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Katherine Nystrom Date

Maternal Socioeconomic Status and the Odds of Failing to Receive Preconception Counseling: an Epidemiologic Study Using 2009-2011 PRAMS Data

By

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Master of Public Health

Global Epidemiology

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Michael Kramer, Ph.D.

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By

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Bachelor of Arts

College of St. Benedict

2013

Thesis Committee Chair: Michael Kramer, Ph.D.

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Abstract

Maternal Socioeconomic Status and the Odds of Failing to Receive Preconception Counseling: an Epidemiologic Study Using 2009-2011 PRAMS Data

By Katherine Nystrom

Objectives: To determine the degree to which maternal characteristics, psychosocial factors, and health behaviors explain or mediate the influence of socioeconomic factors on the receipt of preconception counseling.

Methods: Secondary analysis of Pregnancy Risk Assessment Monitoring System (PRAMS) data from 6 states (Hawaii, Maryland, Michigan, Minnesota, Utah, and West Virginia) that included the following question in their PRAMS questionnaire: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how to prepare for a healthy pregnancy and baby?" The sample is a population-based sample of 27,458 women who gave birth to a live infant during the years 2009-2011.

Results: Women of low socioeconomic status disproportionately had poorer health behaviors and access to health care services in regards to preconception health. For example, among women with an income of less than $10,000, 72.5% reported that their recent pregnancy was unintended. Among women with less than 12 years of education, 69.2% reported that their recent pregnancy was unintended. Pre-pregnancy multivitamin use among women earning less than $10,000 annually was 27.1%, and pre-pregnancy multivitamin use among women with less than 12 years of education was 30.8%. Only 32.7% of respondents received preconception counseling. By using multivariable logistic regression, we found modest evidence for income and education variation, although not in a clear dose-response gradient. We observed a protective, albeit non-significant, effect of extreme poverty (annual income < $10,000) against the failure to receive preconception counseling. Women earning between $10,000 and $49,999 annually or having less than 16 years of education were less likely to receive preconception counseling.

Conclusions for Practice: To prevent adverse pregnancy and infant outcomes, preconception counseling should be incorporated into public health programs and interventions targeted to all women of reproductive age. Currently, the provision of preconception counseling, or women's recognition of the receipt of preconception counseling, remains substandard. While scientific evidence is growing to support the improvement of women's preconception health as an effective way to reduce poor pregnancy and infant outcomes, further research is needed to assess the effectiveness of preconception health programs and policies.

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BACKGROUND

Introduction to Preconception Health

In 2010, the infant mortality rate in the United States was 6.1 infant deaths per 1,000 live births (5). According to the 2014 National Vital Statistics Report, the United States ranked 26th in infant mortality among the 29 Organization for Economic Co-operation and Development (OECD) countries (5). The report also states that in 2010, 9.8% of U.S. births were preterm; this percentage was the highest among the countries studied. In 2007, the three leading causes of infant death in the U.S. were congenital malformations (20%), disorders relating to short gestation and low birth weight (17%), and sudden infant death syndrome (8%) (2). Despite major improvements in access to prenatal care in the United States, we have failed to observe a decrease in the incidence of congenital anomalies, preterm birth, low birth weight, and maternal mortality (6, 7). Researchers who have utilized the perinatal periods of risk approach, an approach that mobilizes communities and analyzes data to address high infant mortality rates, recommend preconception care as an intervention to reduce infant mortality rates and very low birth weight births (8). To prevent adverse pregnancy and infant outcomes, preconception health should be an essential component of public health programs and interventions targeted to women who are planning a pregnancy or could become pregnant.

The Centers for Disease Control and Prevention (CDC) defines preconception care as "a set of interventions aimed at identifying and modifying biomedical, behavioral, and social risks to a woman's health or pregnancy outcome through prevention and management" (9). While preconception care is an important part of primary care for women of reproductive age and should be incorporated into every treatment recommendation and medical decision, only 32.6% of women received preconception care in 2010 (10). Preconception care not only ensures that a

woman is as healthy as possible before conception for the health of her future children, but it also emphasizes an individual's health overall, despite pregnancy intention.

The CDC Preconception Care Work Group and the Select Panel on Preconception Care presented recommendations in 2006 to improve preconception health and health care in the United States. The recommendations focused on improving the health of women, their children, and their families by changing consumer knowledge, clinical practice, public health programs, health care financing, and data and research activities so that these activities may be utilized by individuals, communities, public health and clinical providers, and state and local governments (1). Furthermore, the report outlines a series of actionable steps that were meant to achieve Healthy People 2010 objectives (1). Please see Box 1 for a list of the recommendations from the Work Group and Select Panel.

In 2013, Floyd, Johnson, Owens, Verbiest, Moore, Boyle published a national

Box 1. Recommendations from the CDC Preconception Care Work Group and the Select Panel on Preconception Care (1, 2)

- **Recommendation 1:** Each woman, man, and couple should be encouraged to have a reproductive life plan.
- **Recommendation 2:** Increase public awareness of the importance of preconception health behaviors and preconception care services by using information and tools appropriate across various ages; literacy, including health literacy; and cultural/linguistic contexts.
- **Recommendation 3:** As a part of primary care visits, provide risk assessment and educational and health promotion counseling to all women of childbearing age to reduce reproductive risks and improve pregnancy outcomes.
- **Recommendation 4:** Increase the proportion of women who receive interventions as follow-up to preconception risk screening, focusing on high priority interventions (i.e., those with evidence of effectiveness and greatest potential impact).
- **Recommendation 5:** Use the interconception period to provide additional intensive interventions to women who have had a previous pregnancy that ended in an adverse outcome (i.e., infant death, fetal loss, birth defects, low birth weight, or preterm birth).
- **Recommendation 6:** Offer, as a component of maternity care, one prepregnancy visit for couples and persons planning pregnancy.
- **Recommendation 7:** Increase public and private health insurance coverage for women with low incomes to improve access to preventive women's health and preconception and interconception care.
- **Recommendation 8:** Integrate components of preconception health into existing local public health and related programs, including emphasis on interconception interventions for women with previous adverse outcomes.
- **Recommendation 9:** Increase the evidence base and promote the use of the evidence to improve preconception health.
- **Recommendation 10:** Maximize public health surveillance and related research mechanisms to monitor preconception health.

action plan to further the status of preconception health in the United States. The national action plan focused on the promotion of preconception health and health care and the advancement of the implementation of the recommendations formed by the CDC's Select Panel on Preconception Care (2). However, the national action plan acknowledges that it will be a challenge for health plans, states, and clinicians to implement federal requirements for women's clinical preventive services, including preconception care in well-woman visits. The national action plan also acknowledged that a larger approach that addresses racial inequities, socioeconomic status, and access to resources is needed to address health disparities in preconception health and birth outcomes (2).

In line with the national recommendations from public health experts, Healthy People 2020 has set forth objectives relating to preconception health and behaviors, and several can be assessed using data from the Pregnancy Risk Assessment Monitoring System (PRAMS), a population-based surveillance system that provided data for this analysis. The main Healthy People 2020 objective regarding

Box 2. Preconception health Healthy People 2020 sub-objectives (3)

- **MICH-16.1:** (Developmental) Increase the proportion of women delivering a live birth who discussed preconception health with a health care worker prior to pregnancy
  - Baseline: N/A
  - Target: NA
- **MICH-16.2:** Increase the proportion of women delivering a live birth who took multivitamins/folic acid prior to pregnancy
  - Baseline: 30.1% of females delivering a recent live birth took multivitamins/folic acid every day in the month prior to pregnancy, as reported in 2007
  - Target: 33.1%
- **MICH-16.3:** Increase the proportion of women delivering a live birth who did not smoke prior to pregnancy
  - Baseline: 77.6% of females delivering a recent live birth did not smoke in the 3 months prior to pregnancy, as reported in 2007
  - Target: 85.4%
- **MICH-16.4:** Increase the proportion of women delivering a live birth who did not drink alcohol prior to pregnancy
  - Baseline: 51.3% of females delivering a recent live birth did not drink alcohol in the 3 months prior to pregnancy, as reported in 2007
  - Target: 56.4%
- **MICH-16.5:** Increase the proportion of women delivering a live birth who had a healthy weight prior to pregnancy
  - Baseline: 48.5% of females delivering a recent live birth had a normal weight (i.e., a BMI of 18.5 to 24.9) prior to pregnancy, as reported in 2007
  - Target: 53.4%
- **MICH-16.6:** (Developmental) Increase the proportion of women delivering a live birth who used contraception to plan pregnancy
  - Baseline: N/A
  - Target: N/A

preconception health is to increase the proportion of women who delivered a live birth who received preconception care services and practiced key recommended preconception health behaviors (3). Six sub-objectives and their baseline and targets are included in Box 2.

Despite national recommendations by the CDC and evidence supporting preconception care's link to improved maternal and perinatal outcomes, "preconception care remains fragmented and inconsistent, difficult to access, and poorly understood by many women" (11). Numerous studies have shown that the first few weeks after conception are the most critical for fetal development; however, most women are not aware that they are pregnant until after this critical period (6, 7, 12). Although the United States has experienced major improvements in access to prenatal care, the incidence of congenital anomalies, preterm birth, low birth weight, and maternal mortality have not decreased (6, 7). Furthermore, 52% of a nationally representative sample from the 2008 Behavioral Risk Factor Surveillance System (BRFSS) reported at least one risk factor that could negatively impact a future pregnancy, including tobacco and alcohol use, diabetes, or obesity (13).

Preconception Health Indicators

Broussard, Sappenfield, Fussman, Kroelinger and Grigorescu published a report in 2011 identifying core state indicators to monitor the health of women of reproductive age and preconception health domains. Domains were established based on priority areas within women's health and maternal and child health, and indicators addressing the domains were identified from population-based, state level data systems including PRAMS, the Behavioral Risk Factor Surveillance System (BRFSS), National Vital Statistics System (NVSS), Annual Social and Economic Supplement (ASEC), and National Sexually Transmitted Diseases Database (NSTD). Indicators were evaluated on its public health importance, policy/program importance, data availability, data quality, and the complexity of calculating the indicator (14). Eleven

domains of preconception health and 45 core indicators were identified. A summary table originally presented in Broussard et al.'s report outlining the domains, sub-domains, indicators, and data source is included in Table 4 in the Appendix.

Of the 45 core indicators identified by Broussard et al., Robbins, Zapata, Farr, Morrow, Ahluwalia, D'Angelo,…and Barfield reported data in 2014 for 38 core state preconception health indicators from 2009 and one indicator from 2008; while 41 of the 45 core indicators identified by Broussard et al. are reliant on PRAMS and BRFSS data, Robbins et al. reported surveillance data from PRAMS and BRFSS only and excluded two indicators from their analysis (human immunodeficiency virus (HIV) testing within a year before the most recent pregnancy and heavy drinking on at least one occasion during the preceding month) (4). Twenty-nine reporting areas (n=40,388 respondents) were included using PRAMS data, and 51 reporting areas (n=62,875 respondents) using BRFSS. Respondents were non-pregnant women of reproductive age (18-44 years). Robbins et al. examined ten of the preconception health domains identified by Broussard et al.: general health status and life satisfaction, social determinants of health, health care, reproductive health and family planning, tobacco and alcohol use, nutrition and physical activity, mental health, emotional and social support, chronic conditions, and infections. They present weighted prevalence estimates and 95% confidence intervals (95% CIs) overall and for each reporting area and stratified by maternal age group (18–24, 25–34, and 35–44 years) and race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic other, and Hispanic) (4). Robbins et al. found that while all the preconception health indicators varied by reporting area, significant variations were seen by age group and race/ethnicity. Please see Box 3 for a summary of their results.

Box 3. Summary of results originally found in Robbins et al. (4)

Overall, 88.9% of women of reproductive age reported good, very good, or excellent general health status and life satisfaction (BRFSS). A high school/general equivalency diploma or higher education (social determinants of health domain) was reported by 94.7% of non-Hispanic white, 92.9% of non-Hispanic other, 91.1% of non-Hispanic black, and 70.9% of Hispanic women (BRFSS). Overall, health-care insurance coverage during the month before the most recent pregnancy (health-care domain) was 74.9% (PRAMS). A routine checkup during the preceding year was reported by 79.0% of non-Hispanic black, 65.1% of non- Hispanic white, 64.3% of other, and 63.0% of Hispanic women (BRFSS). Among women with a recent live birth (2–9 months since date of delivery), selected PRAMS results for the reproductive health and family planning, tobacco and alcohol use, and nutrition domains included several factors. Although 43% of women reported that their most recent pregnancy was unintended (unwanted or wanted to be pregnant later), approximately half (53%) of those who were not trying to get pregnant reported not using contraception at the time of conception. Smoking during the 3 months before pregnancy was reported by 25.1% of women, and drinking alcohol 3 months before pregnancy was reported by 54.2% of women. Daily use of a multivitamin, prenatal vitamin, or a folic acid supplement during the month before pregnancy was reported by 29.7% of women.

Selected BRFSS results included indicators pertaining to the nutrition and physical activity, emotional and social support, and chronic conditions domains among women of reproductive age. Approximately one fourth (24.7%) of women were identified as being obese according to body mass index (BMI) on the basis of self-reported height and weight. Overall, 51.6% of women reported participation in recommended levels of physical activity per U.S. Department of Health and Human Services physical activity guidelines. Non-Hispanic whites reported the highest prevalence (85.0%) of having adequate emotional and social support, followed by other races/ethnicities (74.9%), Hispanics (70.5%), and non-Hispanic blacks (69.7%). Approximately 3.0% of persons reported ever being diagnosed with diabetes, and 10.2% of women reported ever being diagnosed with hypertension.

Robbins et al.'s findings identify opportunities for improving the preconception health of women in the United States, including reducing unintended pregnancies, reducing risky behaviors such as smoking and drinking alcohol, and increasing control of chronic conditions among women of reproductive age (4). Robbins et al. assert that increased access to health care and use of essential preventive services for women of reproductive age, whether by alleviating health problems resulting from inadequate social and emotional support or through policy changes to promote health equity, are imperative to bettering the health of women and children in the United States. Finally, Robbins et al. calls for continued research and surveillance to monitor the influence of preconception care on women's prepregnancy and interpregnancy health status, pregnancy and birth outcomes, and health disparities (4).

