurance, and parity (1, 8, 42-46).

Statistical Analysis

Frequencies and percentages were calculated to describe the study population. Logistic regression was used to obtain unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) of the association between ACEs and selected sociodemographic and lifestyle characteristics and the dichotomous contraceptive use outcome. Multivariate logistic regression was used to obtain adjusted ORs and 95% CIs to model the association between ACEs and contraceptive use while controlling for potential confounders. Survey-weighted multinomial logistic regression was used to estimate the unadjusted and adjusted ORs and 95% CIs of the association between ACEs and type of contraceptive method (i.e., coital dependent, non-coital dependent, and no contraceptive use). For the adjusted models, all of the potential confounders were included in the model and the final model was selected using a backward elimination procedure to retain only those variables with a $p<0.20$ (47). Survey weights from wave IV were applied at all stages of the analysis. Data were analyzed using SAS version 9.4 (SAS Institute Inc. Cary, NC) to account for the complex sampling design and weighting used by Add Health.

Results

Characteristics of the Study Population

The mean age of women in this sample was 28.89 years (Table 2). The majority of the women were Non-Hispanic White (67.47%), had health insurance (81.91%) and had at least one child (52.36%). Over half of the women reported experiencing at least 1 ACE (52.37%) (Table

2). The most common ACEs reported were emotional abuse (20.67%), physical abuse (18.01%), and parental incarceration (16.77%) (Table 3). Nearly 9% of women reported a family history of suicidal behavior. More than half of the women reported contraceptive use (53.21%).

Unadjusted Associations between Select Characteristics and ACEs and Contraceptive Use

Women with college or graduate degrees had nearly 3 times increased odds of contraceptive use compared to those with high school degrees or less (college degree: OR=2.75, 95% CI: 2.23-3.38; graduate degree: OR=3.01, 95% CI: 2.22-4.10, respectively; Table 4). Non-Hispanic Black and Hispanic women had statistically significant decreased odds of contraceptive use compared to Non-Hispanic White women (Non-Hispanic Black: OR=0.65, 95% CI: 0.53-0.78; Hispanic: OR=0.74, 95% CI: 0.57-0.98). Women with health insurance had 1.73 times the odds of contraceptive use (95% CI: 1.41-2.13) compared to women without health insurance.

Women who experienced any ACEs had decreased odds of contraceptive use (OR=0.83, 95% CI: 0.70-0.97; Table 4). Women who experienced neglect (OR=0.63, 95% CI: 0.46-0.87), parental death (OR=0.60, 95% CI: 0.42-0.86), or had a family history of suicidal behavior (0.69, 95% CI: 0.52-0.93) had statistically significant decreased odds of contraceptive use compared to women who did not report experiencing these ACEs. Women who reported experiencing 1 ACE had statistically significant decreased odds of contraceptive use (OR=0.77, 95% CI: 0.64-0.94) compared to women with no ACEs. However, there was no strong association between reporting experiencing 2 or 3 or more ACEs and contraceptive use (2 ACEs: OR=0.95, 95% CI: 0.74-1.23; ≥3 ACEs: OR=0.82, 95% CI: 0.65-1.03, respectively).

Unadjusted Associations between ACEs and Type of Contraceptive Method

Women exposed to any ACEs had decreased odds of coital and non-coital dependent methods (coital: OR=0.88, 95% CI: 0.668-1.13; non-coital: OR=0.98, 95% CI: 0.81-1.18,

respectively; Table 4). However, these findings were not statistically significant. Women who experienced neglect had statistically significant decreased odds of using coital dependent methods (OR=0.54, 95% CI: 0.30-0.97) compared to women who did not experience neglect. There was no association between women with a family history of suicidal behavior and using coital or non-coital contraceptive methods (coital: OR=0.97, 95% CI: 0.93-1.01; non-coital: OR=1.01, 95% CI: 0.98-1.04). Similarly, although women with 1 ACE had decreased odds of using coital dependent methods (OR=0.83, 05% CI: 0.62-1.10), there was no strong association between all other categories of frequency of ACEs and using coital or non-coital dependent methods.

Adjusted Associations between ACEs and Contraceptive Use

After adjustment for age, educational attainment, and insurance, there was no longer an association between exposure to any ACEs and contraceptive use (AOR=1.05, 95% CI: 0.87-1.26; Table 5). Although women who experienced neglect and parental death had decreased odds of contraceptive use, these findings were no longer statistically significant after adjustment (neglect: AOR=0.75, 95% CI: 0.48-1.17; parental death: AOR=0.89, 95% CI: 0.58-1.37, respectively). After adjustment, the magnitude of the association between women with a family history of suicidal behavior and contraceptive use was unchanged and the results remained statistically significant (AOR=0.69, 95% CI: 0.51-0.96).

Compared to women with no ACEs, there was no association between experiencing 1 ACE and contraceptive use (AOR=0.96, 95% CI: 0.76-1.22) after adjustment for age, educational attainment, and insurance. After adjustment, women with 2 ACEs or 3 or more ACEs had slightly increased odds of contraceptive use, although these findings were not statistically significant (2 ACEs: AOR=1.10, 95% CI: 0.84-1.44; ≥ 3 ACEs: AOR=1.15, 95% CI:

0.89-1.50, respectively).

Adjusted Associations between ACEs and Type of Contraceptive Method

After adjustment for educational attainment, there was no association between experiencing any ACEs and coital and non-coital dependent methods (coital: AOR=1.04, 95% CI: 0.78-1.37; non-coital: AOR=1.06 (95% CI: 0.89-1.30; Table 5). Women who experienced neglect (AOR=0.63, 95% CI: 0.35-1.13) had decreased odds of using coital dependent methods after adjustment for educational attainment; however, these associations were no longer statistically significant. In addition, women with a family history of suicidal behavior had 0.74 times decreased odds of using coital dependent methods (95% CI: 0.46-1.20) compared to women without a family history of suicidal behavior after adjustment for educational attainment. While there was no strong association between women who experienced 1 ACE (AOR=0.94, 95% CI: 0.68-1.29) and using coital dependent methods and 2 ACEs and using coital dependent methods (OR=1.05, 95% CI: 0.71-1.56), those women with 3 or more ACEs (AOR=1.20, 95% CI: 0.76-1.89) had increased odds of using coital dependent methods compared to women with no ACEs after adjustment.

Women who experienced neglect and had a family history of suicidal behavior had decreased odds of using non-coital dependent methods compared to women who did not experience neglect after adjustment (neglect: AOR=0.81, 95% CI: 0.54-1.21, suicidal behavior: AOR=0.75, 95% CI: 0.53-1.06, respectively). There was no association between women who experienced 1 ACE and using non-coital dependent methods compared to women with no ACEs (AOR=1.01, 95% CI: 0.78-1.31). Although women who experienced 2 ACEs had increased odds of using non-coital dependent contraceptive methods (OR=1.13, 95% CI: 0.84-1.51), this association was not statistically significant. There was a slight association between women with

3 or more ACEs and non-coital dependent methods compared to women without ACEs. However, these findings were not statistically significant (AOR=1.09, 95% CI: 0.83-1.43).

Discussion

In this population-based study, slightly more than half of the women reported contraceptive use. The majority of the women in this study reported having at least 1 ACE (52.95%). Except for women with a family history of suicidal behavior, no statistically significant associations were found between ACE types and contraceptive use. Women with a family history of suicidal behavior had statistically significant decreased odds of contraceptive use after adjustment for educational attainment. While women with a family history of suicidal behavior had decreased odds of using both coital and non-coital dependent methods compared to no contraceptive use, these findings also were not statistically significant.

In our study, which used data collected during Wave IV in 2008, 53% of women reported contraceptive use. These findings are congruent with 2006-2008 National Survey of Family Group (NSFG) data, which reported 62% of women with current contraceptive use (48). In addition, our findings are consistent with the 59.4% of respondents who reported experiencing at least 1 ACE in the 2009 Behavioral Risk Factor Surveillance System (BRFSS), a nationally representative survey (49).

Few studies have examined the association between ACEs and contraceptive use. Our study found no association between exposure to any ACEs and contraceptive use in our study. This finding is consistent with the previous study of women in Honduras who found no association between experiencing any ACEs and contraceptive use, despite differences in the sample populations (17). However, our findings are inconsistent with those of Thomas, Lewis (16) who found that women with ACEs had statistically significant decreased odds of

contraceptive use after birth. It is important to note that Thomas' (15) study was conducted among postpartum women. It may be that women who have recently given birth encounter unique challenges in contraceptive use such as birth spacing and breastfeeding, which may differ from non-postpartum women.

Our study found that women with a family history of suicidal behavior during childhood had statistically significant decreased odds of contraceptive use. To our knowledge, no literature exists on women who experienced a family history of suicidal behavior and contraceptive use. However, a recent study found that women with a history of previous suicide attempts have an increased risk of unplanned pregnancy compared to women who have not attempted suicide (50). While it is plausible that the increased risk for unplanned pregnancy may be due to decreased contraceptive use, contraceptive use was not measured as an outcome in the study. Individuals with a family history of suicidal behavior have an increased risk of depressive symptoms, mental health conditions, and suicidality (51-53). Mental health conditions can decrease the odds of consistent contraceptive use by affecting women's motivations to use contraception or by reducing their ability to negotiate contraceptive use with partners (54-57).

The present study has several limitations. Using self-reported data for both the exposure and outcome variables may result in non-differential misclassification. This is particularly relevant to the use of ACEs data, as participants are required to recall events from their childhood that may be subject to recall or social desirability bias. While ACEs questions such as family history of suicidal behavior were assessed during childhood in Wave I, questions such as childhood sexual abuse were asked in young adulthood in Wave IV, when the survey participants were aged 24-32 years (58). Despite the possibility for misclassification, the women in this study were younger and, thus, surveyed closer to the time of ACE exposure than most other ACEs

studies (1, 4). In addition, retrospective self-reported ACEs data is valid and reliable (59-61). Nondifferential misclassification of the outcome variable, contraceptive use in the past 12 months, is also possible. Self-reported contraceptive use data may be prone to social desirability bias, leading to participants overreporting their contraceptive use (62, 63). Despite these limitations, previous literature has shown that self-reported data on contraceptive use is reliable and valid (64, 65). While selection bias may be possible, it is limited given the high response rates of the Add Health data (wave I: 79%, wave III: 77.4%, and wave IV: 80.3%). Lastly, the study is limited by the questions asked in Add Health, which may lead to uncontrolled confounding.

Despite these limitations, the current study has several strengths. The findings from this study add to the existing literature on the association between ACEs and contraceptive use and focus exclusively on non-pregnant women rather than solely on postpartum women. To our knowledge, this is the first study of its kind to investigate the impact of ACEs on contraceptive use using data from the largest nationally representative longitudinal study of adolescents in the US. Unlike previous studies, this study considered a family history of suicidal behavior an ACE, a known risk factor for adverse mental health outcomes in adulthood, and assessed each type of ACE individually and cumulatively, to allow for a better understanding of the co-occurring nature of ACEs and their combined effects on contraceptive use (17, 37, 51, 66, 67). ACEs were obtained from different waves of data collection, enabling the observation of a temporal sequence of events. Moreover, given our population-based sample and the complex sampling design of Add Health, our findings can likely be generalized to the larger population of women aged 24-32 years residing in the US.

Conclusions

This study provides important insights into the impact of ACEs on contraceptive use among women of reproductive age. Exposure to a family history of suicidal behavior may be an important factor in shaping a woman's contraceptive choices. The present study highlights the potential utility of incorporating ACE screening in reproductive health counseling to identify and address potential barriers to contraceptive use. Further research is needed to assess contraceptive use among women with ACEs in diverse populations. Moreover, studies exploring the intersection of violence prevention and reproductive epidemiology may inform clinical practice and public health interventions aimed at improving women's reproductive health with a history of ACEs.

