Project Title: The Impact of Preconception and Contextual Factors on Obstetric and Child Health Outcomes

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I. Introduction

A. Nature of the research problem. Pregnancy complications and poor birth outcomes have been shown to affect the survival and long-term health of children. The preconception period may represent an opportunity to intervene and improve outcomes; however little was known about women’s life events and health prior to pregnancy as predictors of such outcomes. Moreover, it was unknown if neighborhood-level factors impacted these preconception effects on obstetric and child health outcomes.

B. Purpose, scope, and methods of the investigation. This study determined if and to what extent women’s stressful life events, preconception health behaviors, and neighborhood health and disadvantage influenced pregnancy, birth, and child health outcomes using a nationally representative, population-based sample.

C. Nature of the findings. The goal of this study was to determine if and to what extent women’s preconception stress and health behaviors impacted subsequent adverse obstetric and child outcomes using a nationally representative, population-based sample of women and children. Specifically, we hypothesized that the occurrence of stressful life events in the preconception period would be significantly associated with pregnancy complications, complications of labor and/or delivery, birth outcomes, and infant and child health problems. Women’s preconception health behaviors would mediate these relationships. These relationships were expected to be stronger for women who lived in disadvantaged or unhealthy neighborhoods. To our knowledge, these were the first studies to examine the relationship between preconception determinants and multiple obstetric outcomes and child health using nationally representative data.

Scientific Knowledge Gained and Improvements to Clinical Practice. This study provided critical information about preconception predictors of obstetric and child health outcomes and also provided evidence that poor birth outcomes and the associated sequelae are linked to women’s upstream stress experiences and health behaviors. Further, we gained an understanding of how these relationships differed by neighborhood context was, which is essential in order to design and implement effective interventions aimed to reduce disparities in pregnancy, birth and child outcomes. Therefore, prevention of poor pregnancy, birth, and child outcomes will need to include steps to reduce women’s exposure to stress over the life course and improve health behaviors before pregnancy. Our findings may lead to substantial improvements to clinical practice, and indicate that women of all reproductive ages should be offered a continuum of preventive and primary care health services. Promoting preconception health through screening, education, counseling, treatment, and/or referral should occur in a variety of settings over the life course to ensure that women are effectively identified and treated for health problems, regardless of where or when they interface with the healthcare system. Accordingly, women and their
providers should strive to identify and address stress in the preconception period so as to prevent deleterious obstetric outcomes.

Impact of Results to the Field. There are two significant impacts our results will have on the field. First, our findings suggest that interventions aimed at preventing adverse obstetric and child outcomes may be most effective if they begin in the preconception period. Furthermore, policy changes aimed at increasing access to preconception care will be crucial for improving the health of women and their babies. These steps will ensure that women are in optimal health in the preconception period, which may be highly effective in reducing the incidence of poor obstetric outcomes, particularly for those with the highest risk. Second, our findings suggest that interventions may be needed to take the neighborhood context into account in order to be most effective. Collectively, the findings from these studies may ultimately change the way we intervene with women and their families—namely interventions will need to occur not only on an individual level but also on a neighborhood level. This will involve efforts to reduce the effects of neighborhood level poverty, increase neighborhood level resources, and improve health behaviors on a neighborhood level.

Innovation. This study brought three essential strengths to the field of obstetric outcomes and child health. It was innovative in: 1) leveraging an existing population-based sample to examine women’s health and subsequent outcomes over time; 2) taking a life course approach to understanding the evolution of poor birth and child health outcomes; and 3) providing evidence of the neighborhood level effects on outcomes. This was the first national study to determine if and to what extent women’s stressful life events, preconception health behaviors, and neighborhood health and disadvantage influence pregnancy, birth, and child health outcomes. Moreover, this study was the first to consider key preconception health behaviors in the context of behaviors during pregnancy and the impact on outcomes.

Shift in Current Research. This proposed research sought to not only shift current research but also clinical practice. Our findings may shift current research in providing evidence about modifiable preconception and neighborhood factors that stand to reduce the incidence of adverse birth outcomes and eliminate disparities. Moreover, our findings support to need to shift the clinical practice paradigm upstream to the preconception period, while also shifting the focus of public health practice to the neighborhood level.

Novel Theory. Our research drew upon several unique theoretical models to inform our research questions and hypotheses. The underpinning conceptual framework for this study was derived from a life-course developmental perspective, social-ecological systems theory, stress theory, multiple determinants of health theory, and a framework of perinatal health. Together these theories suggest that that perinatal health and associated outcomes are influenced by cumulative and interactive effects across the lifespan and generations, highlighting the idea that key health determinants prior to pregnancy and neighborhood environments have important impacts on obstetric outcomes and child health.