Preconception Counseling

Preconception counseling is a vital component of preconception care in which providers educate and recommend strategies to improve health and birth outcomes for women of

reproductive age (15). Williams, Zapata, D'Angelo, Harrison, and Morrow analyzed 2004-2008 PRAMS data from four states (n = 30,481) and found that preconception counseling was associated with positive maternal behaviors that increase the likelihood of a healthy woman, pregnancy, and infant. However, only 32.4% of women reported receipt of preconception counseling. This rate was even lower among women with an unintended pregnancy (13.5%) and no health insurance prior to pregnancy (13.7%) (15). Williams et al. also found that receipt of preconception counseling was associated with daily pre-pregnancy multivitamin consumption (adjusted OR = 4.4; 95% CI, 4.0-4.7), first-trimester entry into prenatal care for women with an intended pregnancy (adjusted OR = 2.1; 95% CI,1.8-2.4), and drinking cessation before pregnancy among women who drank alcohol in the 2 years preceding the survey (adjusted OR = 1.3; 95% CI, 1.2-1.5) (15).

Farahi and Zolotor published recommendations for preconception counseling and care in 2013. Their recommendations are targeted to primary care physicians and include identifying health risks and implementing interventions to reduce these risks. Key recommendations and interventions include asking a women of reproductive age about her intention to become pregnant and to provide contraceptive counseling tailored to the patients' intentions; advising the patient to take 400 mcg of folic acid daily to reduce the risk of neural tube defects; assessing the patient's body mass index (BMI) and counseling women who are overweight, obese, or underweight about achieving a healthy body weight before pregnancy; counseling women with diabetes mellitus about the importance of glycemic control before pregnancy; checking for teratogenic medication use and prescribing safer medications if possible; screening patients for sexually transmitted infections (STIs) or other communicable diseases; and updating vaccines as needed (9).

Several studies have shown that preconception counseling is associated with positive maternal behaviors. One notable study by Hillemeier, Downs, Feinberg, Weisman, Chuang, Parrott, Velott, Francis, Baker, Dyer, and Chinchilli reported findings from the randomized trial

of the Strong Healthy Women Intervention in the Central Pennsylvania Women's Health Study in 2008. The study population consisted of 362 non-pregnant pre- and interconceptional women between the ages of 18 and 35 years from one of 15 low-income rural communities in Central Pennsylvania. The intervention group received a multidimensional behavioral intervention that addressed the prevalent modifiable risk factors identified during an earlier phase of the larger study, and the outcome measured was attitudinal and health-related behavior change. Hillemeier et al. found that women in the intervention group were significantly more likely than controls to report higher self-efficacy for eating healthy food, higher preconceptional control of birth outcomes, greater intent to eat healthy foods and frequency of reading food labels, increased physical activity more consistent with recommended levels, and greater daily use of a multivitamin with folic acid (16). The researchers also found a significant dose effect, such that each additional intervention session attended was associated with higher perceived internal preconceptional control of birth outcomes, reading food labels, engaging in relaxation exercise or meditation for stress management, and daily use of a multivitamin with folic acid (16). Hillemeier et al. concluded that the attitudinal and behavior changes attributable to the intervention were primarily related to nutrition and physical activity, and that these topics can be successfully addressed outside the clinical setting in community-based interventions (16).

Hillemeier et al. established that preconception counseling was associated with a higher perceived internal preconceptional control of birth outcomes. Weisman, Hillemeier, Chase, Chuang, Parrott and Dyer published an additional report in 2008 using data from the Central Pennsylvania Women's Health Study that examined maternal characteristics that may be associated with a woman's ability to perceive internal control of her birth outcomes (17). By using multiple logistic regression analysis, Weisman et al. found that internal control of birth outcomes was positively associated with older age (35–45 years), higher education (some college or more), marital status (currently married or living with a partner), and higher self-rated physical health status (17). However, self-rated mental health status or psychosocial stress, previous

adverse pregnancy outcomes, and current access to health care had no association with internal control for birth outcomes (17). Weisman et al. concluded that "educational and social marketing efforts to increase women's use of preconception care may be particularly important for women who are likely to have lower internal control, including younger, less educated, unmarried, and less healthy women" (17).

Barriers and Enablers to Preconception Care

Several quantitative and qualitative studies have been published that examine both physicians' and patients' perspectives and experiences with preconception counseling. While barriers and enablers to the provision of preconception care exist for both providers and patients, barriers appear to be a combination of lack of patient knowledge and demand for services; patient activation; physician practice, such as such as a lack of knowledge of recommended interventions, limited time, inadequate tools and training needed to implement preconception care; and structural barriers such as socioeconomic status and access to care. Enablers to the provision of preconception care include educational materials provided by physicians and the use of a reproductive health self-assessment tool to facilitate the patient-provider interaction.

Barriers

Chuang, Hwang, McCall-Hosenfeld, Rosenwasser, Hillemeier, and Weisman published a qualitative study in 2012 that explored the practices of rural central Pennsylvanian primary care providers' regarding preventive reproductive health services, their "perceptions of unmet needs for such services in their communities, the barriers to providing them, and ways to improve their delivery" (18). Chuang et al. found that while providers tended to focus on contraceptive or prenatal care, they were aware of the benefits of preconception health and that the women may benefit from guidance in planning for pregnancy. Several providers reported taking a broad approach to preconception care, typically by assessing women's behavioral risk factors, medication use, folic acid supplementation, chronic medical conditions, family history, and

pregnancy history. Chuang et al. report that while half of the physicians reported initiating conversations about preconception health when performing a Pap smear or when discussing contraception with younger women, none reported providing dedicated preconception care visits. Study participants identified barriers to preconception counseling as their own failure to prioritize the topic, their belief that it is not the primary care physician's role to initiate and discuss planning for pregnancy and preconception care, or they were uncertain with what they could offer (18).

Mazza, Chapman, and Michie assessed primary care providers' perceptions of the barriers and enablers to the delivery and uptake of preconception care guidelines using focus groups with general practitioners in 2013. In this study, the general practitioners identified 5 main barriers: time constraints, lack of women presenting at the preconception stage, numerous competing preventive priorities within the general practice setting, issues relating to the cost of and access to preconception care, and the lack of resources for assisting in the delivery of preconception care guidelines (19).

Mazza and Chapman published an earlier article focused on women's perceptions of barriers to the uptake of preconception care and periconceptional folate supplementation. Mazza and Chapman found that most women participating in their focus groups were unaware of the need for preconception care, surprised at the breadth of issues involved, and cognizant that they themselves had to be thinking about pregnancy or becoming pregnant to be receptive to it (20). However, the women thought that general practitioners should be more proactive in promoting preconception care availability (20).

Enablers

In Mazza and Chapman's aforementioned study regarding women's perceptions of barriers to the uptake of preconception care and periconceptional folate supplementation, the

participants stated that a desire to do anything they could to ensure optimum pregnancy outcomes, and promotional materials and letters of invitation from their general practitioner to advise them of the availability and need for preconception care serve as enablers to periconceptional folate supplementation (20). Mazza, Chapman, and Michie also identified enablers to preconception care in their previously mentioned study. Mazza et al. found that the availability of preconception care checklists and patient brochures, handouts, and waiting room posters outlining the benefits and availability of preconception care consultations were listed as perceived enablers (19).

Bello, Adkins, Stulberg, and Rao examined patients' and providers' perceptions of a patient prompt (reproductive health self-assessment tool) given before a primary care visit and its impact on the provider-patient interaction. Bello et al. found that the tool helped improve the quality of reproductive health counseling "by increasing patient awareness and participation in discussion of these topics" because "when patients give forethought to reproductive health topics, providers tend to offer more patient-centered counseling that takes less time because it is focused on the patient's specific goals rather than on providing general information" (13).

Women of Low Socioeconomic Status

For women of reproductive age, access to preconception care is considered critical to ensuring healthy pregnancies and improved perinatal outcomes (21). Without adequate access to preconception care, low-income women may not receive critical information about how to get a healthy start to a pregnancy, such as the importance of taking prenatal vitamins, making healthy food choices, controlling chronic diseases, and not using tobacco, alcohol, or illicit drugs (21). As a result, these women may be at increased risk for adverse pregnancy outcomes.

While low-income women are known to be affected disproportionally by unintended pregnancy and adverse birth outcomes, these groups of women also experience a higher

prevalence of preconception risk factors that can negatively affect maternal and child health (13). According to Coffey and Shorten, "the benefits of preconception care depend on the risk profile of the individual woman or population. Low income and minority women potentially have the most to gain from preconception care because they are at the highest risk for adverse pregnancy and birth outcomes" (11).

Impact of Low Socioeconomic Status

Oza-Frank, Gilson, Keim, Lynch, and Klebanoff published a study in 2014 that aimed to explore trends in the proportion of women reporting the receipt of preconception counseling from 2004 to 2010 and to identify factors associated with self-reported receipt of preconception counseling, including which subgroups of women might be at highest risk of not receiving preconception counseling (10). Oza-Frank et al. initially identified non-Hispanic black women, women who have had a previous pre-term birth, a household income of less than or equal to $19,999, an education less than high school, participated in WIC, participated in Medicaid, and possessed no health insurance as those who would be more likely to report receipt of preconception counseling, since these women have an increased risk for adverse birth outcomes and would be more likely to be identified in a clinic setting (10). They found that women who were non-Hispanic Asian, younger (maternal age ≤ 29 years), with lower income (< $50,000), were not married, had private/other or no pre-pregnancy insurance, or had a previous preterm birth were less likely to report preconception counseling (10). Furthermore, women with lower levels of education (< 12 years), who were non-Hispanic black, Hispanic, intended the pregnancy, had no previous children, or had pre-pregnancy government insurance were more likely to report preconception counseling (10).

Harelick, Viola, and Tahara assessed knowledge and behaviors of low socioeconomic status (SES) women in regards to preconception health outcomes including the prevalence of risk factors and correlations between the presence of a risk factor and either a respondent's knowledge

or a health care provider's recommendation (22). Even though the majority of the study participants recalled being spoken to by a health care provider about pregnancy-related risks, most risk factors were not influenced by provider's recommendations, including multivitamin use, drinking alcohol, and smoking (22). Harelick et al. also found significant differences in risk factors between Black, non-Hispanic and Hispanic respondents; alcohol use and overweight/obesity was higher among non-Hispanic blacks, whereas Hispanic women had lower rates of multivitamin use (22). While Harelick et al.'s study identified behaviors amenable to change, a woman's knowledge alone or a doctor's recommendation were not enough to change those behaviors. To encourage women to adopt healthy behaviors throughout their childbearing years, Harelick et al. suggest creating and implementing innovative programs and support systems (22).

Solutions

Dunlop, Logue, Miranda, and Narayan published a study in 2010 that explored the acceptability and utility of integrating reproductive planning with primary health care among low-income, minority women and men who attend publicly-funded clinics in Atlanta, Georgia. Before seeing their health care provider, patients completed a written reproductive plan questionnaire that assessed their desire for a child and contraceptive practices. After seeing their provider, participants were interviewed to elicit patients' opinions about the questionnaire (23). Overall, 81% of females and 42% of males reported that the reproductive plans assessment was important to their visit, and a substantial proportion were at risk for unintended pregnancy. Dunlop et al. concluded that "primary care practices should consider implementing a reproductive plan assessment to facilitate linkage of patients to appropriate family planning, preconception, and sexually-transmitted infection services" (23).

In addition to primary care practices, the Women, Infants, and Children (WIC) Supplemental Nutrition Program may be another entity in which preconception counseling could

be delivered to low-income women. A study published in 2013 by Dunlop, Dretler, Badal, and Logue affirms that "WIC constituted a suitable location for identifying low-income African-American women in need of preconception and reproductive health services" who were at risk for poor reproductive health outcomes (24). Dunlop et al.'s study assessed the acceptability and potential impact of brief preconception health risk assessment and counseling in the WIC setting in Clayton County, Georgia. The study team recruited African American women between the ages of 18 and 44 years from attendees of WIC nutrition classes for postpartum and breastfeeding women and mothers of children under 5 years of age (24). Participant's reproductive risks were assessed quantitatively by using a risk assessment questionnaire administered by a member of the study team. Then, study participants received a standardized brief counseling session. Interviews with the participants revealed that the majority of WIC clients found the preconception risk assessment and brief counseling to be acceptable and important (24).

Similar to Dunlop et al.'s study focusing on the acceptability of preconception counseling in the WIC setting, Dunlop, Logue, Thorne, and Badal published a study in 2013 that explored the knowledge of general and personal preconception health risks among women in publicly funded clinics. This interventional cohort study assessed the change in women's knowledge following targeted brief counseling in 2 cohorts of low-income, non-pregnant African-American and Hispanic women of reproductive age that attended a publically funded primary care clinic (25). Dunlop et al found that women who received targeted brief counseling experienced a significant increase in knowledge related to preconception health from baseline to 3 to 6 months post-encounter. Compared to the comparison cohort, women who received the intervention increased their ability to recognize the importance of folic acid supplementation, seek medical care for chronic conditions, and review medication use in the preconception period. Furthermore, among those with a chronic medical condition, women in the intervention cohort significantly increased their knowledge that the condition could lead to problems in pregnancy (25).

Policy Implications and Access to Preconception Counseling

In 2013, approximately 17 million women (17%) ages 19 to 64 were uninsured, and 13% were covered by Medicaid (26). According to Ahluwalia, Harrison, D'Angelo, and Morrow, "having health insurance is one indicator of access to healthcare and preventive services, and numerous studies have shown associations between lack of health insurance, unmet medical needs, poor health status, and access to healthcare services, especially among low-income populations" (21). Compared to their insured counterparts, uninsured women are 2 to 3 times more likely to go without or postpone preventive care due to cost (21).