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Table 1a. Adverse childhood experiences measures, questions, and recoded variables

ACE Measure	**Add Health Wave:**	**Question:**	**Recoded Variable:**
Physical abuse	IV	Before your 18th birthday, how often did a parent or adult caregiver hit you with a fist, kick you, or throw you down on the floor, into a wall, or down stairs?	1 or more times = Yes Never happened = No
Sexual abuse	IV	How often did a parent or other adult caregiver touch you in a sexual way, force you to touch him or her in a sexual way, or force you to have sexual relations?	1 or more times = Yes Never happened = No
Emotional abuse	IV	Before your 18th birthday, how often did a parent or other adult caregiver say things that really hurt your feelings or made you feel like you were not wanted or loved?	6 or more times = Yes Never happened = No
Neglect	III	How often had your parents or other adult caregivers not taken care of your basic needs, such as keeping you clean or providing food or clothing?	1 or more times = Yes Never happened = No
Parental death	I and II	Is your mother/father still living?	No (Not still living) = Yes Yes (Still living) = No
Parental incarceration	IV	How old were you when your biological mother/father was released from jail or prison (most recently)?	< 18 years = Yes ≥ 18 years = No
Parental alcoholism	I Parent Questionnaire	Does his/her biological mother/father has alcoholism?	Yes = Yes No = No
Family history of suicidal behavior	I and II	Have any of your family members tried to kill themselves during the past 12 months?	Yes = Yes No = No

Table 2a. Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and contraceptive use among women participating in Add Health in Waves I-IV

Variables	Total N=2,460 (%)	Contraceptive Use N=1,309 (%)	Contraceptive Use Unadjusted OR (95% CI)
Age			
Mean age (STD)	28.89 (5.91)	28.80 (4.44)	**0.94 (0.90, 0.98)**
Race/Ethnicity			
Non-Hispanic White	1452 (67.47)	830 (71.11)	Ref
Non-Hispanic Black	601 (15.81)	278 (13.34)	**0.65 (0.53, 0.78)**
Hispanic	245 (10.71)	122 (10.05)	**0.74 (0.57, 0.98)**
Other	162 (6.00)	79 (5.50)	**0.71 (0.52, 0.99)**
Educational Attainment			
High school or less	710 (30.14)	275 (22.83)	Ref
Some college	845 (35.40)	453 (36.46)	**1.83 (1.49, 2.24)**
College degree	701 (26.98)	443 (31.63)	**2.72 (2.19, 3.37)**
Graduate degree	201 (7.49)	138 (9.35)	**3.31 (2.38, 4.60)**
Employment			
Employed	2303 (94.87)	1247 (95.58)	Ref
Not employed	130 (5.13)	62 (4.42)	0.79 (0.56, 1.13)
Marital Status			
Married	317 (13.92)	179 (12.84)	Ref
Divorced/Separated	91 (3.76)	49 (3.68)	0.90 (0.56, 1.44)
Cohabitating	1719 (70.99)	916 (71.87)	0.88 (0.69, 1.12)
Dating/Pregnancy with partner	224 (8.29)	132 (9.30)	1.11 (0.78, 1.56)
Single	109 (3.97)	33 (2.31)	**0.34 (0.21, 0.53)**
Health Insurance			
Yes	2015 (81.91)	1122 (85.32)	**1.73 (1.41, 2.13)**
No	445 (18.09)	187 (14.68)	Ref
Parity			
0	201 (7.24)	116 (7.96)	Ref
≥1	1432 (59.07)	726 (56.88)	0.75 (0.56, 1.02)
Unknown	827 (33.69)	467 (35.16)	0.95 (0.70, 1.30)
Types of ACEs			
Physical abuse			
Yes	433 (18.01)	230 (18.68)	0.99 (0.81, 1.23)
No	2027 (81.99)	1079 (81.32)	Ref
Sexual abuse			
Yes	178 (6.75)	96 (7.12)	1.03 (0.76, 1.40)
No	2282 (93.25)	1213 (92.88)	Ref
Emotional abuse			
Yes	493 (20.67)	273 21.85)	1.12 (0.91, 1.36)
No	1967 (79.33)	1036 (78.15)	Ref
Neglect			
Yes	169 (7.25)	72 (6.17)	**0.63 (0.46, 0.87)**
No	2291 (92.75)	1237 (93.83)	Ref

Table 2a (continued). Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and contraceptive use among women participating in Add Health in Waves I-IV

Variables	Total N=2,460 (%)	Contraceptive Use N=1,309 (%)	Contraceptive Use Unadjusted OR (95% CI)
Types of ACEs			
Parental death			
Yes	131 (4.83)	54 (3.94)	**0.60 (0.42, 0.86)**
No	2329 (95.17)	1255 (96.06)	Ref
Parental incarceration			
Yes	423 (16.77)	214 (16.65)	0.88 (0.71, 1.09)
No	2037 (83.23)	1095 (83.35)	Ref
Parental alcoholism			
Yes	27 (1.01)	9 (0.68)	0.52 (0.23, 1.19)
No	2243 (91.11)	1204 (91.68)	Ref
Unknown	193 (7.88)	96 (7.65)	0.85 (0.64, 1.15)
Family history of suicidal behavior			
Yes	210 (8.79)	95 (7.19)	**0.69 (0.52, 0.93)**
No	1710 (69.74)	929 (71.47)	Ref
Unknown	540 (21.47)	285 (21.33)	0.94 (0.77, 1.14)
Any ACEs			
Yes	1275 (52.37)	649 (51.54)	**0.83 (0.70, 0.97)**
No	1185 (47.64)	660 (484.46)	Ref
Frequency of ACEs			
0 ACEs	1185 (47.64)	660 (48.46)	Ref
1 ACE	594 (24.37)	293 (23.41)	**0.77 (0.64, 0.94)**
2 ACEs	292 (12.19)	159 (12.36)	0.95 (0.74, 1.23)
≥3 ACEs	389 (15.80)	197 (15.77)	0.82 (0.65, 1.03)

Table 3a. Descriptive data of adverse childhood experiences among women

ACEs	%	95% CI
Physical abuse	18.01	16.05-19.97
Sexual abuse	6.75	5.46-8.04
Emotional abuse	20.67	18.46-22.88
Neglect	7.25	5.94-8.55
Parental death	4.83	3.90-5.76
Parental incarceration	16.77	14.68-18.85
Parental alcoholism	1.01	0.60-1.41
Family history of suicidal behavior	8.79	7.29-10.29

Table 4a. Unadjusted odds ratios and 95% confidence intervals for the association between ACEs and type of contraceptive method

Model	Coital dependent methods Unadjusted OR (95% CI)	Non-coital dependent methods Unadjusted OR (95% CI)
Types of ACEs		
Physical abuse		
Yes	1.24 (0.85, 1.79)	1.01 (0.76, 1.35)
No	Ref	Ref
Sexual abuse		
Yes	1.19 (0.78, 1.83)	1.19 (0.80, 1.78)
No	Ref	
Emotional abuse		
Yes	1.17 (0.87, 1.57)	1.17 (0.90, 1.53)
No	Ref	Ref
Neglect		
Yes	**0.54 (0.30, 0.97)**	0.74 (0.50, 1.11)
No	Ref	Ref
Parental death		
Yes	0.65 (0.38, 1.14)	0.65 (0.40, 1.06)
No	Ref	Ref
Parental incarceration		
Yes	0.93 (0.66, 1.31)	1.03 (0.78, 1.35)
No	Ref	Ref
Parental alcoholism		
Yes	0.98 (0.93, 1.04)	0.99 (0.95, 1.04)
No	Ref	Ref
Family history of suicidal behavior		
Yes	0.97 (0.93, 1.01)	1.01 (0.98, 1.04)
No	Ref	Ref
Any ACEs		
Yes	0.88 (0.68, 1.13)	0.98 (0.81, 1.18)
No	Ref	Ref
Frequency of ACEs		
0 ACEs	Ref	Ref
1 ACE	0.83 (0.62, 1.10)	0.95 (0.74, 1.22)
2 ACEs	0.90 (0.61, 1.35)	1.05 (0.79, 1.40)
≥ 3 ACEs	0.94 (0.61, 1.45)	0.96 (0.73, 1.25)

Table 5a. Adjusted odds ratios and 95% confidence intervals for the association between adverse childhood experiences and type of contraceptive method

Model	Contraceptive Use [a, 1] Adjusted OR (95% CI)	Coital dependent methods [b, 2] Adjusted OR (95% CI)	Non-coital dependent methods [b,2] Adjusted OR (95% CI)
Types of ACEs			
Physical abuse			
Yes			
No	1.14 (0.88, 1.46)	1.28 (0.89, 1.84)	1.01 (0.76, 1.34)
Sexual abuse	Ref	Ref	Ref
Yes			
No	1.28 (0.90, 1.82)	1.36 (0.88, 2.10)	1.26 (0.83, 1.93)
Emotional abuse	Ref	Ref	
Yes			
No	1.16 (0.91, 1.48)	1.15 (0.86, 1.54)	1.13 (0.86, 1.50)
Neglect	Ref	Ref	Ref
Yes			
No	0.75 (0.48, 1.17)	0.63 (0.35, 1.13)	0.81 (0.54, 1.21)
Parental death	Ref	Ref	Ref
Yes			
No	0.89 (0.58, 1.37)	0.77 (0.44, 1.33)	0.70 (0.42, 1.18)
Parental incarceration	Ref	Ref	Ref
Yes			
No	1.17 (0.91, 1.50)	1.21 (0.86, 1.71)	1.18 (0.90, 1.55)
Parental alcoholism	Ref	Ref	Ref
Yes			
No	0.57 (0.25, 1.30)	0.56 (0.13, 2.43)	0.69 (0.27, 1.73)
Family history of suicidal behavior	Ref	Ref	Ref
Yes			
No	**0.69 (0.51, 0.96**)	0.74 (0.46, 1.20)	0.75 (0.53, 1.06)
	Ref	Ref	Ref
Any ACEs			
Yes	1.05 (0.87, 1.26)	1.04 (0.78, 1.37)	1.06 (0.87, 1.30)
No	Ref	Ref	Ref
Frequency of ACEs			
0 ACEs	Ref	Ref	Ref
1 ACE	0.96 (0.76, 1.22)	0.94 (0.68, 1.29)	1.01 (0.78, 1.31)
2 ACEs	1.10 (0.84, 1.44)	1.05 (0.71, 1.56)	1.13 (0.84, 1.51)
≥ 3 ACEs	1.15 (0.89, 1.50)	1.20 (0.76, 1.89)	1.09 (0.83, 1.43)

[a] Logistic regression; Contraceptive use versus no contraceptive use.
[b] Multinomial logistic regression; Each contraceptive method versus no contraceptive method
[1] Models adjusted for age, educational attainment, and insurance.
[2] Models adjusted for educational attainment.