Novel Methodology. Our methods were innovative on several fronts. First, we used longitudinal data analysis to examine life course factors related to birth and child outcomes. Second, we used nationally representative population-based data, an improvement over convenience samples which could be biased.
II. Review of the Literature

Pregnancy complications and poor birth outcomes are serious global public health problems, causing substantial morbidity and mortality for mothers and their children. In the US, obstetric outcomes, such as low birthweight (LBW; < 2,500 grams) and pregnancy complications, account for over 40% of all infant deaths \(^7\) and have caused significant increases in childhood morbidity in recent years. \(^8,9\) Because many risk factors for adverse obstetric outcomes can be identified and managed prior to pregnancy, recent recommendations have focused on improving women’s health during this critical preconception period. \(^10\)

Stress, Mental Health, and Obstetric Outcomes. Mounting evidence suggests a relationship between antepartum stressful life events and adverse obstetric outcomes. \(^11\) However, there is a dearth of research examining the effects of stressful life events that occur prior to pregnancy and subsequent obstetric outcomes. \(^12-14\) Non-US population-based evidence indicates that preconception life events may be related to preterm birth \(^12\) and gestational age. \(^12,13\) In addition, European-based studies have started to evaluate the relationship between preconception life events and offspring development and disorders. \(^15,16\) These preliminary results are among the first to show that maternal preconception life events may influence child health and well-being throughout the life course. We examined the relationship between preconception life events and obstetric and child health outcomes in a nationally-representative sample of US women.

Preconception Health Behaviors and Obstetric Outcomes. It is well established that poor health behaviors during pregnancy increase the risk for adverse birth outcomes. \(^17-21\) However, similar to life events, less is known about women’s preconception health behaviors and the impact on such outcomes. The few existing studies suggest that preconception BMI (overweight or obese) and vegetable consumption are independently related to higher infant birthweight and fetal growth. \(^22\) In addition, alcohol use problems in the year prior to pregnancy have been tied to premature rupture of the membranes and lower infant birthweight. \(^23\) Therefore, we sought to investigate the relationship between stress, preconception and pregnancy health behaviors, and obstetric outcomes in order to identify women with the highest preconception risk.

Neighborhoods and Obstetric Outcomes. Research examining the effect of disadvantaged neighborhoods, defined by factors like poverty, education, housing conditions, violence and crime, proximity to services or racial segregation, have found positive relationships with obstetric outcomes including LBW and preterm birth. \(^24\) Living in a disadvantaged neighborhood has also been associated with lower social function among children born at very low birthweight (VLBW). \(^25\) Given that many neighborhood characteristics are modifiable using policy, understanding neighborhood factors is crucial in order to reduce adverse birth outcomes and health disparities through targeted population-based interventions.

III. Study Design and Methods

A. Study design. This research was a longitudinal study that examined the associations of stressful life events, preconception health behaviors and neighborhood health and disadvantage on obstetric and child health outcomes.

B. Population studied. Data were from the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), a nationally representative cohort of 10,688 children born in 2001 and their parents. Data were from parent interviews and questionnaires administered when
the child was approximately 9 months and 2 years old. Birth certificate information, obtained at the 9 month interview, was from the 1989 revision of the U.S. Standard Certificate of Live Birth. In addition, we linked ECLS-B data with county level socioeconomic measures obtained from the US Census.

C. Measures. Our dependent variables included: birth outcomes, including preterm birth and birthweight, method of delivery, perinatal health behaviors, and infant and child health outcomes. Our primary independent measure was preconception stressful life events. We controlled for maternal race/ethnicity, age, parity, multiple status, initiation of prenatal care, marital status, health insurance status, pre-pregnancy body mass index (BMI), pregnancy complications, previous preterm or small-for-gestational-age births, maternal chronic conditions, US region of residence, and socioeconomic status.

i. Outcomes. Our primary outcomes were 1) birth outcomes (e.g., low birthweight and preterm birth); 2) delivery method; 3) perinatal health behaviors; and 4) child health outcomes (overall health, health conditions, and special needs).

1. Birth Outcomes. We defined preterm birth as any birth occurring before 37 weeks gestation. The infant’s birthweight was derived from the birth certificate and categorized as: very low (VLBW; less than 1,500 grams); low (LBW; between 1,500 and 2,499 grams), normal (NBW; between 2,500 and 3,999 grams); or high (HBW; 4,000 grams or more).