Medicaid coverage of women before they become pregnant is an important indicator for both state and federal programs and policies, since changes in these programs and policies directly affect the number of low-income women eligible to receive health care services (21). In 2009, Ahluwalia et al. published a study using PRAMS data to describe Medicaid coverage of women before they become pregnant and changes in this indicator overtime. Ahluwalia et al. found that in 2006, 15.3% of U.S. women delivering a live-born infant reported having Medicaid coverage, with large variations of Medicaid coverage between states included in their analysis. Salganicoff and An published a review in 2008 that explores Medicaid's role in improving access to preconception care for low-income women. Although many of the core components of preconception care are covered under Medicaid, Salganicoff and An assert that from a health equity and fiscal perspective, "more can be done to assure that at-risk, low-income women receive the optimal level of care before they become pregnant, so they can have the healthiest birth outcomes possible" (27). While the current Medicaid program provides coverage to low-income mothers, it does not provide coverage for women who do not have children in many states (27). Unfortunately, it is too early to assess how the Patient Protection and Affordable Care Act has influenced Medicaid coverage, closed coverage gaps, and effected disparities that result from a lack of insurance during the preconception period.

Several researchers have suggested options to provide preconception counseling to low-income women. Gold and Alrich conducted a study in 2008 that examined how Title X family planning clinics could play an important role in introducing preconception care to low-income and young women who are ineligible for Medicaid by expanding services to include basic preconception care, including screening, education, and interventions (28). Although family planning programs hold great promise to improve access and provision of preconception care, these programs need to be broadened to include a wider range of services than what they currently offer. An article published in 2006 by Johnson reviews public finance policy strategies to increase access to preconception care in the United States, based on a review and analysis of state and federal policies (29). Johnson found that three major policy directions are discussed in the literature and in state and federal policies that could increase access to preconception care among women of childbearing age: "(1) improve health care coverage, (2) increase the supply of publicly subsidized health clinics, and (3) direct delivery of preconception screening and interventions in the context of public health programs" (29).

Gaps in the Literature

To prevent adverse pregnancy and infant outcomes, preconception health should be an essential component of public health programs and interventions targeted to all women of reproductive age. While experts and public health agencies have provided recommendations to improve access to preconception care to women in the United States, only 32.4% of women reported receipt of preconception counseling in 2008, and only 13.5% of women who had an unintended pregnancy and 13.7% of women with no health insurance prior to pregnancy received preconception counseling (15). Furthermore, 52% of a nationally representative sample from the 2008 Behavioral Risk Factor Surveillance System (BRFSS) reported at least one risk factor that could negatively impact a future pregnancy, including tobacco and alcohol use, diabetes, or obesity (13).

Preconception counseling has been shown to be associated with positive maternal behaviors (16). However, barriers to the provision of preconception care exist and appear to be a combination of lack of patient knowledge and demand for services; patient activation; physician practice, such as such as a lack of knowledge of recommended interventions, limited time, inadequate tools and training needed to implement preconception care; and structural barriers such as socioeconomic status and access to care (18-20). The availability of preconception care checklists and patient brochures, handouts, waiting room posters outlining the benefits and availability of preconception care consultations, and use of a reproductive health self-assessment tool as a patient prompt have been shown to enable the provision of preconception care (13, 20).

Important socioeconomic indicators, including education and income, have been shown to be inversely associated with poor health outcomes in several longitudinal studies (30). Furthermore, persons in lower socioeconomic strata have increased exposure to psychosocial variables predictive of morbidity and mortality, including a lack of social relationships and social support, personality dispositions such as a lower sense of control, and chronic and acute stress (including racism and classism) (30). Without adequate access to preconception care, low-income women may not receive critical information about how to get a healthy start to a pregnancy, such as the importance of taking prenatal vitamins, making healthy food choices, controlling chronic diseases, and abstaining from the use of tobacco, alcohol, or drugs (21). As a result, these women may be at increased risk for adverse pregnancy outcomes.

Oza-Frank et al. found that women who were non-Hispanic Asian, younger (maternal age $\leq$ 29 years), with lower income (< $50,000), were not married, had private/other or no pre-pregnancy insurance, or had a previous preterm birth were less likely to report preconception counseling (10). However, Dunlop et al. found in two separate studies that integrating reproductive planning with primary health care and WIC encounters among low-income, minority women and men was acceptable and important among participants (23, 24). Furthermore, Dunlop

et al. found that women who received targeted brief counseling experienced a significant increase in knowledge related to preconception health from baseline to 3 to 6 months post-encounter (25). Access to preconception care is especially important among low-income women. Policy changes, such as expanding Medicaid to include preconception care and integrating preconception care with Title X family planning clinics, could play an important role in introducing preconception care to low-income women. Even though low socioeconomic status has been shown to be associated with a reduced chance to receive preconception counseling, socioeconomic status has not been explored as an exposure in the preconception health paradigm (10).

In addition, Oza-Frank et al.'s analysis of preconception care trends over a 7-year period suggest that preconception care recommendations may have not been integrated into clinical practice as recommended. Data from qualitative studies that examined both clinicians and patient's perspectives of barriers to care support Oza-Frank et al.'s findings. Oza-Frank et al. also state that "rather than develop a complicated risk stratification for provision of [preconception counseling], physicians should provide general [preconception counseling] to all women" (10). Even though providing preconception counseling to all women is ideal, qualitative data suggests that barriers, such as time restraints, exist that prevent clinicians from doing so. Since low-income women may experience issues with the timing of insurance coverage, they may have inadequate access to health care services which may prevent these women from receiving critical information about how to get healthy before pregnancy (21). Therefore, identifying a risk profile to identify women who need preconception counseling the most will better align with clinicians' time and practices.

Research Purpose and Questions

The purpose of this study is to determine the degree to which maternal characteristics, psychosocial factors, and health behaviors explain or mediate the influence of socioeconomic factors on the receipt of preconception counseling. We also intend to determine if women of low

socioeconomic status are receiving preconception counseling and identify disparities of the receipt of preconception counseling across levels of household income and maternal education. The research presented here addresses the following questions: (1) what is the relationship between maternal socioeconomic status (represented by household income and maternal education), maternal characteristics, psychosocial factors and health behaviors; (2) what are the relative magnitudes of the effects of maternal socioeconomic status, maternal characteristics, psychosocial factors, and health behaviors on the receipt of preconception counseling; and (3) to what extent do maternal characteristics, psychosocial factors, and health behaviors explain education and income differences in the receipt of preconception counseling?

METHODS

Design and Sample

Data used in this analysis are from PRAMS, a population-based surveillance system that collects self-reported data on a wide range of maternal behaviors, experiences, and health conditions, including preconception health indicators. PRAMS is administered by 40 states, New York City, and one tribal-state partnership in collaboration with the CDC. Sample size varies by state and includes 1,300 to 3,400 births per year. Each month, participating states select a stratified random sample of 100 to 300 women who recently gave birth to a live-born infant within the prior 2 to 3 months, to whom a self-administered questionnaire is then mailed. A stratified systematic sampling method is used to over-sample mothers who experienced an adverse birth outcomes or identify with a racial/ethnic minority group. While the primary mode of data collection is the mail surveys, non-respondents are contacted by telephone to be interviewed after repeated mailings. All states use a standardized core questionnaire and they also can add questions intended to assess and monitor emerging issues at the state level over time. In addition to the information collected by the surveys, selected information from infant birth certificates is included in the PRAMS dataset. More information about PRAMS is available at www.cdc.gov/prams/methodology.htm.

To characterize the population of women who received preconception counseling before pregnancy, we analyzed only the states that included the following question in their questionnaire: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how to prepare for a healthy pregnancy and baby?" Women of reproductive age (15-44 years) from 6 states (Hawaii, Maryland, Michigan, Minnesota, Utah, and West Virginia) were included in the analysis. The analysis dataset includes 27,458 observations from the years 2009 – 2011 (Phase 6 questionnaire). Eighty-four percent of the participants completed mail surveys.

Measures

We collapsed several variables to ease the model building process. We re-coded the original race and ethnicity variables (12 categories total) to represent both race and ethnicity, creating 6 categories total. We combined the two youngest maternal age categories (less than 17 years of age and 18-19 years) and the two lowest maternal education categories (0-8 years and 9-11 years) to account for zeros in some cells. We created a categorical variable that accounts for none, 1-2, or 3 or more stressors experienced by the participant during the 12 months prior to the birth of the participant's new baby. Stressors experience by a respondent could include hospitalization of a close family member; separation or divorce from her husband or partner; moving to a new address; homelessness; loss of her husband or partner's job; loss of the respondent's job; arguing with her husband or partner more than usual; her husband or partner expressed that he didn't want her to be pregnant; the respondent had many bills she couldn't pay; the respondent was in a physical fight; incarceration of her husband, partner, or herself; a close friend or relative had a problem with drinking alcohol or using drugs; and/or a close friend or relative died. Since several participants used multiple forms of insurance or self-pay to pay for their health care use prior to their most recent pregnancy, we created a categorical variable that accounted for pre-pregnancy insurance status by grouping existing binary variables into one categorical variable. The resulting categories include private, Medicaid, no insurance (self-pay), other (TRICARE, military, or paid by someone else), and combination (a combination of private, Medicaid, self-pay, and/or other).

Assuming that the diagnosis of one or more chronic diseases or mental illnesses would indicate exposure to a health care professional, thus providing an opportunity to receive preconception counseling, we combined several binary variables indicating a participant's diagnosis of a chronic disease (diabetes, asthma, hypertension, anemia, heart problems, epilepsy, and/or thyroid problems) or mental illness (depression and/or anxiety) to form two binary

variables that account for if a participant had one or more chronic disease or mental illness diagnosis prior to pregnancy versus no diagnoses. Also, we hypothesized that women who used health care services prior to pregnancy may be more likely to receive preconception counseling because they may have a higher perceived control of birth outcomes. As a result, we created a binary variable that indicated if a participant had been checked or treated for diabetes, high blood pressure, and/or depression; talked to a health care professional about family medical history; and/or had her teeth cleaned. We created a binary poor pregnancy outcome variable based on the same assumption to indicate if the participant had experienced one or more poor pregnancy outcome (preterm or low birth weight) for the baby born just before her new baby.

The following variables were assessed for their association with preconception counseling based on previous research: income (<$10,000, $10,000 - $14,999, $15,000 - $19,999, $20,000 - $24,999, $25,000 - $34,999, $35,000 - $49,999, and ≥$50,000), maternal education (≤11 years, 12 years, 13-15 years, and ≥16 years), maternal age (≤17-19 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years, and ≥40 years), race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, American Indian, Asian, and other non-white), marital status (married, other), pregnancy intent (the mother intended to become pregnant sooner, later, then, or did not want to become pregnant), the mother was trying to become pregnant when she became pregnant (yes, no), multivitamin use during the month before becoming pregnant (yes, no), physical activity for 3 or more days a week during the 12 months before becoming pregnant (yes, no), smoking during the 3 months before pregnancy (yes, no), alcohol use during the 3 months before pregnancy (yes, no), dieting to lose weight during the 12 months before becoming pregnant (yes, no), prescription medication use during the 12 months before becoming pregnant (yes, no), pre-pregnancy health care use (yes, no), maternal Body Mass Index (underweight, normal, overweight, obese), pre-pregnancy chronic disease (yes, no), pre-pregnancy mental illness (yes, no), experienced intimate partner violence during the 12 months before the participant's new

baby was born (yes, no), total number of stressors experienced during the 12 months before the participant's new baby was born (0, 1-2, >3), pre-pregnancy insurance status (private, Medicaid, no insurance, other, combination), number of previous live births (0, 1, ≥2), and prior poor pregnancy outcome (yes, no).

Analytic Strategy

Differences in the report of preconception counseling were ascertained by combining data from all states and using a weighted multivariable logistic regression model to calculate odds ratios (ORs) and 95% confidence intervals (CIs). Weights were calculated and provided by the CDC. To describe the distribution of maternal characteristics, behavioral factors, health conditions, stressors, pre-pregnancy insurance status, and previous birth outcomes, we calculated weighted percents and standard error for each covariate stratified by the two exposure variables (income and education) and outcome variable (failure to receive preconception counseling). Differences in sample characteristics were assessed by chi-square tests. Results were considered significant at a two-sided p-value of <0.05.

The modeling strategy was based on Kleinbaum and Klein's Hierarchical Backward Elimination Approach (31). After specifying variables to assess interaction and confounding based on the literature, we conducted a likelihood ratio test to assess for interaction. A chunk-backwards elimination approach was used to assess confounding. First, we prioritized categories of covariates by their importance to the exposure-outcome relationship. We then chose categories with the least amount of significant associations with the outcome in the gold standard (GS) model, or the model that controls for all possible confounders. We dropped all covariates in the particular category and used the change in estimate rule to determine if any of the subsets yielded exposure ORs within 10% of the GS's exposure ORs. If a meaningful difference (≥10% change) was observed for the exposure levels as a group, we put all the covariates in the particular

category back into the model and conducted BWE within the category (significance level $p<0.05$) until we no longer observed a meaningful difference in the exposure ORs.

Complex survey modules in SAS version 9.4 (SAS Institute, Inc., Cary, NC) were used for statistical analysis to account for the complex sampling design. Data used in this analysis met a required 65% response rate threshold by state. This study was reviewed by the Emory University Institutional Review Board and granted exemption on the grounds that the study does not meet the definition of research with human subjects.

RESULTS

It is well-known that women of low socioeconomic status disproportionately have poorer health outcomes and access to health care services. This phenomenon is evident in the results of this study. While every covariate assessed in this study was highly statistically significantly different ($p<0.0001$) across levels of income, pregnancy intent, pre-pregnancy multivitamin use, and total number of stressors experienced during the 12 months before the respondent's most recent birth exhibited particularly large percentage point differences between the highest (annual income $\geq$ \$50,000) and lowest (annual income < \$10,000) income levels. Among women with an income of less than \$10,000, 72.5% reported that their recent pregnancy was unintended compared to 26.6% of women with an income greater or equal to \$50,000 (Table 1a). Pre-pregnancy multivitamin use among women earning less than \$10,000 annually was only 27.1% while 68.0% of women earning \$50,000 or more annually took multivitamins, resulting in a 150% change in proportion of women taking pre-pregnancy multivitamins between the highest and lowest income level (Table 1a). The largest percentage point difference among women experiencing stressors during the 12 months prior to the baby's birth was between women earning less than \$10,000 and women earning \$50,000 or more was among those experiencing no major life stressors; 17.3% of women in the lowest income level experienced no stressors while 43.4% of women in the highest income level experienced no stressors (Table 1a).