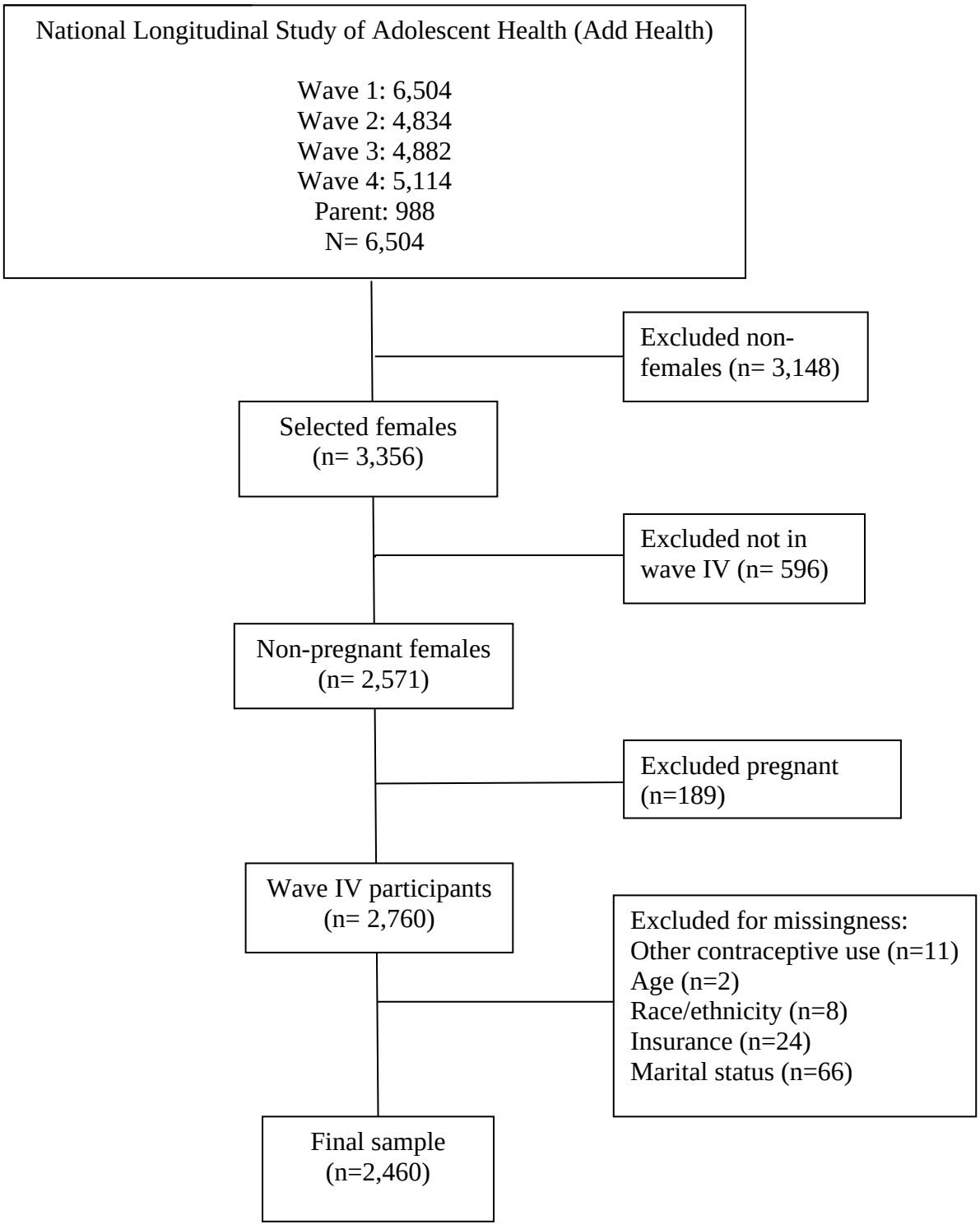

Figure 1a. Flow diagram of sample population.

CHAPTER 3: THE ASSOCIATION BETWEEN ACES AND PRENATAL CARE: A POPULATION-BASED STUDY

Abstract

Background: In the US, nearly 80% of women reported beginning prenatal care (PNC) in their first trimester of pregnancy. In addition, more than half of adults reported at least one adverse childhood experience (ACEs) in their lifetime, which has been positively associated with poor birth outcomes. Although a few studies have examined the association between ACEs and PNC, the findings are inconsistent. The present study aimed to investigate the association between ACEs and early initiation of PNC using data from the National Longitudinal Study of Adolescent Health (Add Health).

Methods: Data were gathered from waves I-V of the Add Health Public-Use data for women aged 32-42 (N=1,619). The outcome variable was early initiation of prenatal care, defined as early PNC and late/no PNC. ACEs were evaluated individually by type of ACE and by frequency. Women self-reported information on PNC and ACEs. Multivariate logistic regression was used to obtain odds ratios (ORs) and 95% confidence intervals (CIs).

Results: Approximately 92% of women reported early initiation of PNC. After adjustment for marital status and educational attainment, women who experienced parental alcoholism had statistically significant decreased odds of early initiation of PNC (AOR=0.18, 95% CI: 0.06-0.55). Women who experienced any ACEs had decreased odds of PNC; however, this finding was no longer statistically significant after adjustment (AOR=0.70, 95% CI: 0.42-1.16).

Conclusions: Women who experienced parental alcoholism during childhood may have unique challenges in accessing early PNC. Findings from this study provide further support for ACEs screening during reproductive health visits prior to the first pregnancy.

Introduction

Nearly two-thirds of adults have experienced at least one adverse childhood experience (ACE) (1). While ACEs tend to co-occur in clusters, four or more ACEs are most reported among females and adults aged 25-34, an age range generally associated with peak reproductive years (1-3). ACEs are associated with poor health outcomes across the lifespan including obesity, diabetes, and cardiovascular disease (4-9). Moreover, ACEs are associated with increased odds of risky reproductive health behaviors among women, as well as adverse birth outcomes such as low birth weight and preterm birth (10-14).

Prenatal care (PNC) remains the standard preventive approach to improving perinatal health outcomes in the US (15, 16). In 2021, approximately 78% of women reported receiving PNC in the first trimester of pregnancy (17). Given the significance of timely PNC, Healthy People 2030 aims to increase the proportion of pregnant women who receive early and adequate PNC to 80.5% (18). However, the percentage of pregnant women who received early and adequate PNC decreased from 76.4% in 2018 to 75.6% in 2021 (18). While data on the effectiveness of PNC in the US is inconsistent, women who lacked or received no PNC had an increased risk for pregnancy complications, such as low birth weight and preterm birth (19). In addition, early PNC is associated with positive maternal health behaviors during the postpartum period, including decreased smoking and increased likelihood of attending four or more well-baby visits (20).

Previous research on ACEs and PNC is limited and inconsistent. In a study of 467 women recruited through the Stress, Trauma and the Childbearing Year (STACY) project, a three-cohort study in Michigan, women who experienced childhood maltreatment had increased odds of receiving adequate PNC (AOR=2.89, 95% CI: 1.41-5.90) (21). However, the exposure

variable, childhood maltreatment, was defined using the Life Stressor Checklist-Revised, which measures a broad range of stressful life events, including abortion and natural disasters. Thus, the stressful life events measured are not restricted to events experienced during childhood (22). Moreover, the events classified as childhood maltreatment in the STACY project were restricted to experiences of abuse or physical neglect under the age of 16 (21). In another study that used data from the 2016-2018 Pregnancy Risk Assessment Monitoring System (PRAMS), a lower proportion of participants with three or more ACEs reported receiving adequate PNC when compared to participants without ACEs (23). However, there was no significant association between ACEs and adequate PNC after adjustment for sociodemographic covariates. While this study had a sample size of 14,510 women from 5 states, information was collected from women who were 2-6 months postpartum and the impact of individual ACEs on PNC was not assessed. In addition, the ACEs questions varied by state. For example, abuse and physical neglect were included in North and South Dakota questionnaires, while living in foster care was included in Kansas, Michigan, and Rhode Island. Given that data from the PRAMS study were derived only from these 5 states in the Midwest and Northeast, generalizability of the study findings may be limited.

To the best of our knowledge, the two studies mentioned above are the only known studies that have investigated the association between ACEs and PNC (24, 25). The present study aims to expand on the current literature using data from the National Longitudinal Study of Adolescent Health (Add Health) to assess the association between ACEs and early initiation of PNC. By examining the cumulative and individual impact of a broad spectrum of ACEs on early initiation of PNC within a population-based sample, findings from this study may contribute to our understanding of the effects of ACEs on perinatal health behaviors among women living in

the US.

Methods

This study used data from the National Longitudinal Study of Adolescent Health (Add Health), a prospective cohort study that provides national estimates of biological, social, and behavioral factors impacting the health of the noninstitutionalized population residing in the US. Add Health follows adolescents in the 7th to 12th grade in 1994-1995 into adulthood (26). The first wave of data was collected in schools using a multi-stage stratified cluster sampling design (26, 27). Participants in waves II-V were selected from the wave I sample. During each wave of data collection, trained interviewers conducted in-home interviews with eligible participants from Wave I (Harris, 2013). Participant responses were recorded by interviewers and audio computer-assisted self-interviewing (audio-CASI) was used to complete sensitive questions such as ACEs (Chen & Chantala, 2014; Harris, 2013).

The full Add Health dataset has nearly 21,000 adolescents who completed the wave I in-home interview (N= 20,745; response rate: 80%). Wave II was conducted in 1996 when the original wave I participants were in grades 8-12 (N=14,738; response rate: 88.6%). In 2001-2002, wave III data collection was completed when the original wave I participants were 18-26 years (N=15,197; response rate: 77.4%). Wave IV was conducted in 2008 when the original wave I participants were aged 24-32 years (N=15,701; response rate: 80.3%) and wave V was conducted in 2016-2018 when the original wave 1 participants were aged 33-43 years (N=12,300; response rate: 71.8%). The full Add Health dataset is not publicly available. Rather, Add Health personnel created the Add Health Public-Use Data, which contains de-identified data of participants randomly selected from the core in-home sample and oversampled special groups. These datasets are accessible to the public and represent one-third of the full dataset. Thus, for

this study, we used waves I-V Public-Use Data to conduct our analyses (Wave I: N=6,504, Wave II: N=4,834, Wave III: N=4,882, Wave IV: 5,114, Wave V: 4,196). Data from waves I-V included items on PNC, whereas waves I-IV included ACEs.

The Add Health Public-Use Data for waves I-V had 6,504 participants. Participants who did not identify as female (n=3,148) were excluded from this analysis. Women who were pregnant at the time of data collection (n=53) or had never had a live birth (n=87) were also excluded. Women who had missing information for PNC (n=1,560) and timing of initiation of PNC (n=53) were excluded. For women who had more than one live birth, only the first birth was included in this analysis (28, 29). Women who had incomplete information on sociodemographic characteristics such as race (n=7), insurance (n=24), marital status (n=1), and employment status (n=4) were also excluded. Thus, 1,619 women were included in this study.

Measurement of PNC

The outcome variable was early initiation of PNC. In wave V, information regarding PNC was collected specifically for pregnancies that resulted in a live birth. Therefore, early initiation of PNC during the first live birth was assessed. Early initiation of PNC was measured using two questions: “During this pregnancy did you or your pregnancy partner ever visit a doctor, nurse-midwife or other health care provider for PNC, that is, for one or more pregnancy check-ups?” and “How many weeks pregnant were you or your pregnancy partner at the time of the first PNC visit?” PNC A dichotomous variable was created to determine if women met PNC recommended guidelines of the Institute of Medicine (IOM) and American College of Obstetricians and Gynecologists (ACOG) for their first PNC visit during the first trimester (16, 30). Women who received PNC within the first 12 weeks of pregnancy were considered to have early initiation of PNC,, while women who responded that they received PNC at 13 weeks or

later or did not receive PNC were considered to have late or no initiation of PNC (31).

Measurement of ACEs

The exposure variables in this study were eight measures of ACEs, including physical abuse, sexual abuse, neglect, emotional abuse, parental death, parental incarceration, parental alcoholism, and a family history of suicidal behavior. ACEs were assessed individually by type and cumulatively by measuring the presence of 0, 1, 2, and 3 or more ACEs.

The ACEs questions were obtained from various waves. The physical abuse question asked respondents how often a parent or adult caregiver hit them with a fist, kicked them, or threw them down on the floor, into a wall, or downstairs before their 18th birthday. Sexual abuse questions assessed how often a respondent's parent or other adult caregivers sexually touched them, forced them to touch them in a sexual way, or forced them to have sexual relations. Neglect questions asked respondents how often their parents or other adult caregivers did not care for their basic needs, such as keeping them clean or providing food or clothing.

Emotional abuse was assessed by how often a respondent's parent or other adult caregiver said things that hurt their feelings or made them feel like they were not wanted or loved. Responses of six or more times were considered to have experienced emotional abuse. Parental death asked respondents whether their biological mother/father was still living. Respondents who reported "no" to having their biological parent still living in the first two waves of data collection were considered to have experienced parental death.

Respondents' age when their biological mother/father was most recently released from jail or prison was used to assess parental incarceration. Respondents who reported being under 18 years of age to this question were considered to have experienced parental incarceration. Parental alcoholism was determined by whether the respondent's biological mother/father had

alcoholism. Respondents whose parents reported "yes" were considered to have a biological parent with alcoholism. The family history of suicidal behavior question asked if any of the respondent's family members had tried to kill themselves during the past 12 months. Respondents who reported "yes" to this question in waves I or II were considered to have experienced a family history of suicidal behavior.