2. Delivery Method. Data from the birth certificate were used to determine if the method of delivery involved a C-section or a vaginal birth; women who delivered via C-section were further classified into two mutually exclusive groups: medically indicated C-section and non-medically indicated C-section (hereafter referred to as indicated and non-indicated C-section, respectively). Women who delivered via C-section and also had any labor complication or delivered a preterm (<37 weeks) baby were classified as having an indicated C-section.

3. Perinatal health behaviors. Participants were asked about their alcohol and tobacco usage during the three months prior to pregnancy and in the final three months of pregnancy; responses were dichotomized as “any” versus “none.” Additionally, participants reported the total number of cigarettes smoked in an average day and the number of alcoholic drinks consumed in an average week both before and during pregnancy (alcohol use categories were operationalized ordinarily at their midpoint). Continuation of use into pregnancy was derived from these variables.

4. Child Health. We examined 3 child health indicators assessed by maternal report at 9 and 24 months: (1) overall health status, reported on a 5-point Likert scale and dichotomized as “excellent, very good, or good” versus “fair or poor;” (2) a doctor diagnosis of a special health care need; and (3) the presence of any severe health condition, defined as childhood asthma, respiratory illness, ear infection, or gastrointestinal illness that required an emergency room visit or overnight hospitalization. Special health care needs assessed at 9 and 24 months included blindness, difficulty seeing, difficulty hearing or deafness, problem with mobility or using legs, and heart defects. At 9 months, mothers were additionally asked to report diagnoses of cleft lip or palate, failure to thrive, problem with arms or
hands, Down syndrome, Turner’s syndrome, Spina Bifida, and any other types of special needs or limitations. At 24 months, additional conditions included diagnoses of developmental delay (e.g., delays to walking or talking), epilepsy or seizures, mental retardation, lactose intolerance, and food allergies or sensitivities.

ii. **Neighborhood disadvantage.** Using an approach from the previous studies, we downloaded five socioeconomic measures from the 2000 Census to construct a neighborhood disadvantage index (NDI) for each county in the U.S., including: (1) percentage of families in poverty; (2) percentage of households with an income below the state median; (3) percentage of females without a bachelor’s degree; (4) percent of single mothers; and (5) percent of unemployed mothers of young children. Principal component analysis was utilized to construct a NDI as the sum of standardized values from socioeconomic measures weighted by their respective factor loadings. The NDI was then divided into tertiles representing advantaged (lowest NDI score), middle advantaged, and disadvantaged (highest NDI score) neighborhoods.

D. **Statistical techniques employed.** Analyses were conducted using survey procedures from SAS version 9.2 (SAS Institute, Cary, NC). The standard errors were corrected for clustering within strata and the primary sampling unit, and survey weights were applied to produce estimates accounting for the complex survey design, unequal probabilities of selection, and survey nonresponse. Summary statistics were generated to describe the sample characteristics; chi-square tests were used in bivariate analyses to determine significant differences in stress, obstetric, and maternal sociodemographic characteristics by women’s exposure to PSLEs. Multivariable multinomial logistic regression models were used to examine the impact of exposure to stress, obstetric, and maternal sociodemographic factors on the odds of birth outcomes, delivery method, and perinatal health behaviors, adjusting for all factors simultaneously. Stratified analyses examined how the association between PSLEs and birthweight varied by neighborhood tertile strata. We also conducted path analysis by using MPLUS 7.1 (Los Angeles, CA) to test whether PSLEs impacted child health by way of infant birthweight. These analyses estimated direct and indirect effects of PSLEs separately on: (1) overall child health; (2) special health care needs; and (3) severe health conditions.

IV. **Detailed Findings**

**Birthweight.** Twenty percent of women experienced any PSLE. In adjusted analyses, exposed women were 38% more likely to have a VLBW infant than non-exposed women. Furthermore, the accumulation of PSLEs was associated with reduced infant birthweight.

**Preterm birth.** Of the women examined, 10.9% had a preterm birth. In adjusted analyses, women aged 15 to 19 years who experienced any PSLE had over a 4-fold increased risk for having a preterm birth. This association differed on the basis of the timing of the PSLE.