While the differences between the highest ($\geq$16 years) and lowest ($\leq$11 years) levels of education were less pronounced than between the highest and lowest levels of income, pregnancy intention, pre-pregnancy multivitamin use, and the total number of stressors experienced during the 12 months before the respondent's most recent birth again had particularly large percentage point differences among all considered factors. All covariates assessed in this study were highly statistically significantly different ($p<0.0001$) across levels of education. Among women with less than 12 years of education, 69.2% reported that their recent pregnancy was unintended

compared to 28.8% of women with 16 or more years of education (Table 1b). Pre-pregnancy multivitamin use among women with less than 12 years of education was only 30.8% while 71.2% of women with 16 or more years of education took multivitamins (Table 1b). The largest percentage point difference among women experiencing stressors during the 12 months prior to the baby's birth between women with the lowest level of education and women with the highest level of education was again observed among those experiencing no major life stressors; 20.0% of women with less than 12 years of education experienced no stressors while 42.0% of women in the highest income level experienced no stressors (Table 1b).

In the 6 states included in this analysis, only 32.7% of respondents received preconception counseling (Table 2). Many of the pre-pregnancy behavioral factors, including multivitamin use, physical activity, smoking, dieting, prescription medication use, and health care use, were statistically significantly different between women who received preconception counseling and those who did not. Among women who reported receiving preconception counseling, 70.1% of women took multivitamins prior to pregnancy compared to 37.0% of women who did not receive preconception counseling (Table 2). Furthermore, among women who reported receiving preconception counseling, 50.6% of women were physically active three or more days a week prior to becoming pregnant (no preconception counseling=40.8%), 80.5% did not smoke in the 3 months prior to the pregnancy (no preconception counseling=72.4%), 30.0% dieted to lose weight during the 12 months prior to pregnancy (no preconception counseling=27.5%), 26.4% used prescription medication(s) prior to becoming pregnant (no preconception counseling=18.8%), and 82.0% used health care prior to becoming pregnant (no preconception counseling=64.6%) (Table 2).

Table 3 presents the odds ratios (ORs) of the failure to receive preconception counseling for all exposures and covariates for the crude (Model 0), gold standard (GS; Model 1), and adjusted models (Models 2-8). Compared to the highest income level (≥ $50,000), respondents

earning less than $50,000 annually were generally less likely to report the receipt of preconception counseling (Model 0, Table 3). Respondents with less than 16 years of education were also less likely to receive preconception counseling (Model 0, Table 3). Women who were 24 years of age or less were less likely to receive preconception counseling while women between 30 and 39 years of age were more likely to report preconception counseling (Model 0, Table 3). Among race/ethnicity categories, Hispanic women were least likely to report preconception counseling (crude OR=1.16; 95% CI, 1.01-1.32) and Asian women were most likely to report preconception counseling (crude OR=0.80; 95% CI, 0.70-0.92) (Model 0, Table 3). Unmarried women were nearly half as likely to report the receipt of preconception counseling (crude OR=1.87; 95% CI, 1.73, 2.03). While women who intended to become pregnant sooner were 1.6 times more likely to receive preconception counseling (the inverse of not receiving preconception care [crude OR=0.64; 95% CI, 0.58-0.70], or the odds of receiving preconception care, is equal to 1.6), women who intended to become pregnant later or didn't want their most recent pregnancy were over half as likely to receive preconception counseling (crude OR=2.08; 95% CI, 1.90-2.29 and crude OR=2.46; 95% CI, 2.12-2.85, respectively) (Model 0, Table 3). Furthermore, women who were trying to become pregnant were almost 3 times more likely to report preconception counseling (crude OR=0.35; 95% CI, 0.33-0.38) (Model 0, Table 3).

Women who used prescription medication(s) before becoming pregnant were 1.5 times more likely to have received preconception counseling (crude OR=0.65; 95% CI, 0.60-0.71), while those who used health care before pregnancy were 2.5 times more likely to have received preconception counseling (crude OR=0.40; 95% CI, 0.37-0.44) (Model 0, Table 3). Similarly, the odds of receiving preconception care was 1.2 times higher among women who were diagnosed with one or more chronic diseases prior to pregnancy (crude OR=0.83; 95% CI, 0.77-0.91). Women who experienced intimate partner violence in the 12 months prior to pregnancy were 1.6 times less likely to receive preconception counseling (crude OR=1.60; 95% CI, 1.26-

2.05), and those experiencing 1 or more stressors during the 12 months before the baby's birth were 1.3 times (1-2 stressors; crude OR=1.28; 95% CI, 1.18-1.39) and 1.8 times (more than 3 stressors; crude OR=1.82; 95% CI, 1.65-2.00) less likely to receive preconception counseling (Model 0, Table 3). Of the five pre-pregnancy insurance status categories, women who were uninsured prior to pregnancy were the least likely to report the receipt of preconception counseling (crude OR=3.08; 95% CI, 2.74-3.47); women on Medicaid or other forms of insurance were also less likely to receive preconception counseling (crude OR=1.30; 95% CI, 1.18-1.45 and crude OR=1.32; 95% CI, 1.14-1.53, respectively). The odds of failing to receive preconception counseling among women with 2 or more previous live births were 1.4 times those of a women who had 0 or 1 previous live births (crude OR=1.41; 95% CI, 1.28-1.55). Finally, women with a prior poor pregnancy outcome were nearly 1.2 times more likely to report receiving preconception counseling (crude OR=0.86; 95% CI, 0.76-0.97) (Model 0, Table 3).

We found no interaction among covariates and exposure variables upon assessing interaction; however, interaction was significant ($p<0.0001$) for the exposure interaction term (income*maternal education). However, we did not observe meaningful patterns across stratum-specific ORs and concluded that we could drop all interaction terms from the analytic model. After assessing interaction and confounding, the semi-final model was Model 7 in Table 3. After further assessing the significance of the exposures in Model 7, we found the Wald statistic for the maternal education exposure variable to be non-significant. Upon dropping maternal education from the model, there was no meaningful change in the ORs for the remaining exposure variable (income) as a group. However, the AIC increased and a likelihood ratio test was significant. Finally, we considered the precision of the final models to the GS by comparing CI ratios of the exposure's ORs. Since Model 7 has a smaller AIC and Model 8 offers the greatest precision, we concluded that both Model 7 and Model 8 are viable final models.

The final models (Model 7 and Model 8) include statistical controls for pregnancy intention, pre-pregnancy health care use, and prior poor pregnancy outcome. In Model 7, adjusted odds ratios for 2 of the 7 income levels and 1 of the 4 education levels were significant; adjusted odds ratios for 3 of the 7 income levels in Model 8 were significant (Table 3). Despite OR estimates being borderline non-significant or non-significant ($\alpha = 0.05$) for most levels of income, general patterns were observed throughout the model selection process. The lowest odds for the failure to receive preconception counseling was consistently observed among women with an annual income less than $10,000 and among women with an annual income greater than or equal to $50,000 (Table 3). A general pattern of greater odds of the failure to receive preconception counseling was observed between the highest and lowest levels of income (Table 3). While the OR estimates were consistently non-significant ($\alpha = 0.05$) for all levels of education, the lowest odds for the failure to receive preconception counseling were consistently observed among women with 16 or more years of education and occasionally for women with 12 years of education (Model 1, 2, and 3, Table 3). Women with less than 12 years of education and women with 13-15 years of education consistently had greater odds of the failure to receive preconception counseling (Table 3).

DISCUSSION

In this study of the socioeconomic determinants of the receipt of preconception counseling, we found modest evidence for income and education variation, although not in a clear dose-response gradient. While we expected to observe higher propensity to receive preconception counseling among women in the highest levels of income (annual income ≥ $50,000) and education (≥16 years), we also observed a protective, albeit non-significant, effect of extreme poverty (annual income < $10,000) against the failure to receive preconception counseling. One possible explanation of this observed effect is that safety net social support services for women in extreme poverty could be more comprehensive and provide preconception counseling, resulting in a doughnut-hole effect for middle-income women. However, this hypothesis has not been tested in the literature. While Oza-Frank et al.'s study of the trends in self-reported receipt of preconception counseling from 2004 to 2010 found that women who reported either an annual household income of ≤ $19,999 or an annual household income between $20,000 and $49,999 were less likely to receive preconception counseling, the lowest income level in this study (annual income < $10,000) was not isolated in Oza-Frank et al.'s study (10).

Second, despite efforts by PRAMS to maximize survey response, different non-response patterns at the extremes of poverty may be present, producing a more highly selected population. In addition, 23% of women with a household annual income of <$10,000 are under 19 years of age compared to 12% or fewer for every other income group. It is possible that this 'poorest' group includes mothers who are not eligible to be in the workforce, thus contributing to their poverty. Also, young mothers may be covered under a parent's health insurance, allowing them greater access to health care services and increasing their odds of receiving preconception counseling. A fourth possible explanation to the observed protective effect of extreme poverty is that the final models may be over adjusted, since the confounders in the final models may

indirectly be on the causal pathway, leading to model misspecification. Since the study design is cross-sectional, this hypothesis is difficult to test.

Of the 27,191 women included in this analysis, only 32.7% received preconception counseling (Table 2). The proportion of women who reported the receipt of preconception counseling between 2009 and 2011 mirrors the proportion reported in an earlier study by Williams et al.; between 2004 and 2008, 32.4% of women received preconception counseling (15). Williams et al. also reported that between 2004 and 2008, 13.5% of women with an unintended pregnancy and 13.7% of women with no health insurance prior to pregnancy received preconception counseling (15). Between 2009 and 2011, 31.0% of women who were not trying to become pregnant and 23.6% of women who intended to become pregnant later or did not want to become pregnant received preconception counseling. Among uninsured women, 18.4% received preconception counseling.

The statistically significant differences between the prevalence of healthy pre-pregnancy behaviors between those who received preconception counseling and those who did not, as well as the strong associations between pre-pregnancy behavioral factors in the crude and GS models, should not go un-noticed. Several studies have shown that preconception counseling is associated with positive maternal behaviors. Hillemeier et al. report that in a randomized control trial, women who received a community-based intervention designed to improve the health behaviors and health status of preconceptional and interconceptional women were significantly more likely than controls to report positive attitudinal and behavior changes related to nutrition and physical activity, and that these changes were attributable to the intervention (16).

STRENGTHS AND WEAKNESSES

There are several limitations and challenges to this study. First, since the study employs a cross-sectional study design, causal inferences cannot be made from the results. Second, the question used to measure the receipt of preconception counseling is ambiguous and can be interpreted in many ways. If women did not categorize counseling they received as being oriented toward preparing for a pregnancy, or did not recall receiving preconception counseling, the proportion of women reporting the receipt of preconception care may be underestimated (10). Also, underreporting of negative health behaviors in a clinical setting may hinder women from receiving preconception counseling, as evidenced in our discussion on barriers to preconception counseling. On the contrary, women who seek out preconception care may have characteristics that inspire them to make positive health behaviors, which may lead to healthier pregnancies. Finally, the generalizability of this study's results to all pregnancies is limited since PRAMS data is restricted to women who experienced a recent live birth, excluding women who experienced miscarriages, elective terminations, or stillbirths. Despite its limitations, PRAMS provides nationally representative data that addresses preconception health behaviors, psychosocial factors, and maternal characteristics, making PRAMS a suitable data source to answer this study's research questions.

FUTURE DIRECTIONS

To prevent adverse pregnancy and infant outcomes, preconception health should be an essential component of public health programs and interventions targeted to all women of reproductive age. Although previous work showed similar low rates of preconception counseling, this study improves upon existing literature by examining the degree to which psychosocial factors and health behaviors explain or mediate the influence of socioeconomic factors on the receipt of preconception counseling. Based on our findings, it appears that the provision of

preconception care, or women's recognition of the receipt of preconception care, remains substandard. While the amount of scientific evidence is growing to support the improvement of women's preconception health as an effective way to reduce poor pregnancy and infant outcomes, further research is needed to assess the effectiveness of preconception health programs and policies (14).

The use of reproductive life plans (RLPs) in publically-funded clinics was successful in facilitating the linkage of patients to appropriate family planning, preconception, and sexually-transmitted infection services (23). Dunlop et al. found that WIC settings were "a suitable location for identifying low-income African-American women in need of preconception and reproductive health services" (24). Targeted preconception counseling has also been shown to increase healthy preconception behaviors (16, 25). Improving health care coverage, increasing the supply of publicly subsidized health clinics, and directing the provision of preconception care may eliminate access barriers to the receipt of preconception counseling (1). Several policy changes, such as expanding Medicaid eligibility criteria and implementing Medicaid family planning waivers, have the potential to increase the proportion of women who receive interconception and preconception care, especially among low-income women (28).

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Table 1a. Distribution of maternal characteristics, behavioral factors, health conditions, stressors, pre-pregnancy insurance status, and previous birth outcomes stratified by income level. Frequency (n) is displayed in the table. Column percent is displayed as weighted percent (%), each with its respective standard error (SE). Differences in sample characteristics were assessed by chi-square tests; results were considered significant at a two-sided p-value of <0.05. PRAMS, 2009-2011.