Measurement of Confounders

Potential confounders were identified in the literature as factors associated with ACEs and PNC. Sociodemographic and lifestyle characteristics such as maternal age, race/ethnicity, educational attainment, health insurance, marital status, and employment status were included (32-34).

Statistical analysis

Descriptive statistics of the sociodemographic and lifestyle characteristics of the sample population were calculated using frequencies and percentages. Logistic regression was used to obtain unadjusted odds ratios (ORs) and 95% confidence intervals (CIs) to provide the crude association between sociodemographic and lifestyle characteristics, ACEs, and early initiation of PNC. Multivariate logistic regression was used to calculate adjusted ORs and 95% CIs for the ACEs and early initiation of PNC associations. Maternal age, race/ethnicity, educational attainment, health insurance, marital status, and employment status were included in the adjusted models as potential confounders. The change-in-estimate strategy was used to evaluate potential confounders, wherein covariates that resulted in more than a 10% change in the adjusted odds ratio were retained (35). Since the outcome variable, early initiation of PNC was selected from wave V, the cross-sectional variable from wave V was used for all analyses (36). SAS survey procedures (version 9.4, SAS Institute Inc. Cary, NC) were used to account for Add Health's

complex sampling design and weighting .

Results

Study population

The mean age of women in this study was 37.06 years (Table 1). The majority of women were Non-Hispanic White (70.01%) and married (65.61%). Approximately 92% of women had early initiation of PNC. Nearly half of the women in this sample reported experiencing at least 1 ACE (44.57%). Of the women who experienced ACEs, 22% experienced 1 ACE, 9% experienced 2 ACEs, and 13% experienced 3 or more ACEs. Among reported ACEs, emotional abuse (14.57%), physical abuse (14.30%), and parental incarceration (13.74%) were the most frequent. Fewer women reported experiencing parental death (5.17%) and parental alcoholism (1.33%).

Unadjusted Associations between Select Characteristics and ACEs and Early Initiation of PNC

Non-Hispanic Black and Hispanic women had statistically significant decreased odds of early initiation of PNC compared to Non-Hispanic White women (Non-Hispanic Black: OR=0.39 95% CI: 0.22-0.68; Hispanic: OR=0.49, 95% CI: 0.26-0.90, respectively; Table 1). Moreover, women with some college had nearly 2 times increased odds of early initiation of PNC (OR=1.89, 95% CI: 1.11-3.21), while women with a college degree and graduate degree had nearly 5-times and 8-times increased odds of early initiation of PNC, respectively (College: OR=4.83, 95% CI: 2.26-10.31; Graduate: OR=7.62, 95% CI: 2.48-23.44).

There was no association between women who experienced neglect and early initiation of PNC compared to women who did not experience neglect (OR=0.93, 95% CI: 0.30-2.83). These findings were not statistically significant. However, women who experienced parental death and parental alcoholism had statistically significant decreased odds of early initiation of PNC

compared to women who did not experience these ACEs (Parental death: OR=0.40, 95% CI: 0.18-0.92 and Parental alcoholism: OR=0.17, 95% CI: 0.04-0.68; Table 1).

Women who experienced any ACE had statistically significant decreased odds of early initiation of PNC (OR=0.56, 95% CI: 0.35-0.91). When considering the exposure by number of ACEs, women who experienced 3 or more ACEs had statistically significant decreased odds of early initiation of PNC compared to women with no ACEs (OR=0.48, 95% CI: 0.29-0.81). Women who reported 2 ACEs had similar decreased odds of early initiation of PNC; however, this finding was not statistically significant (OR=0.47, 95% CI: 0.21, 1.04). Women who experienced 1 ACE had 30% decreased odds of early initiation of PNC compared to women who experienced no ACEs (OR=0.69, 95% CI: 0.36-1.33).

Adjusted Associations between ACEs and Early Initiation of PNC

After adjustment for marital status and educational attainment, the association between women who experienced neglect and early initiation of PNC increased in magnitude and remained not statistically significant compared to women who did not experience neglect (AOR=1.37, 95% CI: 0.43-4.33; Table 2). The association for women who experienced parental death and early initiation of PNC was slightly increased after adjustment for race/ethnicity and educational attainment (AOR=0.51, 95% CI: 0.23-1.12); however, this finding was no longer statistically significant. In contrast, the magnitude of the association between women who experienced parental alcoholism and early initiation of PNC remained relatively unchanged and statistically significant after adjustment for marital status and educational attainment (AOR=0.18, 95% CI: 0.06-0.55).

Women who experienced ACEs had decreased odds of receiving early initiation of PNC compared to women without ACEs after adjustment for marital status and educational attainment

(AOR=0.70, 95% CI: 0.42-1.16); however, these findings were no longer statistically significant. After adjustment for marital status and educational attainment, the magnitude of the associations between women with ACEs and early initiation of PNC was slightly attenuated. When examining ACEs by frequency, women who experienced 3 or more ACEs had decreased odds of early initiation of PNC after adjustment; however, this finding was also no longer statistically significant (AOR=0.64, 95% CI: 0.38-1.09). Similarly, women who experienced 2 ACEs had decreased odds of early initiation of PNC after adjustment (AOR=0.59, 95% CI: 0.27-1.32). After adjustment, women who reported 1 ACE had 20% decreased odds of early initiation of PNC (AOR=0.81, 95% CI: 0.41-1.62).

Discussion

In this population-based study, we found that women who experienced parental alcoholism had statistically significant decreased odds of early initiation of PNC in both unadjusted and adjusted models. In the unadjusted model, parental death was associated with statistically significant decreased odds of early initiation of PNC; however, this finding was no longer statistically significant after adjustment. Women who experienced neglect had increased odds of early initiation of PNC after adjustment; however, this finding was not statistically significant. In addition, women who experienced any ACEs and one or more ACEs had decreased odds of early initiation of PNC in the unadjusted and adjustment models; however, these results were not significant after adjustment.

More than 90% of the women in our sample reported early initiation of PNC. In 2018, 78% of women in the US received PNC in their first trimester (37). While our sample reported a higher proportion of women with early initiation of PNC, the majority of the women in this sample identified as Non-Hispanic White and 40% of women had a college degree or higher

(37). A previous study using the Behavioral Risk Factor Surveillance System found that 58% of the US population have experienced at least 1 ACE compared to the 45% of women with ACEs in our study (38). This discrepancy may be due to differences in the measures of ACEs. Specifically, the BRFSS study included emotional abuse with a cut-off point of 1, whereas our study used a cut-off point of six or more times. In addition, the BRFSS study included ACEs such as household substance use and mental illness, whereas our study included parental alcoholism specifically.

In this current study, women who experienced parental alcoholism had statistically significant decreased odds of early initiation of PNC. To our knowledge, no prior studies have explored the relationship between a family history of parental alcoholism and PNC. Evidence suggests that children who experience parental alcoholism have an increased likelihood of substance use in adulthood and during pregnancy (39, 40). Women who engage in substance use may experience additional barriers to prenatal care, such as limited accessibility and the stigma associated with alcohol use during pregnancy, which may prevent early initiation of PNC in the first trimester (41-43). Therefore, women with a family history of parental alcoholism and who may be engaging in substance use during pregnancy may face additional challenges with accessing PNC compared to women without this ACE.

Although parental death was associated with statistically significant decreased odds in the unadjusted model, this association was no longer statistically significant after adjustment. To date, no prior studies have assessed parental death as an ACE and its association with early initiation of PNC. Individuals who experienced parental death during childhood have an increased risk for psychiatric disorders, including depression and lower socioeconomic status in adulthood (44, 45). Moreover, childhood bereavement is associated with an increased risk for

adverse health outcomes and maladaptive stress responses, which may limit their capacity to seek early PNC (45). These pathways, however, may also serve as mechanisms for increased morbidity in the next generation (45, 46). Women who experienced parental death may face unique barriers and needs related to early initiation of PNC that warrant further research.

Few studies have assessed the association between experiencing neglect during childhood and PNC. In our study, women who experienced neglect had increased odds of early initiation of PNC; however, this result was not statistically significant. Our findings are consistent with a previous study of 467 nulliparous women from the STACY study that found that women who experienced childhood maltreatment, including neglect, had nearly 3-fold increased odds of receiving adequate PNC defined as having at least nine visits with the first visit during the first 14 weeks of gestation (AOR=2.88, 95% CI: 1.41-5.90) (21). It is plausible that some women who experienced neglect or childhood maltreatment demonstrate resilience and have additional experience with navigating health care services, which may aid in their ability to seek adequate PNC (21).

With regard to experiencing any ACEs and multiple ACEs, our results are incongruent with the study that used data from 2016-2018 PRAMS, which found no association between experiencing 1, 2, or 3 or more ACEs and adequate PNC (23). In our current study, women who experienced any ACEs and 3 or more ACEs had decreased odds of early initiation of PNC; however, these findings were no longer statistically significant after adjustment. Nevertheless, the measures of ACEs in the aforementioned PRAMS study were limited to site-specific ACEs questionnaires that differed from those included in the present study and could explain the inconsistent findings (23).

Several limitations should be considered. First, women were asked to retrospectively self-

report their experiences of ACEs, which may be subject to non-differential misclassification. However, the validity of retrospective self-reported ACEs is well-established and should pose minimal threats to interpreting the study findings (47, 48). Second, given that early initiation of PNC was also self-reported, nondifferential misclassification of the outcome variable is also possible. Maternal reports of PNC were not confirmed using medical records. However, previous studies have shown that self-reported PNC is a valid measure commonly used in population-based studies (49). Moreover, self-reported PNC remains the most common form of assessing PNC utilization and continues to demonstrate significant effects on birth outcomes (50, 51). Third, this cross-sectional study has potential for selection bias, as we utilized a subset of the full Add Health sample. Nevertheless, specific sampling weights were used to adjust for the design effects of the Add Health Public-Use Data. In addition, the response rates for the 5 waves of Add Health data included in this study were favorable (wave I: 79%, wave II: 77.4%, wave III: 77.4%, wave IV: 80.3%, and wave v: 71.8%) and special groups were oversampled.

This study also has several strengths. To our knowledge, this is the first study to examine the association between ACEs and early initiation of PNC using a nationally representative sample of women in the US. In addition, the potential for information bias is minimal in this study since Add Health employs trained interviewers and utilizes audio-CASI to collect data on sensitive questions. Lastly, the complex sampling design of Add Health enhances the generalizability of this study's findings to the broader population of women with live births in the US.

Conclusions

Findings from this study address gaps in the literature on the association between ACEs and prenatal health behaviors. In particular, women who experienced parental alcoholism during

childhood may have additional barriers to early PNC. Understanding these disparities is especially important given the increased risk of adverse health outcomes associated with a family history of parental alcoholism and health in adulthood (39, 40). While previous studies support the feasibility of screening for ACEs during PNC visits, our findings suggest that ACEs screening may be more advantageous if conducted prior to the first PNC visit, possibly during preconception counseling or reproductive health visits (52). This primary prevention approach could ensure that women with ACEs receive the necessary support prior to their first PNC visit. Given the few studies examining the association between ACEs and PNC, there is a crucial need for additional studies in diverse populations.