**Delivery method.** 74.2% of women had a vaginal delivery, 11.6% had a non-medically indicated C-section, and 14.2% had a medically indicated C-section. Multivariable analyses revealed that prior C-section was the strongest predictor of both medically indicated and non-medically indicated C-sections. However, we found salient differences between the risk factors for indicated and non-indicated C-sections.
Child health. Path analyses showed indirect and direct relationships among PSLEs, VLBW, and child health. PSLEs increased the risk of VLBW (beta (b): 0.004; s.e.=0.001), and in turn, VLBW was associated with greater risks of fair or poor health (9 month b: 0.051; s.e.=0.012 and 24 month b: 0.041; s.e.=0.010), having any special health care need (9 month b: 0.268; s.e.=0.019 and 24 month b: 0.211; s.e.=0.018), and severe health conditions (9 month b: 0.082; s.e.=0.014 and 24 month b: 0.093; s.e.=0.014) in offspring.

Health behaviors. 37.9% of women reported any alcohol use in the three months prior to pregnancy, while 3.3% of women reported any alcohol use in the final three months of pregnancy. 23.2% of women reported any cigarette use in the three months prior to pregnancy, while 11.0% of women reported any cigarette use in the final three months of pregnancy. Experiencing any PSLE increased the odds of tobacco use prior to and during pregnancy. Women exposed to PSLEs smoked approximately five additional packs of cigarettes in the three months prior to pregnancy and consumed 0.31 additional alcoholic drinks during the last three months of pregnancy compared to unexposed women.

Health behaviors and infant birthweight. 1.2% of women delivered a VLBW baby and 5.6% of women delivered a LBW baby. Compared to women who never smoked, women who used tobacco prior to conception or during their last trimester were more likely to give birth to LBW infants, independent of their exposure to PSLEs.

Neighborhood disadvantage. A gradient in the associations between PSLEs and having a VLBW infant by NDI tertile was found. The association was strongest in disadvantaged neighborhoods (AOR=1.62, CI=1.04-2.53) followed by middle (AOR=1.39; CI=1.00-1.93) and advantaged (AOR=1.29; CI=0.91-1.82) neighborhoods. The similar gradient was also found in maternal chronic conditions and among Black (non-Hispanic [N-H]) mothers.

V. Discussion and Interpretation of Findings

A. Conclusions to be drawn from findings.

Birthweight. This was the first nationally representative study to our knowledge to investigate the impact of PSLEs on VLBW and LBW in the United States. Interventions aimed to improve birth outcomes will need to shift the clinical practice paradigm upstream to the preconception period to reduce women’s exposure to stress over the life course and improve the long-term health of children.

Preterm birth. Findings suggest that adolescence may be a sensitive period for the risk of preterm birth among adolescents exposed to PSLEs. Clinical, programmatic, and policy interventions should address upstream PSLEs, especially for adolescents, to reduce the prevalence of preterm birth and improve maternal and child health.

Delivery method. Surgical deliveries continue to occur at a high rate in the US despite evidence that they increase the risk for morbidity and mortality among women and their children. Reducing the number of non-medically indicated C-sections is warranted to lower the short- and long-term risks for deleterious health outcomes for women and their babies across the lifecourse. Healthcare providers should address the risk factors for medically indicated C-sections to optimize low-risk delivery methods and improve the survival, health, and well-being of children and their mothers.
**Child health.** Findings provide support for a lifecourse “chains of risk” trigger model, such that women’s exposure to any PSLE increases the risk for having a VLBW baby, and in turn, VLBW increases the risk for poor health in early childhood.

**Health behaviors.** PSLEs are associated with tobacco use before pregnancy and alcohol and tobacco use during pregnancy. Alcohol and tobacco screening and cessation services should be implemented prior to and during pregnancy, especially for women who have experienced PSLEs.

**Health behaviors and infant birthweight.** PSLEs and maternal smoking before and during pregnancy are independent risk factors for having a LBW baby, and may affect infant birthweight through different pathways. Interventions to improve birth outcomes will need to shift the clinical practice paradigm upstream to the preconception period to reduce women’s exposure to stress over the life course and prevent poor health behaviors.

**Neighborhood disadvantage.** The findings of this study highlight that both maternal experience before pregnancy and neighborhood conditions before and during pregnancy may play critical roles on infants’ birthweight. Therefore, policy interventions should aim to not only improve women’s health in reproductive age even before pregnancy, but also ameliorate neighborhood conditions to enhance better birth outcomes.

**B. Explanation of study limitations.**

Several potential limitations should be considered when interpreting our results.