	Income level																		
	< $10,000		$10,000 - $14,999		$15,000 - $19,999		$20,000 - $24,999		$25,000 - $34,999		$35,000 - $49,999		≥ $50,000		Total				p-value
	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)	n	% (SE)			-
Overall	5,553	20.0 (0.37)	2,206	8.7 (0.27)	1,558	6.3 (0.23)	1,765	7.3 (0.25)	2,509	11.0 (0.29)	2,915	12.7 (0.30)	6,312	34.0 (0.43)	22,818	-	-		-
Maternal Characteristics																			
Education																			<0.0001
≤11 years	1,817	34.5 (1.02)	483	21.4 (1.37)	284	18.5 (1.51)	246	13.6 (1.24)	258	9.1 (0.82)	158	5.6 (0.67)	56	0.7 (0.13)	3,302	12.8 (0.32)			
12 years	2,320	39.5 (1.02)	875	37.8 (1.56)	620	38.8 (1.84)	695	40.2 (1.75)	774	30.2 (1.31)	719	24.5 (1.14)	516	7.9 (0.47)	6,519	25.7 (0.41)			
13-15 years	1,086	22.0 (0.87)	666	33.3 (1.53)	460	32.4 (1.74)	594	35.3 (1.66)	937	40.6 (1.38)	1,099	40.4 (1.25)	1,387	23.1 (0.70)	6,229	29.4 (0.42)			
≥16 years	236	4.0 (0.38)	151	7.4 (0.85)	160	10.3 (1.11)	211	10.8 (0.97)	506	20.0 (1.08)	915	29.5 (1.13)	4,331	68.3 (0.77)	6,510	32.1 (0.43)			
Age																			<0.0001
≤17-19	1,235	22.8 (0.89)	265	11.9 (1.04)	104	5.7 (0.89)	109	5.6 (0.82)	115	4.6 (0.64)	74	2.5 (0.45)	47	0.4 (0.10)	1,949	7.3 (0.25)			
20-24	2,271	41.6 (1.03)	846	41.7 (1.61)	551	35.3 (1.77)	576	35.6 (1.70)	620	25.4 (1.23)	529	18.4 (1.01)	260	4.0 (0.34)	5,653	23.3 (0.40)			
25-29	1,129	20.8 (0.86)	570	27.4 (1.46)	474	35.1 (1.83)	528	33.1 (1.68)	853	38.6 (1.38)	1,077	39.7 (1.26)	1,642	32.1 (0.78)	6,273	31.4 (0.44)			
30-34	538	9.9 (0.62)	315	13.2 (1.04)	258	15.2 (1.32)	299	17.2 (1.30)	535	21.7 (1.14)	719	26.9 (1.14)	2,086	40.6 (0.80)	4,750	24.9 (0.41)			
35-39	288	4.0 (0.36)	178	4.9 (0.53)	125	5.6 (0.68)	203	6.7 (0.68)	293	7.3 (0.62)	410	10.4 (0.70)	1,819	18.3 (0.54)	3,316	10.4 (0.24)			
≥40	91	1.0 (0.17)	32	0.9 (0.27)	46	3.1 (0.67)	50	1.9 (0.39)	93	2.4 (0.35)	106	2.2 (0.31)	458	4.5 (0.29)	876	2.7 (0.13)			
Race/Ethnicity																			<0.0001
Hispanic	745	15.2 (0.80)	305	12.6 (1.03)	250	16.0 (1.39)	252	15.1 (1.32)	285	10.3 (0.85)	270	8.1 (0.71)	136	2.5 (0.28)	2,243	9.2 (0.28)			
Non-Hispanic White	2,302	44.9 (1.03)	1,093	56.3 (1.59)	778	58.3 (1.84)	906	60.0 (1.72)	1,380	65.0 (1.32)	1,815	72.6 (1.13)	4,888	83.4 (0.60)	13,162	66.7 (0.39)			
Non-Hispanic Black	1,456	29.2 (0.87)	412	21.4 (1.32)	241	16.0 (1.31)	269	15.1 (1.25)	389	15.1 (1.03)	317	9.9 (0.79)	695	7.0 (0.39)	3,779	15.1 (0.28)			
American Indian	170	1.4 (0.18)	57	1.0 (0.24)	35	0.9 (0.28)	35	1.1 (0.38)	33	0.3 (0.08)	41	0.4 (0.09)	61	0.3 (0.09)	432	0.7 (0.06)			
Asian	343	3.7 (0.28)	139	3.8 (0.55)	108	4.4 (0.74)	140	4.4 (0.62)	224	5.1 (0.54)	243	4.8 (0.50)	335	4.4 (0.34)	1,532	4.4 (0.17)			
Other non-white	443	5.6 (0.46)	153	4.9 (0.68)	105	4.4 (0.67)	125	4.3 (0.67)	163	4.2 (0.54)	201	4.3 (0.46)	135	2.4 (0.24)	1,325	3.9 (0.17)			
Marital status																			<0.0001
Married	1,251	21.9 (0.85)	752	33.4 (1.49)	703	43.7 (1.84)	962	53.3 (1.76)	1,632	65.1 (1.36)	2,275	78.4 (1.13)	5,846	93.1 (0.44)	13,421	62.7 (0.45)			
Other	4,292	78.1 (0.85)	1,451	66.6 (1.49)	848	56.3 (1.84)	798	46.7 (1.76)	874	34.9 (1.36)	639	21.6 (1.13)	464	6.9 (0.44)	9,366	37.3 (0.45)			
Number of dependents																			<0.0001
1-2	2,992	55.9 (1.06)	1,050	48.9 (1.63)	690	44.8 (1.87)	699	38.1 (1.71)	959	36.8 (1.36)	976	33.1 (1.21)	2,481	38.7 (0.80)	9,847	42.4 (0.47)			
3-4	1,815	33.2 (1.00)	895	41.0 (1.60)	669	42.7 (1.86)	800	48.1 (1.76)	1,165	47.9 (1.40)	1,487	51.2 (1.28)	3,244	52.9 (0.82)	10,075	46.3 (0.47)			
≥5	569	10.8 (0.66)	236	10.1 (0.93)	187	12.5 (1.26)	254	13.8 (1.17)	374	15.2 (0.99)	445	15.7 (0.93)	566	8.3 (0.44)	2,631	11.4 (0.29)			
Pregnancy intent																			<0.0001
Sooner	629	10.8 (0.63)	272	10.9 (0.95)	228	14.3 (1.29)	276	13.9 (1.16)	437	18.0 (1.07)	624	21.9 (1.05)	1,789	25.9 (0.71)	4,255	18.6 (0.36)			
Later	2,513	47.4 (1.06)	914	45.5 (1.63)	616	41.2 (1.86)	629	37.5 (1.73)	776	33.9 (1.37)	734	24.5 (1.11)	886	15.3 (0.61)	7,068	30.8 (0.44)			
Then	1,373	25.3 (0.91)	656	28.5 (1.45)	477	30.1 (1.72)	602	36.8 (1.70)	963	37.1 (1.34)	1,246	44.1 (1.28)	3,134	53.2 (0.82)	8,451	39.9 (0.46)			
Did not want	932	16.5 (0.79)	319	15.1 (1.22)	215	14.4 (1.38)	231	11.8 (1.14)	289	11.0 (0.88)	269	9.6 (0.82)	430	5.7 (0.37)	2,685	10.7 (0.30)			
Trying to become pregnant																			<0.0001
Yes	1,432	27.5 (0.95)	679	29.0 (1.45)	502	31.8 (1.73)	676	39.9 (1.71)	1,147	46.7 (1.40)	1,562	56.7 (1.28)	4,549	73.4 (0.73)	10,547	50.3 (0.47)			
No	4,030	72.5 (0.95)	1,496	71.0 (1.45)	1,043	68.2 (1.73)	1,070	60.1 (1.71)	1,323	53.3 (1.40)	1,333	43.3 (1.28)	1,710	26.6 (0.73)	12,005	49.7 (0.47)			

Behavioral Factors																				
Pre-pregnancy multivitamin use																				<0.0001
Yes	1,456	27.1 (0.92)	637	28.6 (1.45)	499	34.4 (1.79)	671	37.3 (1.69)	1,069	42.4 (1.38)	1,434	49.1 (1.28)	4,329	68.0 (0.77)	10,095	46.8 (0.47)				
No	4,097	72.9 (0.92)	1,569	71.4 (1.45)	1,059	65.6 (1.79)	1,094	62.7 (1.69)	1,440	57.6 (1.38)	1,481	50.9 (1.28)	1,983	32.0 (0.77)	12,723	53.2 (0.47)				
Pre-pregnancy physical activity (≥3 days/week)																				<0.0001
Yes	1,707	31.2 (0.97)	727	32.9 (1.5)	573	35.7 (1.78)	662	37.9 (1.71)	1,072	43.5 (1.39)	1,386	46.0 (1.27)	3,249	53.4 (0.82)	9,376	42.9 (0.47)				
No	3,785	68.8 (0.97)	1,456	67.1 (1.5)	977	64.3 (1.78)	1,083	62.1 (1.71)	1,416	56.5 (1.39)	1,510	54.0 (1.27)	3,037	46.6 (0.82)	13,264	57.1 (0.47)				
Pre-pregnancy smoking																				<0.0001
Yes	2,531	42.3 (1.04)	869	37.6 (1.59)	575	37.1 (1.84)	520	31.8 (1.68)	649	26.4 (1.27)	566	19.9 (1.09)	860	13.4 (0.57)	6,570	26.4 (0.42)				
No	2,959	57.7 (1.04)	1,317	62.4 (1.59)	969	62.9 (1.84)	1,231	68.2 (1.68)	1,839	73.6 (1.27)	2,329	80.1 (1.09)	5,423	86.6 (0.57)	16,067	73.6 (0.42)				
Pre-pregnancy alcohol use																				<0.0001
Yes	2,283	43.9 (1.05)	1,006	51.5 (1.62)	732	49.7 (1.88)	825	50.8 (1.76)	1,160	51.3 (1.40)	1,400	52.8 (1.26)	4,318	75.0 (0.70)	11,724	58.0 (0.45)				
No	3,199	56.1 (1.05)	1,169	48.5 (1.62)	804	50.3 (1.88)	916	49.2 (1.76)	1,318	48.7 (1.40)	1,492	47.2 (1.26)	1,939	25.0 (0.70)	10,837	42.0 (0.45)				
Pre-pregnancy dieting																				<0.0001
Yes	1,043	19.2 (0.82)	479	23.2 (1.38)	388	23.1 (1.54)	476	28.7 (1.60)	757	30.2 (1.28)	899	30.8 (1.17)	2,078	33.9 (0.78)	6,120	28.2 (0.42)				
No	4,457	80.8 (0.82)	1,711	76.8 (1.38)	1,165	76.9 (1.54)	1,276	71.3 (1.60)	1,742	69.8 (1.28)	1,996	69.2 (1.17)	4,208	66.1 (0.78)	16,555	71.8 (0.42)				
Pre-pregnancy prescription medication use																				<0.0001
Yes	1,097	19.1 (0.83)	442	17.9 (1.22)	309	18.7 (1.46)	331	18.2 (1.37)	513	19.3 (1.09)	624	21.2 (1.04)	1,741	26.1 (0.72)	5,057	21.5 (0.39)				
No	4,403	80.9 (0.83)	1,752	82.1 (1.22)	1,246	81.3 (1.46)	1,415	81.8 (1.37)	1,984	80.7 (1.09)	2,276	78.8 (1.04)	4,542	73.9 (0.72)	17,618	78.5 (0.39)				
Pre-pregnancy health care use																				<0.0001
Yes	3,235	61.1 (1.02)	1,215	54.7 (1.62)	861	54.6 (1.87)	1,008	57.5 (1.74)	1,575	62.6 (1.37)	2,032	70.8 (1.18)	5,336	85.3 (0.58)	15,262	69.5 (0.43)				
No	2,281	38.9 (1.02)	985	45.3 (1.62)	696	45.4 (1.87)	747	42.5 (1.74)	928	37.4 (1.37)	872	29.2 (1.18)	966	14.7 (0.58)	7,475	30.5 (0.43)				
Health Conditions																				
Body Mass Index																				<0.0001
Underweight (<18.5)	410	6.2 (0.51)	111	4.2 (0.63)	77	5.0 (0.83)	78	2.8 (0.51)	102	3.3 (0.48)	123	4.1 (0.50)	173	2.3 (0.24)	1,074	3.8 (0.18)				
Normal (18.5-24.9)	2,413	46.8 (1.08)	994	48.0 (1.67)	676	47.0 (1.94)	781	47.7 (1.79)	1,095	46.0 (1.42)	1,398	49.8 (1.30)	3,307	55.9 (0.82)	10,664	50.4 (0.48)				
Overweight (25.0-29.9)	1,235	23.9 (0.91)	482	24.8 (1.46)	349	24.9 (1.66)	414	23.9 (1.49)	604	25.9 (1.26)	677	24.4 (1.11)	1,555	24.7 (0.70)	5,316	24.6 (0.41)				
Obese (≥30.0)	1,168	23.1 (0.91)	493	23.0 (1.38)	361	23.1 (1.63)	419	25.6 (1.61)	616	24.8 (1.23)	636	21.8 (1.08)	1,180	17.1 (0.62)	4,873	21.2 (0.39)				
Pre-pregnancy chronic disease																				<0.0001
Yes	1,953	34.1 (0.99)	657	27.4 (1.43)	435	26.9 (1.66)	470	23.8 (1.48)	622	24.1 (1.21)	635	20.8 (1.07)	1,410	19.7 (0.65)	6,182	24.6 (0.40)				
No	3,563	65.9 (0.99)	1,536	72.6 (1.43)	1,118	73.1 (1.66)	1,287	76.2 (1.48)	1,870	75.9 (1.21)	2,270	79.2 (1.07)	4,876	80.3 (0.65)	16,520	75.4 (0.40)				
Pre-pregnancy mental illness																				<0.0001
Yes	1,351	25.1 (0.94)	439	19.7 (1.31)	308	19.3 (1.49)	302	19.3 (1.46)	398	16.9 (1.06)	441	15.9 (0.96)	783	12.3 (0.54)	4,022	17.4 (0.36)				
No	4,105	74.9 (0.94)	1,736	80.3 (1.31)	1,226	80.7 (1.49)	1,443	80.7 (1.46)	2,082	83.1 (1.06)	2,453	84.1 (0.96)	5,489	87.7 (0.54)	18,534	82.6 (0.36)				