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Table 1b. Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and early initiation of prenatal care among women participating in Add Health in Waves I-V

Variables	Total N=1,567 (%)	Early Initiation of PNC N=1,444 (%)	Early Initiation of PNC Unadjusted OR (95% CI)
Age			
Mean age (STD)	37.06 (5.11)	37.04 (5.13)	0.95 (0.84, 1.08)
Race/Ethnicity			
Non-Hispanic White	1002 (70.01)	946 (71.35)	Ref
Non-Hispanic Black	323 (15.02)	282 (13.96)	**0.39 (0.22, 0.68)**
Hispanic	147 (9.84)	1128 (9.41)	**0.49 (0.26, 0.90)**
Other	95 (5.13)	88 (5.28)	1.18 (0.35, 3.94)
Educational Attainment			
High school or less	261 (20.10)	222 (18.42)	Ref
Some college	612 (39.51)	555 (39.09)	**1.89 (1.11, 3.21)**
College degree	406 (24.04)	386 (25.15)	**4.83 (2.26, 10.31)**
Graduate degree	288 (16.35)	281 (17.34)	**7.62 (2.48, 23.44)**
Employment			
Employed	1233 (76.56)	1141 (76.74)	Ref
Not employed	334 (23.44)	303 (23.26)	0.88 (0.51, 1.54)
Marital Status			
Married	1061 (65.61)	1006 (67.87)	Ref
Divorced/Separated/ Widowed	234 (16.90)	210 (16.44)	**0.43 (0.24, 0.77)**
Never married	272 (17.49)	228 (15.70)	**0.24 (0.15, 0.39)**
Health Insurance			
Yes	1469 (92.14)	1361 (92.45)	Ref
No	98 (7.86)	83 (7.55)	0.63 (0.26, 1.54)
Types of ACEs			
Physical abuse			
Yes	236 (14.30)	212 (14.09)	0.82 (0.44, 1.54)
No	1331 (85.70)	1232 (85.91)	Ref
Sexual abuse			
Yes	87 (5.46)	79 (5.47)	1.02 (0.39, 2.65)
No	1480 (94.54)	1365 (94.53)	Ref
Emotional abuse			
Yes	255 (14.57)	231 (14.55)	0.98 (0.56, 1.72)
No	1312 (85.43)	1213 (85.45)	Ref
Neglect			
Yes	88 (6.30)	80 (6.26)	0.93 (0.30, 2.83)
No	1479 (93.70)	1364 (93.74)	Ref

Table 1b (continued). Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and early initiation of prenatal care among women participating in Add Health in Waves I-V

Variables	Total N=1,567 (%)	Early Initiation of PNC N=1,444 (%)	Early Initiation of PNC Unadjusted OR (95% CI)
Types of ACEs			
Parental death			
Yes	77 (5.17)	64 (4.67)	**0.40 (0.18, 0.92)**
No	1490 (94.83)	1380 (95.33)	Ref
Parental incarceration			
Yes	219 (13.74)	198 (13.57)	0.85 (0.42, 1.72)
No	1348 (86.26)	1246 (86.43)	Ref
Parental alcoholism			
Yes	15 (1.33)	12 (0.99)	**0.17 (0.04, 0.68)**
No	1440 (91.28)	1337 (92.11)	Ref
Unknown	112 (7.39)	95 (6.89)	**0.47 (0.27, 0.80)**
Family history of suicidal behavior			
Yes	113 (7.52)	106 (7.52)	0.96 (0.34, 2.71)
No	1070 (68.78)	990 (69.07)	Ref
Unknown	384 (23.70)	348 (23.41)	0.82 (0.48, 1.40)
Any ACEs			
Yes	711 (44.57)	72 (57.68)	**0.56 (0.35, 0.91)**
No	856 (55.43)	51 (42.32)	Ref
Frequency of ACEs			
0 ACEs	856 (55.43)	805 (55.56)	Ref
1 ACE	357 (21.90)	329 (21.75)	0.69 (0.36, 1.33)
2 ACEs	148 (9.42)	131 (9.00)	0.47 (0.21, 1.04)
≥3 ACEs	206 (13.25)	179 (12.68)	**0.48 (0.29, 0.81)**

Table 2b. Adjusted odds ratios and 95% confidence intervals for the association between adverse childhood experiences and early initiation of prenatal care

Model	Early Initiation of PNC AOR (95% CI)
Types of ACEs	
Physical abuse	
Yes	0.82 (0.44, 1.54)[a]
No	Ref
Sexual abuse	
Yes	1.02 (0.39, 2.65)[a]
No	Ref
Emotional abuse	
Yes	0.89 (0.50, 1.58)[b]
No	Ref
Neglect	
Yes	1.37 (0.43, 4.33)[c]
No	Ref
Parental death	
Yes	0.51 (0.23, 1.12)[d]
No	Ref
Parental incarceration	
Yes	1.26 (0.61, 2.59)[e]
No	Ref
Parental alcoholism	
Yes	**0.18 (0.06, 0.55)**[c]
No	Ref
Unknown	0.63 (0.37, 1.09)[c]
Family history of suicidal behavior	
Yes	1.17 (0.45, 3.02)[f]
No	Ref
Unknown	0.80 (0.46, 1.38)[f]
Any ACEs	
Yes	0.70 (0.42, 1.16)[c]
No	Ref
Frequency of ACEs	
0 ACEs	Ref
1 ACE	0.81 (0.41, 1.62)[c]
2 ACEs	0.59 (0.27, 1.32)[c]
≥ 3 ACEs	0.64 (0.38, 1.09)[c]

[a] Model unadjusted; no confounders fit the criteria.

[b] Models adjusted for race/ethnicity.

[c] Model adjusted for marital status and educational attainment.

Table 2b (continued). Adjusted odds ratios and 95% confidence intervals for the association between adverse childhood experiences and early initiation of prenatal care

[d] Model adjusted for race/ethnicity and educational attainment.
[e] Model adjusted for race/ethnicity, marital status, and educational attainment.
[f] Models adjusted for educational attainment.

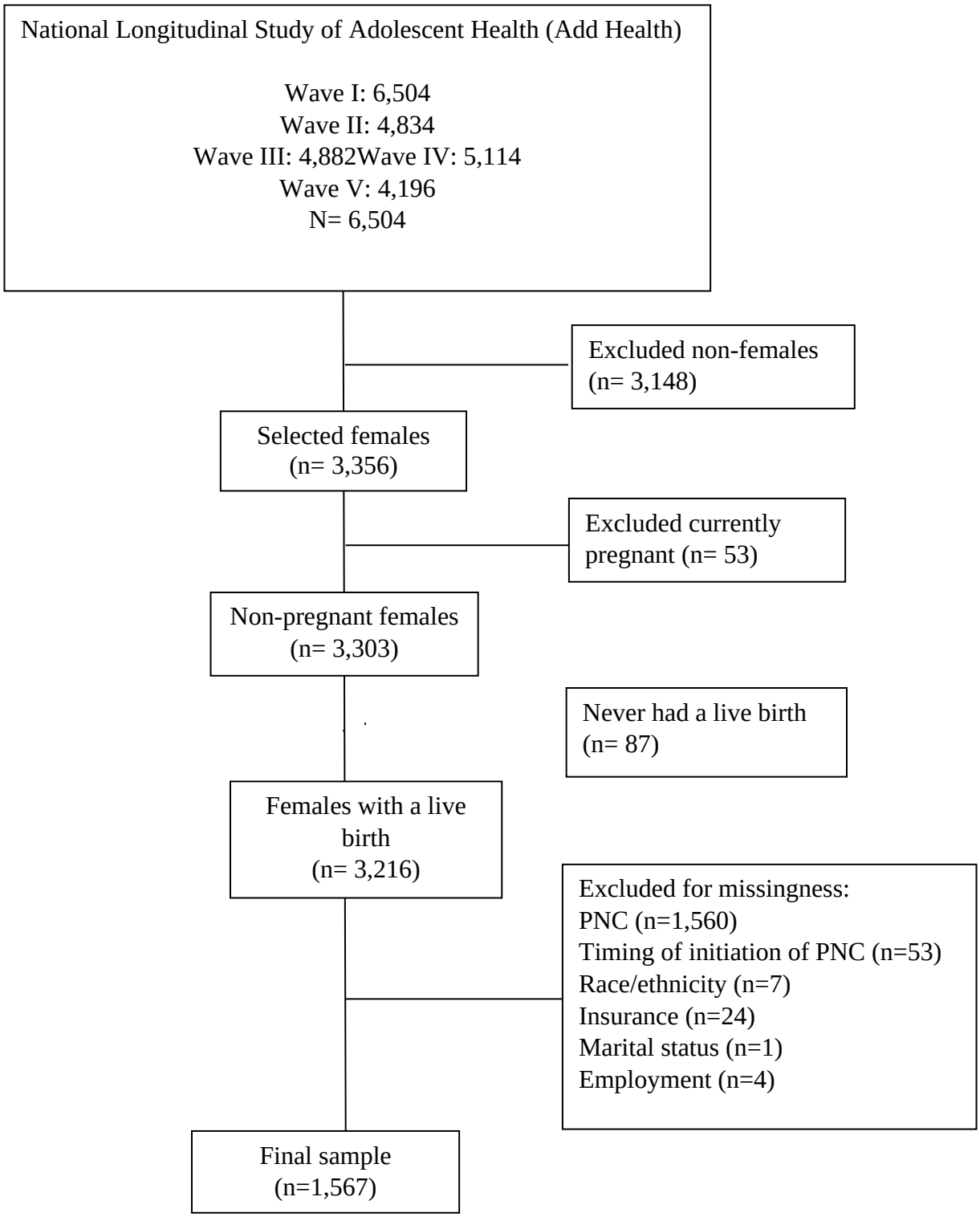

Figure 1b. Flow diagram of sample population.

CHAPTER 4: THE ASSOCIATION BETWEEN ADVERSE CHILDHOOD EXPERIENCES AND DELIVERING A SMALL FOR GESTATIONAL AGE INFANT

Abstract

Background: Women with adverse childhood experiences (ACEs) are more likely to have infants born low birth weight and preterm. Further, there are racial/ethnic disparities among women with ACEs and adverse birth outcomes such as small for gestational age (SGA). The present study aimed to assess the association between ACEs and delivering an SGA using waves I-IV of the National Longitudinal Study of Adolescent Health (Add Health) Public Use data.

Methods: Self-reported data was collected from 1,462 women aged 24-32 years with singleton live births. Women self-reported data on exposure to ACEs and infant birth weight and gestational age, which was used to determine SGA. Multivariate logistic regression was used to obtain odds ratios (ORs) and 95% confidence intervals (CIs) for the ACEs-SGA association. In addition, stratified analysis was performed to assess if race/ethnicity was an effect modifier of the ACEs-SGA association.

Results: Women who experienced parental alcoholism had statistically significant increased odds of delivering an SGA infant (AOR=4.11, 95% CI: 1.09-15.52). Among Non-Hispanic White women, those who experienced parental alcoholism had 7-fold increased odds of delivering an SGA infant (AOR=7.39, 95% CI: 1.44-37.88). However, among Non-Hispanic Black/Hispanic/Other women, parental alcoholism was associated with 1.6-fold increased odds of delivering an SGA infant (AOR=1.55, 95% CI: 0.22-10.84).

Conclusions: Findings highlight the importance of trauma-informed care during prenatal care visits for women with a history of ACEs, particularly parental alcoholism. Future studies should examine racial/ethnic differences in the ACEs-SGA association in diverse samples of women.

Introduction

Adverse childhood experiences (ACEs) can have lasting impacts on health across the life course. ACEs are linked to increased morbidity in adulthood (1). ACEs are widespread with nearly 65% of US adults reporting experiencing at least 1 ACE in their lifetime (2). Exposure to ACEs is highest among women, and Non-Hispanic Black, Hispanic, and American Indian/Alaska Natives (2-5). Among women, ACEs are associated with immediate and long-term adverse reproductive health outcomes. Specifically, ACEs are linked to risky sexual behaviors and perinatal depression (5, 6). Women who experienced ACEs also have an increased risk of delivering low birth weight and preterm infants (7, 8). Given the association between ACEs and adverse birth outcomes such as low birth weight and preterm birth, the association between ACEs and delivering a small for gestational age (SGA) infant, a leading indicator for adverse fetal development, is plausible (7, 8).

Infants born with a birth weight below the 10^{th} percentile are classified as SGA (9). While there are numerous risk factors for delivering an SGA infant, SGA births are more prevalent among African American, American Indian/Alaska Native, and Asian women compared to White women (10). In addition, women with a maternal age at birth less than 24 years or over 34 years have increased risk of birthing an SGA infant (11). Maternal substance use such as cigarette smoking and short or very long inter-pregnancy intervals may also increase risk for delivering an SGA infant (10). Infants born as SGA have increased risk for metabolic diseases, including type 2 diabetes and cardiovascular disease, and an increased risk for premature mortality (12-16).