First, children who died before nine months of age were not eligible to participate in the ECLS-B. Our study therefore likely excluded the children with the worst birth outcomes (e.g., stillbirth, neonatal death), which could create a potential survival bias and may have led to conservative estimates of the effect of PSLEs on infant birthweight and preterm birth. Second, the data were collected approximately nine months postpartum and might be subject to recall bias. For example, if events were systematically underreported by mothers of very LBW and LBW infants, or mothers of NBW infants, our findings could be biased toward or away from the null, respectively. Third, birth certificate data might have been underreported or incorrectly reported some information (e.g., pregnancy complications), leading to misclassification. However, underreporting these data would lead to conservative estimates. Similarly, we relied on self-reported data for factors like prepregnancy BMI, which might have biased our estimates in an unknown direction. We also could not examine indications for C-section deliveries other than those indicated on the birth certificate. Further inquiry into factors leading to non indicated C-section deliveries, including those associated with maternal request, hospital policy or pelvic preservation, is needed to further understand the degree to which C-sections are preventable. Fourth, although consistent with a lifecourse perspective, the null relationship for C-section and stressful life events during pregnancy may have been due to the limited number of events that were evaluated and their low incidence given the relatively short time frame of pregnancy. ECLS-B collected limited data on stressful life events and might not have comprehensively captured the spectrum of stressors some women experience. Failing to capture additional events (including adverse childhood experiences) might have resulted in misclassification. Although there is a rich literature on adverse childhood experiences and adult outcomes, only one study has investigated the relationship between adverse childhood experiences and reproductive outcomes. Clearly, more research into the nexus of adverse childhood experiences and women’s reproductive health is warranted. Fifth, the number of individuals who endorsed
specific preconception stressful life events was small; therefore, we were unable to conduct analyses examining the independent effect of each type of event on infant birthweight. Furthermore, some of these events were mutually exclusive (i.e., could only happen before or during pregnancy), and future work should examine a broader spectrum of stressors and daily stress in order to confirm and better understand our findings.

C. Possible application of findings to actual MCH health care delivery situations.

Collectively, the results from these studies suggest that it might be important to shift the clinical paradigm upstream to the preconception period to improve birth, infant, and early child health outcomes. The preconception period is increasingly being acknowledged as an important area for women’s health, and strategies to reduce general mental distress and improve health behaviors, for example, have been recognized as important avenues for women’s preconception health care. Screening women for PSLEs and offering targeted interventions, including interventions that provide women with resources (e.g., mental healthcare) to cope with PSLEs, may be instrumental for lowering the risk of having a VLBW infant and an indicated C-section delivery. Findings also emphasize the importance of providing care to pregnant teens, especially those who have experienced a stressful life event, to prevent preterm birth.

D. Policy implications.

Our findings could lead to substantial improvements to clinical practice, and indicate that women of all reproductive ages should be offered continuous preventive and primary care health services. Promoting preconception health through screening, education, counseling, treatment, and referral should occur in a variety of settings over the lifecourse to ensure that women are effectively identified and treated for health problems, regardless of when or where they interface with the healthcare system. This is especially true for women who are more vulnerable to “double disadvantage” due to increased risk of VLBW attributable to PSLEs, substance use, living in disadvantaged neighborhoods, experiencing chronic health conditions, or being a minority race/ethnicity. This suggests that we cannot just address one risk factor or another, and that we cannot focus only on individual level risk factors. Instead, these findings highlight the importance of multifaceted preventive interventions and integrative health screenings to improve intergenerational health outcomes and eliminate health disparities for these vulnerable women and their children. Furthermore, women and their providers should strive to identify and address stress in the preconception period so as to prevent deleterious obstetric outcomes. Accordingly, if women who reside in disadvantaged or unhealthy neighborhoods are at an increased risk, then those neighborhoods, which may moderate the amount of stress and resources linked to adverse birth outcomes, can be targeted for community level intervention.

E. Suggestions for further research.

Future research needs to examine the effect of stress prior to and during pregnancy to confirm our findings and determine the independent, cumulative, or interactive roles of stress on obstetric outcomes. Specifically, future research should strive to extend the exposure window when investigating the antecedents of adverse obstetric outcomes to better understand how the timing of events may influence birth outcomes. Additionally, use of more culturally appropriate sets of PSLEs is warranted to understand how their effects on birth outcomes vary across races and ethnicities. Future research also needs to adopt a lifecourse approach and investigate adolescence as a sensitive period for reproductive health.
VI. List of products

A. Peer Reviewed Articles


B. Conference Presentations


Meeting of American Public Health Association, Boston, MA (November 2013).


C. Submitted Manuscripts


D. Manuscript In Progress


References