Stressors																				
Intimate partner violence																				<0.0001
Yes	386	6.7 (0.52)	95	4.2 (0.64)	69	5.1 (0.85)	53	3.3 (0.67)	65	2.6 (0.50)	45	1.4 (0.32)	48	0.7 (0.14)	761	3.0 (0.16)				
No	5,127	93.3 (0.52)	2,101	95.8 (0.64)	1,483	94.9 (0.85)	1,705	96.7 (0.67)	2,436	97.4 (0.50)	2,862	98.6 (0.32)	6,258	99.3 (0.14)	21,972	97.0 (0.16)				
Total number of stressors																				<0.0001
None	995	17.3 (0.78)	375	15.1 (1.10)	324	20.6 (1.51)	407	22.0 (1.43)	582	23.0 (1.18)	885	29.8 (1.15)	2,700	43.4 (0.81)	6,268	28.8 (0.42)				
1-2	1,858	35.8 (1.01)	863	40.7 (1.60)	605	39.7 (1.83)	702	40.6 (1.72)	1,127	44.8 (1.39)	1,276	46.0 (1.28)	2,872	45.8 (0.82)	9,303	42.5 (0.47)				
≥3	2,677	46.9 (1.05)	961	44.2 (1.61)	624	39.7 (1.83)	649	37.4 (1.72)	789	32.2 (1.34)	750	24.2 (1.11)	727	10.7 (0.52)	7,177	28.7 (0.43)				
Pre-Pregnancy Insurance																				
Pre-pregnancy insurance																				<0.0001
Private	543	10.1 (0.65)	353	15.2 (1.13)	411	24.9 (1.64)	606	32.1 (1.63)	1,281	51.9 (1.42)	1,988	67.7 (1.23)	5,645	90.8 (0.48)	10,827	52.8 (0.47)				
Medicaid	2,534	44.8 (1.05)	720	32.3 (1.53)	350	22.5 (1.59)	313	16.9 (1.37)	259	9.1 (0.79)	144	5.0 (0.62)	44	0.6 (0.13)	4,364	16.1 (0.34)				
No insurance	1,723	31.3 (0.98)	831	37.9 (1.59)	567	38.8 (1.86)	554	36.4 (1.74)	543	22.9 (1.23)	358	13.1 (0.92)	140	1.9 (0.22)	4,716	19.3 (0.38)				
Other	314	7.0 (0.56)	129	8.7 (1.00)	101	8.1 (1.03)	146	9.0 (1.01)	213	9.1 (0.82)	243	8.9 (0.71)	283	4.2 (0.33)	1,429	6.9 (0.24)				
Combination	296	6.9 (0.56)	120	6.0 (0.77)	84	5.7 (0.91)	96	5.7 (0.87)	160	6.9 (0.74)	138	5.2 (0.60)	172	2.4 (0.26)	1,066	4.9 (0.21)				
Previous Birth Outcomes																				
Number of previous live births																				<0.0001
0	2,508	46.1 (1.05)	924	43.2 (1.61)	605	40.8 (1.85)	664	37.3 (1.70)	908	36.0 (1.35)	1,010	35.2 (1.24)	2,505	40.8 (0.81)	9,124	40.6 (0.46)				
1	1,480	27.1 (0.94)	630	29.3 (1.48)	450	30.1 (1.74)	515	33.0 (1.68)	785	33.6 (1.35)	936	31.7 (1.18)	2,289	37.8 (0.80)	7,085	32.8 (0.44)				
≥2	1,542	26.8 (0.92)	647	27.5 (1.43)	496	29.1 (1.67)	579	29.8 (1.57)	804	30.5 (1.26)	961	33.1 (1.20)	1,450	21.5 (0.66)	6,479	26.6 (0.41)				
Poor prior pregnancy outcome																				<0.0001
Yes	827	23.9 (1.20)	311	20.4 (1.67)	217	17.6 (1.75)	229	19.4 (1.79)	324	16.0 (1.26)	324	14.2 (1.09)	590	13.0 (0.71)	2,822	16.9 (0.45)				
No	1,991	76.1 (1.20)	887	79.6 (1.67)	682	82.4 (1.75)	799	80.6 (1.79)	1,181	84.0 (1.26)	1,488	85.8 (1.09)	2,980	87.0 (0.71)	10,008	83.1 (0.45)				

Table 1b. Distribution of maternal characteristics, behavioral factors, health conditions, stressors, pre-pregnancy insurance status, and previous birth outcomes stratified by education level. Frequency (n) is displayed in the table. Column percent is displayed as weighted percent (%), each with its respective standard error (SE). Differences in sample characteristics were assessed by chi-square tests; results were considered significant at a two-sided p-value of <0.05. PRAMS, 2009-2011.

	Education Level												
	≤11 years			12 Years			13-15 Years			≥16 years			Total			p-value
	n	%	(SE)	n	%	(SE)	n	%	(SE)	n	%	(SE)	n	%	(SE)	-
Overall	3,949	13.4	(0.30)	7,587	25.1	(0.37)	7,382	29.2	(0.39)	8,188	32.3	(0.39)	27,106	-	-	-
Maternal Characteristics																
Income																<0.0001
< $10,000	1,817	53.5	(1.37)	2,320	30.6	(0.85)	1,086	14.9	(0.62)	236	2.5	(0.24)	5,459	19.9	(0.37)	
$10,000 - $14,999	483	14.5	(0.98)	875	12.8	(0.62)	666	9.9	(0.53)	151	2.0	(0.24)	2,175	8.7	(0.27)	
$15,000 - $19,999	284	9.1	(0.79)	620	9.5	(0.56)	460	7.0	(0.43)	160	2.0	(0.23)	1,524	6.3	(0.23)	
$20,000 - $24,999	246	7.8	(0.74)	695	11.5	(0.62)	594	8.8	(0.48)	211	2.5	(0.23)	1,746	7.3	(0.25)	
$25,000 - $34,999	258	7.8	(0.71)	774	12.9	(0.64)	937	15.2	(0.62)	506	6.9	(0.39)	2,475	11.0	(0.29)	
$35,000 - $49,999	158	5.5	(0.67)	719	12.1	(0.62)	1,099	17.5	(0.64)	915	11.7	(0.49)	2,891	12.7	(0.30)	
≥ $50,000	56	1.8	(0.35)	516	10.5	(0.61)	1,387	26.8	(0.78)	4,331	72.5	(0.69)	6,290	34.1	(0.43)	
Age																<0.0001
≤17-19	1,237	29.2	(1.13)	918	11.5	(0.56)	224	3.2	(0.31)	1	0.0	(0.01)	2,380	7.7	(0.24)	
20-24	1,165	30.6	(1.18)	2,641	34.7	(0.84)	1,949	26.8	(0.72)	441	4.9	(0.31)	6,196	22.2	(0.37)	
25-29	749	21.8	(1.08)	1,993	29.3	(0.82)	2,376	35.7	(0.77)	2,287	32.3	(0.70)	7,405	31.1	(0.41)	
30-34	449	12.2	(0.81)	1,145	15.6	(0.64)	1,629	23.3	(0.67)	2,823	40.8	(0.73)	6,046	25.5	(0.38)	
35-39	278	5.1	(0.44)	676	6.6	(0.38)	961	8.8	(0.39)	2,109	18.0	(0.49)	4,024	10.7	(0.22)	
≥40	70	1.2	(0.24)	214	2.4	(0.24)	243	2.2	(0.21)	527	4.0	(0.24)	1,054	2.7	(0.12)	
Race/Ethnicity																<0.0001
Hispanic	1,067	29.8	(1.18)	835	11.0	(0.56)	492	5.8	(0.38)	298	3.2	(0.27)	2,692	9.4	(0.26)	
Non-Hispanic White	1,553	39.1	(1.26)	3,857	59.9	(0.82)	4,438	70.3	(0.69)	5,645	78.2	(0.59)	15,493	66.2	(0.36)	
Non-Hispanic Black	740	22.3	(1.00)	1,318	18.8	(0.63)	1,277	15.5	(0.55)	788	7.6	(0.40)	4,123	14.6	(0.25)	
American Indian	120	1.3	(0.19)	147	0.8	(0.13)	137	0.7	(0.12)	63	0.3	(0.08)	467	0.7	(0.06)	
Asian	155	2.7	(0.34)	612	4.1	(0.26)	549	3.9	(0.27)	1,004	7.6	(0.36)	2,320	5.0	(0.16)	
Other non-white	203	4.8	(0.56)	729	5.4	(0.35)	409	3.7	(0.28)	335	3.2	(0.24)	1,676	4.1	(0.16)	
Marital status																<0.0001
Married	1,186	27.4	(1.09)	3,323	45.8	(0.86)	4,756	65.7	(0.77)	7,363	91.7	(0.42)	16,628	64.0	(0.41)	
Other	2,750	72.6	(1.09)	4,257	54.2	(0.86)	2,620	34.3	(0.77)	823	8.3	(0.42)	10,450	36.0	(0.41)	
Number of dependents																<0.0001
1-2	1,252	36.5	(1.29)	3,226	42.4	(0.89)	3,070	41.3	(0.80)	3,543	42.3	(0.74)	11,091	41.3	(0.44)	
3-4	1,619	42.6	(1.30)	3,110	44.3	(0.89)	3,195	45.8	(0.81)	3,796	49.5	(0.74)	11,720	46.3	(0.44)	
≥5	733	20.8	(1.06)	920	13.3	(0.60)	944	12.9	(0.51)	717	8.2	(0.38)	3,314	12.4	(0.28)	
Pregnancy intent																<0.0001
Sooner	453	12.0	(0.82)	1,205	15.6	(0.63)	1,381	17.8	(0.60)	2,262	26.1	(0.64)	5,301	19.2	(0.33)	
Later	1,675	43.7	(1.27)	2,766	37.8	(0.87)	2,228	30.9	(0.75)	1,409	17.6	(0.58)	8,078	30.0	(0.41)	
Then	1,125	28.9	(1.15)	2,352	32.6	(0.83)	2,827	40.8	(0.79)	3,928	50.8	(0.74)	10,232	40.4	(0.43)	
Did not want	597	15.3	(0.93)	1,124	14.0	(0.61)	821	10.5	(0.51)	478	5.5	(0.34)	3,020	10.4	(0.27)	
Trying to become pregnant																<0.0001
Yes	1,188	30.8	(1.17)	2,625	37.0	(0.85)	3,512	50.5	(0.80)	5,681	71.2	(0.68)	13,006	51.2	(0.43)	
No	2,689	69.2	(1.17)	4,862	63.0	(0.85)	3,779	49.5	(0.80)	2,425	28.8	(0.68)	13,755	48.8	(0.43)	
Behavioral Factors																
Pre-pregnancy multivitamin use																<0.0001
Yes	1,158	30.0	(1.16)	2,391	33.1	(0.83)	3,426	46.9	(0.79)	5,560	67.8	(0.70)	12,535	47.9	(0.43)	
No	2,791	70.0	(1.16)	5,196	66.9	(0.83)	3,956	53.1	(0.79)	2,628	32.2	(0.70)	14,571	52.1	(0.43)	
Pre-pregnancy physical activity (≥3 days/week)																<0.0001
Yes	1,181	29.8	(1.16)	2,600	34.4	(0.83)	3,219	44.0	(0.79)	4,631	57.2	(0.73)	11,631	44.0	(0.43)	
No	2,690	70.2	(1.16)	4,922	65.6	(0.83)	4,118	56.0	(0.79)	3,521	42.8	(0.73)	15,251	56.0	(0.43)	
Pre-pregnancy smoking																<0.0001
Yes	1,639	39.3	(1.25)	2,864	37.2	(0.86)	1,931	25.8	(0.71)	736	8.9	(0.44)	7,170	25.0	(0.38)	
No	2,228	60.7	(1.25)	4,597	62.8	(0.86)	5,378	74.2	(0.71)	7,395	91.1	(0.44)	19,598	75.0	(0.38)	
Pre-pregnancy alcohol use																<0.0001
Yes	1,202	34.2	(1.24)	3,513	51.2	(0.88)	3,805	56.8	(0.77)	4,775	64.4	(0.67)	13,295	54.9	(0.42)	
No	2,636	65.8	(1.24)	3,930	48.8	(0.88)	3,491	43.2	(0.77)	3,339	35.6	(0.67)	13,396	45.1	(0.42)	