There is limited research assessing the association between ACEs and SGA, and findings have been inconsistent. While some studies have found no observed association between ACEs

and pregnancy risk, including SGA, others have found that women who experienced ACEs had increased odds of delivering an SGA infant (6-8). Of note, many of these studies had small samples of women with SGA and lacked diverse samples, which could limit the generalizability of the findings to the US population. Thus, this study aimed to evaluate the association between ACEs and SGA in a population-based sample using data from the National Longitudinal Study of Adolescent Health (Add Health). Additionally, given the racial disparities present in the occurrence of ACEs and SGA, this study aimed to examine race/ethnicity as an effect modifier of the association between ACEs and SGA in a diverse sample of women living in the US.

Methods

The National Longitudinal Study of Adolescent Health (Add Health) is the largest and most comprehensive longitudinal study of adolescent health and behaviors in the US. The Add Health study provides biological, behavioral, psychosocial, and health-related information for individuals living in the US. In 1994-1995, Add Health began data collection for participants in grades 7-12. The Add Health study continues to follow this cohort of adolescents into their adult years. There are 5 waves of data collection, with the most recent wave V conducted in 2016-2018 when participants were 32-42 years (17). Add Health utilized a school-based sampling design using probability proportional to size. Once students were selected from their respective school rosters, a questionnaire was administered to generate an in-home sample. Participants were then tasked to complete a 90-minute in-home interview conducted by trained Add Health interviewers. For sensitive questions such as ACEs items, participants were provided the laptop to answer them using audio computer-assisted self-interviewing (audio-CASI) (18).

The full Add Health wave I sample, collected in 1993-1994 is the foundational sample from which participants in subsequent waves II-V are derived (N=20,745; response rate: 79.0%),

Wave II was completed in 1996 when participants were in grades 8-12 (N=14,738; response rate: 88.6%) (17). In 2001-2002, participants were aged 18-26 during wave III of data collection (N=15,197; response rate: 77.4%). Wave IV was conducted when participants were aged 24-32 years in 2008 (N=15,701; response rate: 80.3%). Most recently, wave V, was completed in 2016-2018 when respondents were 33-42 years old (N=13,200; response rate: 71.8%). Although the full Add Health sample is restricted to the public, the Add Health Public-Use Data is a randomly selected subset of the entire sample. Data from waves I-IV Public-Use Data included ACEs and birth outcomes, including weight and gestational weeks. While wave V is the most recent wave of data, the Public-Use Dataset for wave V did not include exact birth weights and thus was not included in the analysis. The present population-based study included waves I-IV Public Use Data (Wave I: N=6,504, Wave II: N=4,834, Wave III: N=4,882, Wave IV: N=5,114).

A total of 5,114 participants were gathered from waves I-IV Add Health Public-Use Data. Males were excluded from this analysis (n=2,354). Female participants who did not have a live birth or were currently pregnant were also excluded (n=1,208). In addition, participants with multiple gestations and participants who refused or did not know how many babies were born alive were excluded from this sample (n=43). Women who did not have complete information for birth weight (n=12) and gestational weeks or births that did not fall within 22-44 weeks gestation (n=14) were excluded from this analysis. Women who were missing data for sociodemographic and behavioral confounders such as race/ethnicity (n=6), insurance (n=12), and cigarette use during pregnancy (n=3) were also excluded. Thus, the final sample consisted of 1,462 women with singleton live births living in the US.

Measurement of SGA

The outcome variable was SGA. SGA was calculated as birth weight within the 10th

percentile of gestational age (19). Birth weight was converted to grams using the question, “How much did [baby’s name] weigh at birth?” Gestational age was determined using two questions: “Was [baby’s name] born before or after (his/her/their) due date?” and “How many weeks or days (before/after) the due date was [baby’s name] born (weeks)?” For babies born before their due date, gestational age was calculated by subtracting the number of early weeks from 40 weeks. On the contrary, for babies born after their due date, gestational age was calculated as 40 weeks plus the number of additional weeks when the baby was born. Women with babies born with a weight below the 10th percentile for their gestational age, as determined by the US birth weight reference, were coded as having a baby born as SGA (20).

Measurement of ACEs

The exposure variable was ACEs. Exposure to ACEs was assessed by individual ACE type and frequency described as 0, 1, or 2 or more ACEs (21). There were 8 measures of ACEs assessed. Exposure to ACEs was determined by an affirmative response to any of the ACEs items included in waves I-IV: physical abuse, sexual abuse, emotional abuse, neglect, parental death, parental incarceration, parental alcoholism, and a family history of suicidal behavior.

Physical abuse was assessed in wave IV using the question, “Before your 18th birthday, how often did a parent or adult caregiver hit you with a fist, kick you, or throw you down on the floor, into a wall, or down stairs?” Sexual abuse was derived from the wave IV question, “How often did a parent or other adult caregiver touch you in a sexual way, force you to touch him or her in a sexual way, or force you to have sexual relations?” Neglect was evaluated in wave IIII using the question, “How often had your parents or other adult caregivers not taken care of your basic needs, such as keeping you clean or providing food or clothing?” Responses of 1 or more times were coded as having experienced the respective ACE. Emotional abuse was assessed in

wave IV by the question, “Before your 18th birthday, how often did a parent or other adult caregiver say things that really hurt your feelings or made you feel like you were not wanted or loved?” Responses of 6 or more times were coded as having experienced emotional abuse.

Parental death was assessed in wave I and II using the question, “Is your mother/father still living?” Parental incarceration was gathered from wave IV using the question, “How old were you when your biological mother/father was released from jail or prison (most recently)?” Women who reported being less than 18 years were considered as experiencing parental incarceration as an ACE, whereas responses of 18 years or older were coded as not experiencing parental incarceration. Parental alcoholism was derived from wave I by asking the question, “Does his/her biological mother/father has alcoholism?” and family history of suicidal behavior was assessed in waves I and II by the question, “Have any of your family members tried to kill themselves during the past 12 months?” Responses of “yes” to either one of the two aforementioned questions were coded as having experienced those respective ACEs, whereas responses of “no” were considered not to have that ACE.

Measurement of Confounders

This present study collected information on potential sociodemographic and health behavior confounders selected from the literature. These confounders included age, maternal age at birth, race/ethnicity, educational attainment, employment, marital status, health insurance, cigarette use during pregnancy, timing of prenatal care, and infant sex (22-24). Due to small cell counts, categories for race/ethnicity were collapsed into two levels: Non-Hispanic White (NHW) and Non-Hispanic Black/Hispanic/Others (NHB/H/O).

Statistical Analysis

Frequencies and percentages were calculated to describe the analytic sample. Logistic

regression was used to determine the unadjusted association between ACEs and SGA, and to assess other factors associated with SGA. Multivariate logistic regression was used to obtain adjusted odds ratios (ORs) and 95% confidence intervals (CIs) to model the association between ACEs and SGA while controlling for potential confounders. Potential confounders were selected using the backwards elimination procedure to retain variables with a ($p<20$) (25). In addition, a stratified analysis was performed to assess whether race/ethnicity was an effect modifier of the ACEs-SGA association. The cross-sectional weight variable from wave IV was used for all analyses. SAS survey procedures (version 9.4, SAS Institute Inc. Cary, NC) were used in all analyses to account for the complex sampling design of Add Health Public-Use Data.

Results

Among the 1,461 women in this sample, the mean age was 29 years (standard deviation (SD)= 4.77) and maternal age at birth was 23 years (SD= 0.83) (Table 1). Nearly two-thirds of the women were NHW and well-educated (some college: 42.02% and college degree/higher: 21.55%). Parental incarceration (19.93%), physical abuse (19.81%) and emotional abuse (19.81%) were the most commonly reported ACEs. Approximately 5% of the infants were delivered SGA.

Unadjusted Associations Between Select Characteristics and ACEs and SGA

Women who identified as NHB/H/O had nearly 2-fold statistically significant increased odds of delivering an SGA infant compared to NHW women (OR=1.75, 95% CI: 1.04-2.94; Table 1). Women with a college degree or higher had statistically significant decreased odds of delivering SGA compared to women with a high school degree or less (OR=0.39, 95% CI: 0.18-0.84).

Compared to women without these ACEs, women who experienced neglect and a family

history of suicidal behavior had increased odds of delivering an SGA infant; however, both findings were not statistically significant (Neglect: OR=1.25, 95% CI: 0.50-3.14; Family history of suicidal behavior: OR=1.41, 95% CI: 0.57-3.48). Women who experienced parental incarceration had nearly 2-fold statistically significant increased odds of delivering an SGA infant (OR=1.83, 95% CI: 1.07-3.12). Similarly, women who experienced parental alcoholism had 4.63 times increased odds of having an SGA birth; this finding was statistically significant (95 CI%: 1.30-16.47).

Women who experienced any ACEs had increased odds of delivering an SGA infant compared to women who did not experience ACEs; however, this finding was not statistically significant (OR=1.19, 95% CI: 0.70-2.01). When considering ACEs by frequency, there was no association between experiencing 1 ACE and delivering an SGA infant (OR=1.01, 95% CI: 0.51-2.02). On the contrary, women who experienced 2 or more ACEs had increased odds of having an SGA birth (OR=1.33 95% CI: 0.75-2.35). However, this relationship was not statistically significant.

Adjusted Associations Between ACEs and SGA

After adjusting for race/ethnicity, educational attainment, and prenatal care, the neglect-SGA association was instead associated with decreased odds of delivering an SGA infant (AOR=0.57, 95% CI: 0.18-1.76; Table 2); however, this finding was not statistically significant. The magnitude of the association between a family history of suicidal behavior and SGA slightly decreased in magnitude and remained not statistically significant after adjustment compared to women who did not experience this ACE (AOR=1.34, 95% CI: 0.54-3.36). The association for women who experienced parental incarceration and delivering an SGA infant also decreased in magnitude and was no longer statistically significant after adjustment (AOR=1.67, 95% CI: 0.97-

2.88). After adjustment for race/ethnicity, educational attainment, and prenatal care, women with parental alcoholism continued to have 4-fold statistically significant increased odds of delivering an SGA infant compared to women who did not experience parental alcoholism (AOR=4.11, 95% CI: 1.09-15.52).

The magnitude of the association between women who experienced any ACEs and SGA decreased slightly after adjustment for race/ethnicity, educational attainment, and prenatal care, when compared to women who did not experience ACEs (AOR=1.09, 95% CI: 0.63-1.87), and this finding remained not statistically significant. After adjustment, no statistically significant association remained between women who experienced 1 ACE compared to women with no ACEs (AOR=0.95, 95% CI: 0.47-1.91) and SGA. The magnitude of the association between women who experienced 2 or more ACEs and SGA was slightly attenuated after adjustment such that women who had 2 or more ACEs had 1.2 times the odds of delivering an SGA infant (AOR=1.20, 95% CI: 0.66-2.16); this finding remained not statistically significant.

ACEs-SGA Association Stratified by Race/Ethnicity

Race/ethnicity appeared to modify some, but not all of the ACEs-SGA associations. Among NHW women, participants who experienced parental alcoholism had 7.39 times the odds of delivering an SGA infant (95% CI: 1.44, 37.88; Table 3). However, among NHB/H/O women, parental alcoholism was associated with 1.55 times the odds of delivering an SGA infant (95% CI: 0.22, 10.84); this finding was not statistically significant. Among NHW women, experiencing any ACEs was associated with decreased odds of delivering an SGA infant after adjustment for educational attainment and prenatal care compared to women who experienced no ACEs (OR=0.88, 95% CI: 0.10-1.86). However, in the model of NHB/H/O women, women who experienced any ACEs had 1.55 times the odds of delivering an SGA infant (95% CI: 0.69-3.31).

Discussion

In this study, 5% of women delivered SGA infants and more than half reported experiencing at least one ACE. Women who experienced parental alcoholism had 4-fold statistically significant increased odds of delivering an SGA infant after adjustment for race/ethnicity, educational attainment, and prenatal care. Although there was no association between women who experienced 1 ACE and SGA, women who experienced two or more ACEs had increased odds of delivering an SGA infant; however, these findings were not statistically significant. In the analysis stratified by race/ethnicity, ACEs-SGA associations differed. Among NHW women, those who experienced parental alcoholism had more than 7-fold statistically significant increased odds of delivering an SGA infant. Among NHB/H/O women, women who experienced parental alcoholism had 1.5 times increased odds of delivering an SGSA infant; however, this finding was not statistically significant.

Approximately 5% of the women in our sample had SGA infants. This finding is consistent with previous population estimates of 4-11% of SGA infants born in the US (9, 26). In addition, in our study, 54% of women experienced at least one ACE which is congruent with a previous population-based studies that estimated 59% of US adults with ACEs (3, 27).

To our knowledge, no existing studies assessed the association between a family history of parental alcoholism and delivering an SGA infant. While the exact biological mechanism for the parental alcoholism-SGA association is unknown, women who experienced parental alcoholism have increased risk of alcohol abuse in adulthood and during pregnancy (11, 12, 28, 29). Alcohol is a known teratogen, meaning that alcohol may cross the placental barrier, negatively affect fetal biological, neurological and behavioral development, and have long-lasting impacts on their health into adulthood (30).

Women who experienced two or more ACEs had increased odds of delivering an SGA infant; however, these findings were not statistically significant. Our findings are consistent with results from the Collaborative Care Model for Perinatal Depression Support Services (COMPASS) which demonstrated that women who experienced 4 or more ACEs had slight increased, though not statistically significant, odds of SGA compared to women with 3 or less ACEs (OR=1.20; 95% CI: 0.64-2.25) (7). Findings are also somewhat consistent with the PRAMS study, which found that women who experienced two ACEs had an increased prevalence of delivering an SGA infant compared to those without ACEs (aPR=1.6, 95% CI: 1.02-2.60) (6).

No prior studies have assessed the role of race/ethnicity as an effect modifier of the association between ACEs and delivering an SGA infant. We found that among NHW women, parental alcoholism was associated with a 7-fold statistically significant increased odds of delivering an SGA infant. In contrast, among NHB/H/O women, women with ACEs had 1.55 times increased odds of delivering an SGA infant; however, this finding was not statistically significant. While the exact mechanism by which race/ethnicity may modify the ACEs-SGA association is unknown, there are racial/ethnic disparities in alcohol use during pregnancy. Compared to NHW women, NHB and Hispanic women have decreased odds of prenatal alcohol use as well as binge drinking during pregnancy (31, 32). Moreover, NHW women who experienced ACEs and adverse adult experiences are more likely to have adverse pregnancy and birth outcomes such as pregnancy loss, preterm birth, and low birth weight than NHB and Hispanic women with the same adversity (33) Thus, it is plausible that the ACEs-SGA association may differ by race/ethnicity. However, given our small sample of NHB/H/O women, future studies with larger samples are warranted to confirm this finding.

This study has several limitations. Nondifferential misclassification of the exposure and outcome variables is possible due to the fact that these variables were self-reported. However, self-reported ACEs are a valid measure (34) and prior studies support the validity of maternal-reported gestational age and infant birth weight (35). While there is a possibility of selection bias in this study, response rates were favorable (wave I: 79.0%, wave II: 88.6%, wave III: 77.4%, and wave IV: 80.3%) (17). Secondary data were derived from the Add Health Public-Use Data, a subset of the full Add Health sample. However, this subset was randomly selected and sampling weights were employed by Add Health personnel to account for design effects in the public-use data (18). Lastly, residual confounding by unmeasured confounders associated with ACEs and SGA is possible.

Our research has a several strengths. Despite the growing body of knowledge on the association between ACEs and adverse birth outcomes, this is the first study to investigate the association between ACEs and SGA, and race/ethnicity as an effect-modifier of this association using a nationally representative sample. This study utilized data from four waves of Add Health, the longest-running longitudinal study of adolescent health in the US. Furthermore, the complex sampling design used in this study supports the generalizability of the study findings to women with singleton live births living in the US.

Conclusions

In summary, this study found that women who experienced ACEs, specifically parental alcoholism, have increased odds of delivering an SGA infant. These women may require additional support during their pregnancy to mitigate the risk of SGA births. The differential ACEs-SGA associations observed across races/ethnicities also warrant further research. Findings from this study have important implications at the intersection of violence prevention and

maternal and child research by increasing scientific knowledge of race/ethnicity as an effect modifier of the association between ACEs and SGA. Healthcare providers may implement ACEs screening tools during prenatal care visits to identify women with ACEs and provide early intervention (36). In addition, policies that increase funding for addiction treatment programs for individuals with substance use disorder and their families are necessary to improve health outcomes across generations (37). Lastly, collaborative care models that provide mental health support for pregnant women with a history of ACEs may aid in improving birth outcomes for this population (38-40).

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Table 1c. Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and SGA among women participating in Add Health in Waves I-IV

Variables	Total N=1,461 (%)	SGA N=75 (%)	SGA Unadjusted OR (95% CI)
Age			
Mean age (STD)	29.12 (4.77)	29.07 (2.29)	0.98 (0.84, 1.15)
Maternal age at birth			
Mean age (STD)	23.10 (0.83)	23.13 (0.76)	1.08 (0.64, 1.82)
Race/Ethnicity			
Non-Hispanic White	853 (66.41)	34 (53.76)	Ref
Black/Hispanic/Others	608 (33.59)	41 (46.24)	**1.75 (1.04, 2.94)**
Educational Attainment			
High school or less	521 (36.43)	37 (52.29)	Ref
Some college	598 (42.02)	28 (35.02)	0.56 (0.31, 1.03**)**
College degree or higher	342 (21.55)	10 (12.69)	**0.39 (0.18, 0.84)**
Employment			
Employed	1386 (95.10)	71 (95.74)	Ref
Not employed	75 (4.90)	4 (4.26)	0.86 (0.27, 2.74)
Marital Status			
Married	325 (22.02)	15 (22.62)	Ref
Not married	1136 (77.98)	60 (77.38)	0.96 (0.47, 1.97)
Health Insurance			
Yes	1201 (82.08)	56 (75.23)	Ref
No	260 (17.92)	19 (24.77)	1.54 (0.85, 2.81)
Prenatal Care			Ref
Yes	1427 (97.89)	70 (94.27)	3.09 (1.
No	34 (2.11)	5 (5.73)	00, 9.62)
Cigarette Use			
Yes	279 (21.22)	16 (22.93)	Ref
No	1182 (78.78)	59 (77.07)	1.11 (0.59, 2.08)
Infant sex			
Male	737 (50.49)	34 (43.86)	Ref
Female	724 (49.51)	41 (56.14)	1.32 (0.80, 2.20)
Types of ACEs			
Physical abuse			
Yes	281 (19.81)	14 (18.37)	0.91 (0.46, 1.80)
No	1180 (80.19)	61 (81.63)	Ref
Sexual abuse			
Yes	126 (8.34)	5 (5.24)	0.60 (0.19, 1.84)
No	1335 (91.66)	70 (94.76)	Ref
Emotional abuse			
Yes	280 (19.81)	12 (15.52)	0.73 (0.36, 1.49)
No	1181 (80.19)	63 (84.48)	Ref

Table 1c (continued). Sociodemographic and adverse childhood experiences characteristics and unadjusted odds ratios and 95% confidence intervals of the associations between selected characteristics and SGA among women participating in Add Health in Waves I-IV

Variables	Total N=1,461 (%)	SGA N=75 (%)	SGA Unadjusted OR (95% CI)
Types of ACEs			
Neglect			
Yes	105 (7.52)	7 (9.15)	1.25 (0.50, 3.14)
No	1356 (92.48)	68 (90.85)	Ref
Parental death			
Yes	76 (4.85)	7 (8.86)	1.99 (0.89, 4.45)
No	1385 (95.15)	68 (91.14)	Ref
Parental incarceration			
Yes	293 (19.93)	20 (30.52)	**1.83 (1.07, 3.12)**
No	1168 (80.07)	55 (69.48)	Ref
Parental alcoholism			
Yes	16 (1.13)	3 (4.27)	**4.63 (1.30, 16.47)**
No	1320 (90.44)	64 (85.97)	Ref
Unknown	125 (8.43)	8 (9.76)	1.23 (0.54, 2.80)
Family history of suicidal behavior			
Yes	114 (7.94)	7 (11.11)	1.41 (0.57, 3.49)
No	976 (67.06)	52 (67.74)	Ref
Unknown	371 (25.00)	16 (21.15)	0.83 (0.41, 1.70)
Any ACEs			
No	681 (45.73)	31 (41.69)	Ref
Yes	780 (54.27)	44 (58.31)	1.19 (0.70, 2.01)
Frequency of ACEs			
0 ACEs	681 (45.73)	31 (41.69)	Ref
1 ACE	346 (24.34)	17 (22.47)	1.01 (0.51, 2.02)
≥2 ACEs	434 (29.93)	27 (35.84)	1.33 (0.75, 2.35)

Table 2c. Adjusted odds ratios and 95% confidence intervals for the association between adverse childhood experiences and small for gestational age using backwards elimination

Model	SGA AOR (95% CI)[a]
Types of ACEs	
Physical abuse	
Yes	0.90 (0.45, 1.81)
No	Ref
Sexual abuse	
Yes	0.57 (0.18, 1.76)
No	Ref
Emotional abuse	
Yes	0.80 (0.38, 1.69)
No	Ref
Neglect	
Yes	0.57 (0.18, 1.76)[a]
No	Ref
Parental death	
Yes	1.71 (0.74, 3.96)
No	Ref
Parental incarceration	
Yes	1.67 (0.97, 2.88)
No	Ref
Parental alcoholism	
Yes	**4.11 (1.09, 15.52)**
No	Ref
Unknown	1.04 (0.45, 2.43)
Family history of suicidal behavior	
Yes	1.34 (0.54, 3.36)
No	Ref
Unknown	0.91 (0.44, 1.89)
Any ACEs	
No	Ref
Yes	1.09 (0.63, 1.87)
Frequency of ACEs	
0 ACEs	Ref
1 ACE	0.95 (0.47, 1.91)
≥ 2 ACEs	1.20 (0.66, 2.16)

[a] All models adjusted for race/ethnicity, educational attainment, and prenatal care.

Table 3c. Adjusted odds ratios and 95% confidence intervals for the association between adverse childhood experiences and small for gestational age stratified by race/ethnicity

	Race/Ethnicity[a]	
Variables	**Non-Hispanic White OR (95% CI)**	**Non-Hispanic Black/ Hispanic/Others OR (95% CI)**
Types of ACEs		
Physical abuse		
Yes	0.90 (0.32, 2.57)	0.95 (0.37, 2.45)
No	Ref	Ref
Sexual abuse		
Yes	0.25 (0.03, 1.98)	0.92 (0.27, 3.17)
No	Ref	Ref
Emotional abuse		
Yes	0.61 (0.23, 1.59)	1.21 (0.43, 3.39)
No	Ref	Ref
Neglect		
Yes	0.93 (0.28, 3.13)	1.34 (0.32, 5.57)
No	Ref	Ref
Parental death		
Yes	2.18 (0.66, 7.20)	1.37 (0.46, 4.11)
No	Ref	Ref
Parental incarceration		
Yes	1.64 (0.82, 3.30)	1.95 (0.83, 4.56)
No	Ref	Ref
Parental alcoholism		
Yes	**7.39 (1.44, 37.88)**	1.55 (0.22, 10.84)
No	Ref	Ref
Unknown	0.93 (0.23, 3.72)	1.05 (0.35, 3.17)
Family history of suicidal behavior		
Yes	1.09 (0.34, 3.53)	1.77 (0.42, 7.40)
No	Ref	Ref
Unknown	0.45 (0.13, 1.63)	1.94 (0.82, 4.56)
Any ACEs		
No	Ref	Ref
Yes	0.88 (0.41, 1.86)	1.51 (0.69, 3.31)
Frequency of ACEs		
0 ACEs	Ref	Ref
1 ACE	0.77 (0.30, 1.97)	1.29 (0.44, 3.77)
≥ 2 ACEs	0.97 (0.43, 2.16)	1.67 (0.72, 3.90)

[a] All models adjusted for educational attainment and prenatal care.