Pre-pregnancy dieting																<0.0001
Yes	645	17.3	(0.96)	1,801	24.4	(0.75)	2,286	31.6	(0.75)	2,605	32.9	(0.70)	7,337	28.3	(0.39)	
No	3,246	82.7	(0.96)	5,737	75.6	(0.75)	5,058	68.4	(0.75)	5,545	67.1	(0.70)	19,586	71.7	(0.39)	
Pre-pregnancy prescription medication use																<0.0001
Yes	689	18.1	(1.01)	1,512	18.6	(0.68)	1,723	22.9	(0.67)	1,921	23.4	(0.63)	5,845	21.4	(0.36)	
No	3,214	81.9	(1.01)	6,016	81.4	(0.68)	5,622	77.1	(0.67)	6,225	76.6	(0.63)	21,077	78.6	(0.36)	
Pre-pregnancy health care use																<0.0001
Yes	2,262	60.6	(1.23)	4,521	60.5	(0.86)	5,118	69.8	(0.74)	6,645	82.4	(0.56)	18,546	70.3	(0.40)	
No	1,656	39.4	(1.23)	3,033	39.5	(0.86)	2,238	30.2	(0.74)	1,524	17.6	(0.56)	8,451	29.7	(0.40)	
Health Conditions																
Body Mass Index																<0.0001
Underweight (<18.5)	293	6.0	(0.60)	416	4.4	(0.36)	300	3.3	(0.26)	298	3.2	(0.26)	1,307	3.9	(0.16)	
Normal (18.5-24.9)	1,709	47.9	(1.34)	3,331	46.4	(0.90)	3,320	48.2	(0.81)	4,694	59.2	(0.73)	13,054	51.4	(0.44)	
Overweight (25.0-29.9)	847	25.3	(1.17)	1,675	23.6	(0.76)	1,837	25.6	(0.70)	1,802	23.1	(0.63)	6,161	24.3	(0.38)	
Obese (≥30.0)	673	20.8	(1.12)	1,818	25.6	(0.78)	1,723	22.9	(0.68)	1,242	14.5	(0.53)	5,456	20.5	(0.36)	
Pre-pregnancy chronic disease																<0.0001
Yes	1,252	30.5	(1.16)	2,222	27.9	(0.79)	2,020	25.4	(0.70)	1,632	18.1	(0.57)	7,126	24.3	(0.37)	
No	2,677	69.5	(1.16)	5,324	72.1	(0.79)	5,318	74.6	(0.70)	6,515	81.9	(0.57)	19,834	75.7	(0.37)	
Pre-pregnancy mental illness																<0.0001
Yes	879	23.8	(1.12)	1,419	18.7	(0.70)	1,313	18.8	(0.64)	903	11.2	(0.47)	4,514	17.0	(0.34)	
No	2,991	76.2	(1.12)	6,074	81.3	(0.70)	5,989	81.2	(0.64)	7,214	88.8	(0.47)	22,268	83.0	(0.34)	
Stressors																
Intimate partner violence																<0.0001
Yes	214	5.5	(0.59)	282	3.7	(0.34)	238	2.9	(0.28)	81	0.8	(0.13)	815	2.8	(0.15)	
No	3,668	94.5	(0.59)	7,228	96.3	(0.34)	7,088	97.1	(0.28)	8,070	99.2	(0.13)	26,054	97.2	(0.15)	
Total number of stressors																<0.0001
None	815	20.2	(1.00)	1,772	23.6	(0.74)	1,985	27.0	(0.70)	3,318	42.0	(0.73)	7,890	30.1	(0.39)	
1-2	1,499	40.1	(1.25)	2,905	39.0	(0.86)	3,039	43.3	(0.80)	3,684	45.5	(0.74)	11,127	42.5	(0.43)	
≥3	1,567	39.7	(1.25)	2,841	37.4	(0.86)	2,309	29.7	(0.74)	1,150	12.5	(0.50)	7,867	27.4	(0.39)	
Pre-Pregnancy Insurance																
Pre-pregnancy insurance																<0.0001
Private	551	13.5	(0.86)	2,538	34.4	(0.84)	3,929	55.0	(0.80)	6,650	84.1	(0.53)	13,668	53.9	(0.43)	
Medicaid	1,503	39.8	(1.26)	2,017	24.0	(0.74)	1,043	12.3	(0.53)	196	1.7	(0.18)	4,759	15.4	(0.32)	
No insurance	1,291	32.2	(1.18)	2,014	28.2	(0.81)	1,316	18.5	(0.64)	471	5.0	(0.33)	5,092	18.3	(0.34)	
Other	207	6.3	(0.65)	452	7.1	(0.48)	561	8.2	(0.45)	539	6.2	(0.34)	1,759	7.0	(0.22)	
Combination	249	8.2	(0.74)	412	6.2	(0.42)	417	6.0	(0.40)	283	2.9	(0.24)	1,361	5.3	(0.20)	
Previous Birth Outcomes																
Number of previous live births																<0.0001
0	1,512	38.2	(1.23)	3,033	38.9	(0.86)	2,836	38.8	(0.79)	3,482	42.8	(0.74)	10,863	40.0	(0.43)	
1	1,022	27.2	(1.13)	2,178	30.6	(0.82)	2,263	32.4	(0.76)	2,809	35.6	(0.71)	8,272	32.3	(0.41)	
≥2	1,400	34.6	(1.19)	2,358	30.6	(0.80)	2,251	28.7	(0.70)	1,833	21.6	(0.58)	7,842	27.7	(0.38)	
Poor prior pregnancy outcome																<0.0001
Yes	675	23.6	(1.36)	1,011	19.9	(0.89)	888	16.1	(0.73)	711	12.4	(0.63)	3,285	16.9	(0.42)	
No	1,601	76.4	(1.36)	3,221	80.1	(0.89)	3,410	83.9	(0.73)	3,701	87.6	(0.63)	11,933	83.1	(0.42)	

Table 2. Distribution of maternal characteristics, behavioral factors, health conditions, stressors, pre-pregnancy insurance status, and previous birth outcomes stratified by receipt of preconception counseling. Frequency (n) is displayed in the table. Column percent is displayed as weighted percent (%), each with its respective standard error (SE). Differences in sample characteristics were assessed by chi-square tests; results were considered significant at a two-sided p-value of <0.05. PRAMS, 2009-2011.

	Received Preconception Counseling									
	YES			NO			Total			p-value
	n	%	(SE)	n	%	(SE)	n	%	(SE)	-
Overall	9,306	32.7	(0.40)	17,885	67.3	(0.40)	27,191	-	-	-
Maternal Characteristics										
Income										<0.0001
< $10,000	1,676	17.6	(0.60)	3,812	21.0	(0.47)	5,488	19.9	(0.37)	
$10,000 - $14,999	524	5.1	(0.34)	1,657	10.5	(0.36)	2,181	8.7	(0.27)	
$15,000 - $19,999	388	4.7	(0.34)	1,161	7.2	(0.30)	1,549	6.4	(0.23)	
$20,000 - $24,999	459	5.3	(0.36)	1,286	8.2	(0.32)	1,745	7.3	(0.25)	
$25,000 - $34,999	690	8.8	(0.45)	1,792	12.1	(0.37)	2,482	11.0	(0.29)	
$35,000 - $49,999	920	11.3	(0.49)	1,978	13.4	(0.38)	2,898	12.7	(0.30)	
≥ $50,000	2,902	47.2	(0.80)	3,362	27.7	(0.51)	6,264	34.0	(0.43)	
Education										<0.0001
≤11 years	1,203	11.9	(0.50)	2,694	14.0	(0.39)	3,897	13.3	(0.31)	
12 years	2,218	20.8	(0.60)	5,302	27.3	(0.47)	7,520	25.2	(0.37)	
13-15 years	2,235	25.0	(0.64)	5,071	31.2	(0.49)	7,306	29.2	(0.39)	
≥16 years	3,549	42.3	(0.73)	4,571	27.5	(0.46)	8,120	32.3	(0.39)	
Age										<0.0001
≤17-19	697	6.7	(0.39)	1,682	8.2	(0.30)	2,379	7.7	(0.24)	
20-24	1,831	17.6	(0.56)	4,408	24.6	(0.47)	6,239	22.3	(0.37)	
25-29	2,561	31.5	(0.70)	4,876	31.0	(0.50)	7,437	31.2	(0.41)	
30-34	2,317	29.6	(0.68)	3,753	23.4	(0.45)	6,070	25.5	(0.37)	
35-39	1,510	11.7	(0.41)	2,501	10.1	(0.27)	4,011	10.6	(0.22)	
≥40	390	2.7	(0.20)	664	2.6	(0.15)	1,054	2.7	(0.12)	
Race/Ethnicity										0.001
Hispanic	820	8.6	(0.44)	1,912	9.8	(0.32)	2,732	9.4	(0.26)	
Non-Hispanic White	5,273	66.8	(0.67)	10,190	65.9	(0.46)	15,463	66.2	(0.36)	
Non-Hispanic Black	1,402	13.7	(0.48)	2,702	15.0	(0.34)	4,104	14.6	(0.25)	
American Indian	165	0.7	(0.09)	303	0.7	(0.07)	468	0.7	(0.06)	
Asian	960	5.9	(0.29)	1,371	4.6	(0.20)	2,331	5.0	(0.16)	
Other non-white	559	4.4	(0.29)	1,128	4.0	(0.19)	1,687	4.1	(0.16)	
Marital status										<0.0001
Married	6,427	73.2	(0.66)	10,249	59.3	(0.52)	16,676	63.9	(0.41)	
Other	2,867	26.8	(0.66)	7,611	40.7	(0.52)	10,478	36.1	(0.41)	
Number of dependents										<0.0001
1-2	4,077	43.8	(0.75)	7,069	40.2	(0.54)	11,146	41.4	(0.43)	
3-4	3,980	46.3	(0.75)	7,760	46.1	(0.54)	11,740	46.2	(0.44)	
≥5	905	9.9	(0.45)	2,433	13.7	(0.36)	3,338	12.5	(0.28)	
Pregnancy intent										<0.0001
Sooner	2,631	28.0	(0.66)	2,698	14.8	(0.37)	5,329	19.1	(0.33)	
Later	1,994	20.3	(0.61)	6,167	35.0	(0.52)	8,161	30.1	(0.41)	
Then	3,932	45.7	(0.74)	6,378	37.8	(0.52)	10,310	40.4	(0.43)	
Did not want	646	6.1	(0.37)	2,390	12.4	(0.36)	3,036	10.3	(0.27)	
Trying to become pregnant										<0.0001
Yes	5,936	68.2	(0.69)	7,168	42.9	(0.52)	13,104	51.2	(0.43)	
No	3,282	31.8	(0.69)	10,589	57.1	(0.52)	13,871	48.8	(0.43)	

Behavioral Factors							
Pre-pregnancy multivitamin use							<0.0001
Yes	6,230	70.1 (0.68)	6,313	37.0 (0.51)	12,543	47.8 (0.43)	
No	3,076	29.9 (0.68)	11,572	63.0 (0.51)	14,648	52.2 (0.43)	
Pre-pregnancy physical activity (≥3 days/week)							<0.0001
Yes	4,550	50.6 (0.74)	7,124	40.8 (0.52)	11,674	44.0 (0.43)	
No	4,679	49.4 (0.74)	10,622	59.2 (0.52)	15,301	56.0 (0.43)	
Pre-pregnancy smoking							<0.0001
Yes	1,987	19.5 (0.60)	5,199	27.6 (0.49)	7,186	24.9 (0.38)	
No	7,206	80.5 (0.60)	12,477	72.4 (0.49)	19,683	75.1 (0.38)	
Pre-pregnancy alcohol use							0.4604
Yes	4,340	54.4 (0.73)	8,963	55.1 (0.52)	13,303	54.9 (0.42)	
No	4,821	45.6 (0.73)	8,668	44.9 (0.52)	13,489	45.1 (0.42)	
Pre-pregnancy dieting							0.0024
Yes	2,642	30.0 (0.68)	4,716	27.5 (0.48)	7,358	28.3 (0.39)	
No	6,600	70.0 (0.68)	13,063	72.5 (0.48)	19,663	71.7 (0.39)	
Pre-pregnancy prescription medication use							<0.0001
Yes	2,403	26.4 (0.66)	3,443	18.8 (0.42)	5,846	21.3 (0.36)	
No	6,830	73.6 (0.66)	14,341	81.2 (0.42)	21,171	78.7 (0.36)	
Pre-pregnancy health care use							<0.0001
Yes	7,395	82.0 (0.57)	11,185	64.6 (0.51)	18,580	70.3 (0.40)	
No	1,871	18.0 (0.57)	6,641	35.4 (0.51)	8,512	29.7 (0.40)	
Health Conditions							
Body Mass Index							0.1341
Underweight (<18.5)	426	3.6 (0.26)	901	4.1 (0.21)	1,327	3.9 (0.16)	
Normal (18.5-24.9)	4,608	52.5 (0.75)	8,521	50.7 (0.55)	13,129	51.3 (0.44)	
Overweight (25.0-29.9)	2,137	24.2 (0.64)	4,062	24.3 (0.47)	6,199	24.3 (0.38)	
Obese (≥30.0)	1,779	19.8 (0.61)	3,688	20.9 (0.44)	5,467	20.5 (0.36)	
Pre-pregnancy chronic disease							<0.0001
Yes	2,685	26.5 (0.65)	4,477	23.2 (0.45)	7,162	24.3 (0.37)	
No	6,616	73.5 (0.65)	13,396	76.8 (0.45)	20,012	75.7 (0.37)	
Pre-pregnancy mental illness							0.1935
Yes	1,476	16.3 (0.56)	3,077	17.2 (0.41)	4,553	16.9 (0.33)	
No	7,768	83.7 (0.56)	14,673	82.8 (0.41)	22,441	83.1 (0.33)	
Stressors							
Intimate partner violence							0.0002
Yes	215	2.0 (0.21)	605	3.2 (0.20)	820	2.8 (0.15)	
No	8,999	98.0 (0.21)	17,134	96.8 (0.20)	26,133	97.2 (0.15)	
Total number of stressors							<0.0001
None	3,152	35.5 (0.71)	4,768	27.4 (0.47)	7,920	30.1 (0.39)	
1-2	3,882	43.0 (0.74)	7,288	42.5 (0.53)	11,170	42.7 (0.43)	
≥3	2,180	21.5 (0.62)	5,700	30.1 (0.50)	7,880	27.3 (0.39)	

Pre-Pregnancy Insurance						
Pre-pregnancy insurance						<0.0001
Private	5,384	62.5 (0.72)	8,314	49.7 (0.54)	13,698	53.9 (0.43)
Medicaid	1,717	14.9 (0.52)	3,043	15.5 (0.40)	4,760	15.3 (0.31)
No insurance	944	9.3 (0.44)	4,197	22.8 (0.46)	5,141	18.4 (0.34)
Other	582	6.8 (0.38)	1,177	7.1 (0.28)	1,759	7.0 (0.22)
Combination	529	6.5 (0.39)	841	4.8 (0.23)	1,370	5.4 (0.20)
Previous Birth Outcomes						
Number of previous live births						<0.0001
0	3,872	42.3 (0.73)	7,015	39.0 (0.53)	10,887	40.1 (0.43)
1	3,067	34.4 (0.71)	5,231	31.2 (0.50)	8,298	32.2 (0.41)
≥2	2,313	23.3 (0.62)	5,558	29.8 (0.48)	7,871	27.7 (0.38)
Poor prior pregnancy outcome						0.0155
Yes	1,197	18.5 (0.75)	2,117	16.3 (0.50)	3,314	17.0 (0.42)
No	3,873	81.5 (0.75)	8,161	83.7 (0.50)	12,034	83.0 (0.42)

Table 3. Odds ratios (OR) and 95% confidence intervals (CI) from logistic regression models. PRAMS, 2009-2011.