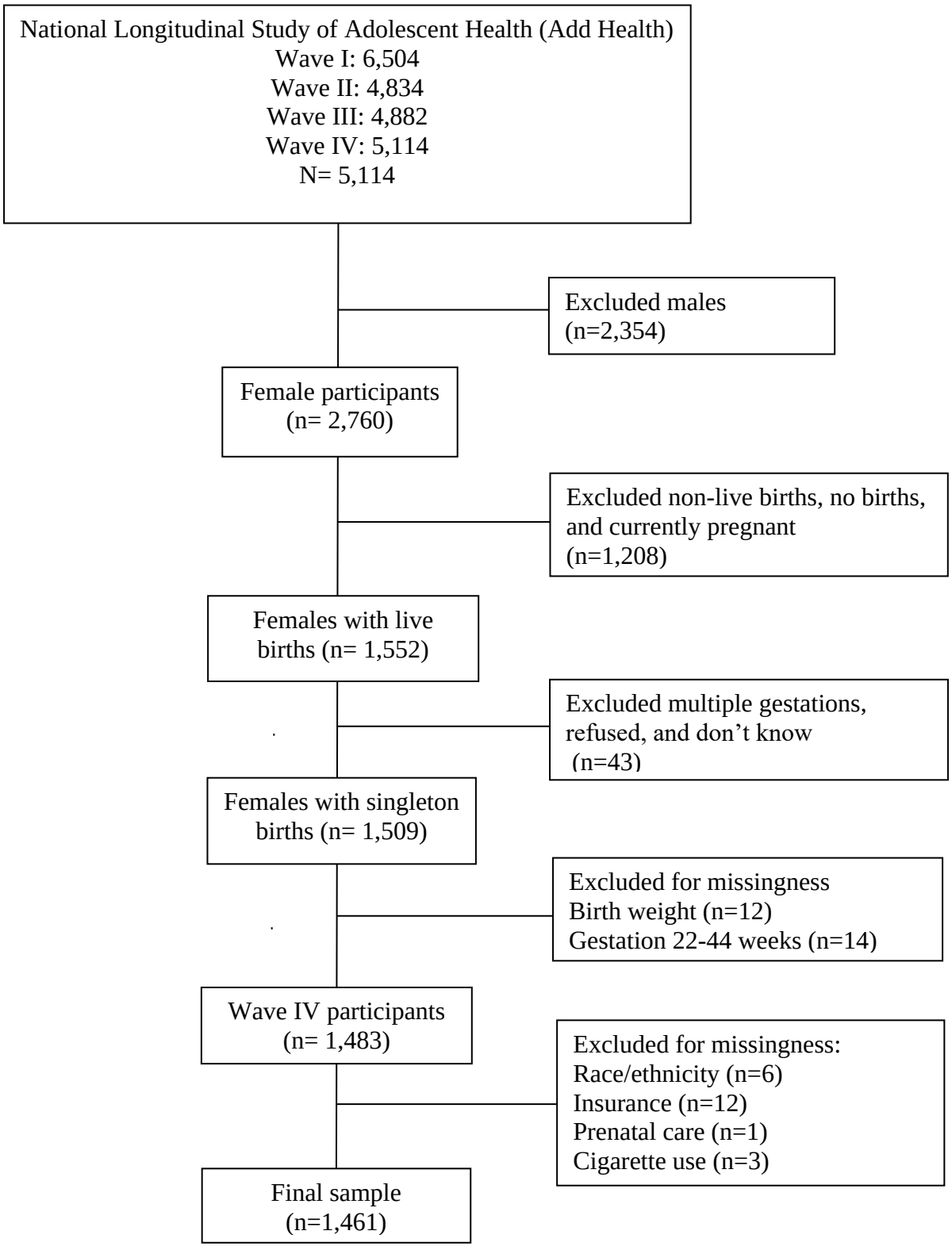

Figure 1c. Flow diagram of sample population.

CHAPTER 5: DISCUSSION

Summary of Key Findings

A woman's reproductive window represents a brief yet pivotal period in one's life. This dissertation aimed to elucidate the impact of ACEs on women's reproductive health outcomes. By grounding this dissertation in a life-course epidemiology approach, this research provides a comprehensive understanding of the multifaceted nature of ACEs on women's reproductive health. Three separate population-based studies were conducted to assess the association between ACEs and contraceptive use, PNC and SGA, respectively. Across the three studies, specific types of ACEs were associated with adverse reproductive health outcomes. In the third study, race/ethnicity modified specific ACEs-SGA associations. These findings contribute to the emerging literature on ACEs and their association with reproductive behaviors and birth outcomes during the preconception, prenatal, and perinatal periods. Taken together, this dissertation highlights the unique challenges of women with a history of ACEs and underscores the need for trauma-informed interventions in reproductive health care.

In the first study that examined the association between ACEs and contraceptive use, women with a family history of suicidal behavior had statistically significant decreased odds of contraceptive use. While no prior studies have assessed the family history of suicidal behavior-contraceptive use association, related studies demonstrate the plausibility of this association due to the increased risk for mental health conditions and inconsistent contraceptive practices (1-4). The second study, which focused on the prenatal period, found that women who experienced parental alcoholism had statistically significant decreased odds of early initiation of PNC. To our knowledge, there are no previous studies that investigated this association. However, women who experienced parental alcoholism may delay PNC due to potential substance use and

associated barriers such as limited accessibility to care and stigma (5, 6). In the third and final study on perinatal health, women who experienced parental alcoholism had statistically significant increased odds of delivering an SGA infant. Notably, among NHW women, women who experienced parental alcoholism had 7-fold statistically significant increased odds of delivering an SGA infant. Of NHB/H/O women, those who experienced parental alcoholism had 1.6 times increased odds of delivering an SGA infant; however, this finding was not statistically significant. Women who experienced parental alcoholism may have increased risk of delivering an SGA infant due to their increased risk of alcohol abuse during pregnancy which can have deleterious effects on the fetus (7, 8). Additionally, previous studies have demonstrated differential associations between ACEs and SGA by race/ethnicity (9).

Strengths and Limitations

The findings from this dissertation should be considered in the context of the study limitations. In each of the three studies, nondifferential misclassification of the exposure and outcome variables is possible given that these variables used self-reported measures. Nevertheless, the main exposure in all studies, self-reported ACEs, is valid and reliable (10, 11). In addition, prior studies support the validity of self-reported contraceptive use, prenatal care, as well as birth weight and gestational age, both of which are used to calculate SGA (12-15). The Add Health Public-Use Data, which represents one-third of the full Add Health dataset, was used across all studies. The public-use sample was generated through random selection, and sampling weights were applied to account for design effects, making this dataset representative of the full Add Health dataset and improving the generalizability of these study findings to the broader US population. Despite controlling for confounders in all three studies, residual confounding due to unmeasured confounders is possible.

Nevertheless, this dissertation features the first studies to assess the association between ACEs and contraceptive use, early initiation of PNC, and delivering an SGA infant in a nationally representative sample of women in the US. In particular, the third study is the first of its kind to assess the role of race/ethnicity as an effect modifier on the ACEs-SGA association. In addition, Add Health used trained interviewers and the audio-CASI method for sensitive health questions for data collection. Audio-CASI allowed participants to enter their information directly into the computer to reduce the potential for information bias.

Implications for Public Health Practice

Collectively, this dissertation contributes to the public health knowledge base on the impact of ACEs on reproductive, prenatal, and perinatal health outcomes among women. Throughout the three studies, ACEs were associated with adverse reproductive, prenatal, and perinatal health outcomes. Given the close relationship between mental health and reproductive health, public health programming and clinical practice should encourage this integration of services.

The impact of ACEs on adverse reproductive, prenatal, and perinatal health outcomes emphasizes the importance of ACEs screening in reproductive health and maternity settings. Findings from the first study underscore the need for ACEs screening during reproductive health counseling. These findings may also inform contraceptive counseling practices to ensure that women with a history of ACEs receive tailored, trauma-informed care and resources. Women with a family history of suicidal behavior may need additional support to improve access to and use of contraceptives. Suicide postvention programs that are designed to support families of suicide loss may consider incorporating reproductive health information and resources. Mental health resources and support that incorporate reproductive health counseling may provide

additional support for this high-risk population of women with a history of ACEs. During preconception and reproductive health counseling, healthcare providers may also consider discussing the importance of early PNC. Given the decreased odds of early PNC among women who experienced ACEs, reproductive health visits may provide a valuable opportunity to reach these women prior to pregnancy.

Furthermore, ACEs screening during routine PNC visits is well-accepted and can identify pregnancy-related health risks (16, 17). Early access to PNC is critical to improving maternal and infant health outcomes during pregnancy and postpartum. Given the increased risk for adverse reproductive, prenatal, and perinatal health outcomes for women with a history of ACEs, these findings may inform future interventions that promote early identification and management of adverse birth outcomes among women with ACEs. In addition, this research may inform future PNC practices by highlighting the need for trauma-informed support and interventions for women with a history of ACEs, specifically women who experienced parental alcoholism. Public health interventions during the prenatal period should prioritize women with a history of parental alcoholism given their increased risk for delivering an SGA infant. Culturally sensitive, trauma-informed PNC programs that provide more intensive support for NHW women who have experienced parental alcoholism may be warranted. Trauma-informed care has been implemented in PNC settings and is associated with reduced maternal mental health symptoms and improved bonding with infants (18, 19). Finally, community-based maternal and child health programs should collaborate with support groups for families affected by alcoholism. This collaboration may ensure this high-risk population receives comprehensive preventive resources throughout their reproductive journey.

Implications for Future Policy

Recent changes in US policies related to contraceptive access have limited affordability, availability, and appropriateness of contraceptive care for women of reproductive age (20). Thus, future policies should increase access to contraceptives for all women, expand insurance coverage for contraceptives, and provide increased funding for family planning programs. In addition, policies that provide additional support to integrate reproductive health and suicide prevention and postvention efforts warrant further research. Policies that enhance early and comprehensive PNC access for pregnant women with a history of ACEs are necessary to improve perinatal health outcomes. Additionally, increased funding for trauma-informed collaborative care models in PNC settings may provide further opportunities for valuable research and support for high-risk women with ACEs.

Future Research

Given the limited body of research on ACEs and reproductive, prenatal, and perinatal health, there are a myriad of opportunities for future studies. First, the novel findings from this dissertation warrant further research in large, diverse populations. Second, this dissertation utilized eight measures of ACEs (21). While there is an expansive and growing list of ACEs measures as the conceptualization of ACEs continues to evolve, future studies are needed to assess the validity of these eight ACEs measures (22). Third, future studies may take a more in-depth look at the potential underlying mechanisms for these associations. For instance, further studies that assess depressive symptoms or individual suicidality as potential effect modifiers of the family history of suicidal behavior-contraceptive use association are needed. Fourth, research on the racial/ethnic differences in ACEs-SGA is critical to understanding the disproportionate effects of ACEs on perinatal health outcomes. Finally, prior studies have shown that social

support may serve as a protective factor for maternal depression and perinatal health risk among women with ACEs (23, 24). Additional research is needed to examine the role of social support as an effect modifier of the ACEs-PNC and ACEs-SGA associations.

Conclusions

This dissertation addresses gaps in the literature on ACEs and reproductive, prenatal, and perinatal health outcomes. By utilizing the life-course epidemiology perspective, findings from this research demonstrated that women with a history of ACEs face additional challenges with contraceptive use, early initiation of PNC, and delivering an SGA infant. The role of race/ethnicity in modifying the association between ACEs and SGA highlights the need for additional research on this topic. Further examination of the effects of ACEs on reproductive, prenatal, and perinatal outcomes is essential to improving women's health over their life course and the health of subsequent generations.

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