	Model 0 (Crude)	Model 1 (GS)	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Number of Observations	N/A	11,081	11,127	11,155	11,337	11,797	12,085	12,490	12,643
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Maternal Characteristics									
Income									
< $ 10,000	2.03 (1.818, 2.265)	0.90 (0.664, 1.216)	0.91 (0.673, 1.224)	0.93 (0.691, 1.254)	0.98 (0.758, 1.257)	0.92 (0.716, 1.171)	0.94 (0.744, 1.182)	0.84 (0.689, 1.020)	0.85 (0.722, 1.001)
$10,000 - $14,999	3.48 (2.953, 4.106)	1.49 (1.074, 2.076)	1.51 (1.089, 2.099)	1.53 (1.106, 2.128)	1.62 (1.209, 2.172)	1.66 (1.249, 2.211)	1.68 (1.275, 2.204)	1.46 (1.138, 1.883)	1.50 (1.189, 1.888)
$15,000 - $19,999	2.60 (2.172, 3.123)	1.20 (0.847, 1.694)	1.21 (0.861, 1.713)	1.23 (0.873, 1.732)	1.33 (0.975, 1.814)	1.32 (0.974, 1.774)	1.27 (0.960, 1.681)	1.26 (0.968, 1.627)	1.32 (1.036, 1.685)
$20,000 - $24,999	2.63 (2.216, 3.125)	1.04 (0.778, 1.398)	1.06 (0.790, 1.413)	1.07 (0.798, 1.424)	1.12 (0.858, 1.469)	1.13 (0.870, 1.473)	1.18 (0.913, 1.524)	1.08 (0.844, 1.378)	1.11 (0.882, 1.404)
$25,000 - $34,999	2.33 (2.021, 2.673)	1.18 (0.927, 1.489)	1.18 (0.929, 1.487)	1.19 (0.941, 1.502)	1.24 (0.990, 1.550)	1.20 (0.961, 1.491)	1.20 (0.978, 1.480)	1.14 (0.938, 1.391)	1.20 (0.998, 1.447)
$35,000 - $49,999	2.01 (1.772, 2.281)	1.40 (1.146, 1.703)	1.40 (1.151, 1.707)	1.42 (1.164, 1.723)	1.43 (1.176, 1.730)	1.40 (1.161, 1.696)	1.42 (1.188, 1.706)	1.36 (1.140, 1.617)	1.42 (1.200, 1.679)
≥ $50,000	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference
Education									
≤11 years	1.82 (1.607, 2.052)	1.00 (0.756, 1.321)	1.01 (0.761, 1.327)	1.04 (0.788, 1.371)	1.04 (0.790, 1.356)	1.01 (0.775, 1.302)	1.07 (0.836, 1.369)	1.00 (0.801, 1.243)	- -
12 years	2.02 (1.830, 2.218)	0.97 (0.797, 1.176)	0.96 (0.793, 1.167)	0.98 (0.807, 1.187)	1.01 (0.831, 1.217)	1.00 (0.825, 1.202)	1.09 (0.909, 1.298)	1.09 (0.920, 1.294)	- -
13-15 years	1.92 (1.757, 2.106)	1.16 (0.980, 1.365)	1.15 (0.978, 1.361)	1.17 (0.993, 1.379)	1.17 (0.995, 1.379)	1.14 (0.968, 1.334)	1.17 (1.004, 1.362)	1.19 (1.024, 1.373)	- -
≥16 years	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -
Age									
≤17-19	1.24 (1.056, 1.443)	0.47 (0.294, 0.741)	0.47 (0.295, 0.749)	0.44 (0.276, 0.693)	0.40 (0.254, 0.621)	0.41 (0.263, 0.627)	0.41 (0.273, 0.625)	- -	- -
20-24	1.42 (1.276, 1.574)	0.87 (0.713, 1.055)	0.86 (0.711, 1.050)	0.84 (0.696, 1.022)	0.81 (0.672, 0.979)	0.80 (0.669, 0.964)	0.83 (0.692, 0.989)	- -	- -
25-29	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -
30-34	0.80 (0.731, 0.885)	1.03 (0.877, 1.208)	1.02 (0.872, 1.199)	1.03 (0.878, 1.207)	1.04 (0.885, 1.214)	1.03 (0.879, 1.198)	0.96 (0.823, 1.109)	- -	- -
35-39	0.88 (0.783, 0.981)	1.26 (1.043, 1.522)	1.25 (1.034, 1.507)	1.28 (1.058, 1.537)	1.28 (1.062, 1.539)	1.29 (1.074, 1.546)	1.13 (0.947, 1.351)	- -	- -
≥40	0.99 (0.813, 1.202)	1.37 (0.998, 1.870)	1.33 (0.975, 1.821)	1.37 (1.005, 1.871)	1.42 (1.041, 1.925)	1.31 (0.974, 1.765)	1.12 (0.834, 1.508)	- -	- -
Race/Ethnicity									
Hispanic	1.16 (1.011, 1.323)	0.79 (0.612, 1.020)	0.80 (0.618, 1.029)	0.80 (0.617, 1.026)	0.87 (0.678, 1.119)	0.86 (0.680, 1.091)	0.94 (0.755, 1.172)	- -	- -
Non-Hispanic White	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -
Non-Hispanic Black	1.11 (0.998, 1.231)	0.74 (0.613, 0.905)	0.75 (0.615, 0.905)	0.75 (0.622, 0.915)	0.73 (0.604, 0.881)	0.67 (0.560, 0.807)	0.72 (0.606, 0.855)	- -	- -
American Indian	1.01 (0.714, 1.438)	0.73 (0.466, 1.136)	0.72 (0.462, 1.123)	0.73 (0.467, 1.133)	0.76 (0.499, 1.143)	0.68 (0.442, 1.035)	0.71 (0.452, 1.128)	- -	- -
Asian	0.80 (0.697, 0.920)	0.75 (0.563, 0.988)	0.75 (0.564, 0.987)	0.74 (0.557, 0.974)	0.69 (0.521, 0.901)	0.67 (0.511, 0.866)	0.78 (0.605, 1.014)	- -	- -
Other non-white	0.92 (0.779, 1.095)	0.61 (0.456, 0.824)	0.61 (0.452, 0.814)	0.63 (0.467, 0.838)	0.59 (0.442, 0.786)	0.56 (0.427, 0.746)	0.64 (0.481, 0.839)	- -	- -
Marital status									
Married	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -
Other	1.87 (1.732, 2.029)	1.00 (0.819, 1.209)	1.00 (0.825, 1.213)	1.01 (0.833, 1.224)	1.03 (0.853, 1.239)	1.03 (0.859, 1.235)	1.14 (0.962, 1.351)	- -	- -
Number of dependents									
1-2	0.92 (0.855, 0.998)	1.04 (0.851, 1.277)	1.04 (0.852, 1.275)	1.01 (0.830, 1.233)	1.01 (0.826, 1.222)	1.00 (0.828, 1.216)	1.00 (0.829, 1.212)	- -	- -
3-4	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -
≥5	1.39 (1.230, 1.567)	1.14 (0.940, 1.376)	1.13 (0.935, 1.366)	1.20 (1.003, 1.434)	1.20 (1.002, 1.426)	1.18 (0.993, 1.400)	1.21 (1.027, 1.436)	- -	- -
Pregnancy intent									
Sooner	0.64 (0.584, 0.703)	0.72 (0.611, 0.838)	0.72 (0.613, 0.839)	0.72 (0.613, 0.840)	0.71 (0.608, 0.830)	0.70 (0.603, 0.819)	0.71 (0.614, 0.826)	- -	- -
Later	2.08 (1.898, 2.288)	1.04 (0.853, 1.277)	1.05 (0.857, 1.281)	1.06 (0.870, 1.299)	1.06 (0.872, 1.294)	1.03 (0.849, 1.251)	1.07 (0.891, 1.294)	- -	- -
Then	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -
Did not want	2.46 (2.122, 2.849)	1.28 (0.988, 1.654)	1.28 (0.994, 1.659)	1.32 (1.023, 1.702)	1.30 (1.013, 1.671)	1.32 (1.029, 1.682)	1.43 (1.126, 1.806)	- -	- -
Trying to become pregnant									
Yes	0.35 (0.326, 0.379)	0.63 (0.525, 0.755)	0.63 (0.526, 0.756)	0.63 (0.528, 0.757)	0.63 (0.529, 0.753)	0.63 (0.529, 0.748)	0.56 (0.478, 0.666)	0.46 (0.409, 0.515)	0.46 (0.410, 0.516)
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference

Behavioral Factors									
Pre-pregnancy multivitamin use									
Yes	0.25 (0.232, 0.270)	0.40 (0.347, 0.453)	0.40 (0.348, 0.453)	0.40 (0.346, 0.450)	0.39 (0.338, 0.439)	0.38 (0.333, 0.430)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy physical activity (≥3 days/week)									
Yes	0.67 (0.624, 0.721)	0.84 (0.739, 0.960)	0.84 (0.737, 0.955)	0.84 (0.740, 0.959)	0.84 (0.738, 0.954)	0.84 (0.741, 0.950)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy smoking									
Yes	1.57 (1.435, 1.715)	0.85 (0.720, 1.006)	0.85 (0.723, 1.008)	0.85 (0.718, 1.000)	0.84 (0.716, 0.991)	0.83 (0.707, 0.972)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy alcohol use									
Yes	1.03 (0.957, 1.105)	1.13 (0.988, 1.287)	1.13 (0.991, 1.289)	1.12 (0.986, 1.281)	1.11 (0.971, 1.258)	1.11 (0.976, 1.260)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy dieting									
Yes	0.88 (0.816, 0.956)	1.02 (0.889, 1.179)	1.03 (0.893, 1.183)	1.03 (0.895, 1.185)	1.05 (0.911, 1.203)	1.04 (0.913, 1.188)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy prescription medication use									
Yes	0.65 (0.595, 0.706)	0.90 (0.770, 1.057)	0.90 (0.765, 1.049)	0.89 (0.760, 1.041)	0.87 (0.743, 1.015)	0.80 (0.693, 0.914)	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -
Pre-pregnancy health care use									
Yes	0.40 (0.367, 0.437)	0.60 (0.512, 0.694)	0.60 (0.511, 0.693)	0.60 (0.515, 0.697)	0.57 (0.495, 0.665)	0.57 (0.491, 0.652)	0.50 (0.439, 0.575)	0.52 (0.454, 0.588)	0.52 (0.455, 0.588)
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference
Health Conditions									
Body Mass Index									
Underweight (<18.5)	1.19 (0.989, 1.424)	0.83 (0.601, 1.158)	0.83 (0.601, 1.158)	0.87 (0.627, 1.213)	0.88 (0.634, 1.209)	- -	- -	- -	- -
Normal (18.5-24.9)	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -	- -
Overweight (25.0-29.9)	1.04 (0.953, 1.140)	0.90 (0.780, 1.048)	0.90 (0.780, 1.048)	0.91 (0.783, 1.051)	0.93 (0.800, 1.071)	- -	- -	- -	- -
Obese (≥30.0)	1.09 (0.991, 1.204)	0.96 (0.815, 1.131)	0.96 (0.816, 1.132)	0.96 (0.818, 1.135)	0.95 (0.808, 1.114)	- -	- -	- -	- -
Pre-pregnancy chronic disease									
Yes	0.83 (0.768, 0.905)	0.80 (0.688, 0.919)	0.80 (0.692, 0.923)	0.80 (0.692, 0.924)	0.79 (0.684, 0.910)	- -	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -	- -
Pre-pregnancy mental illness									
Yes	1.07 (0.968, 1.180)	0.94 (0.782, 1.117)	0.95 (0.795, 1.130)	0.96 (0.806, 1.145)	0.97 (0.817, 1.154)	- -	- -	- -	- -
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -	- -
Stressors									
Intimate partner violence									
Yes	1.60 (1.258, 2.047)	1.24 (0.862, 1.787)	- -	- -	- -	- -	- -	- -	- -
No	1.00 Reference	1.00 Reference	- -	- -	- -	- -	- -	- -	- -
Total number of stressors									
None	1.00 Reference	1.00 Reference	- -	- -	- -	- -	- -	- -	- -
1-2	1.28 (1.179, 1.392)	1.04 (0.900, 1.195)	- -	- -	- -	- -	- -	- -	- -
≥3	1.82 (1.647, 2.001)	1.00 (0.837, 1.198)	- -	- -	- -	- -	- -	- -	- -

Pre-Pregnancy Insurance									
Pre-pregnancy insurance									
Private	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -	- -	- -
Medicaid	1.30 (1.175, 1.447)	0.96 (0.761, 1.215)	0.95 (0.755, 1.202)	0.95 (0.753, 1.199)	- -	- -	- -	- -	- -
No insurance	3.08 (2.743, 3.465)	1.56 (1.230, 1.973)	1.54 (1.220, 1.951)	1.53 (1.212, 1.938)	- -	- -	- -	- -	- -
Other	1.32 (1.140, 1.527)	0.97 (0.750, 1.249)	0.96 (0.749, 1.241)	0.96 (0.749, 1.242)	- -	- -	- -	- -	- -
Combination	0.94 (0.794, 1.100)	0.81 (0.609, 1.072)	0.81 (0.608, 1.068)	0.80 (0.602, 1.058)	- -	- -	- -	- -	- -
Previous Birth Outcomes									
Number of previous live births									
0	1.02 (0.934, 1.107)	1.04 (0.644, 1.693)	1.03 (0.636, 1.664)	- -	- -	- -	- -	- -	- -
1	1.00 Reference	1.00 Reference	1.00 Reference	- -	- -	- -	- -	- -	- -
≥2	1.41 (1.283, 1.548)	1.14 (0.991, 1.313)	1.14 (0.993, 1.316)	- -	- -	- -	- -	- -	- -
Poor prior pregnancy outcome									
Yes	0.86 (0.761, 0.970)	0.89 (0.759, 1.037)	0.89 (0.761, 1.039)	0.89 (0.763, 1.041)	0.89 (0.767, 1.041)	0.89 (0.767, 1.031)	0.87 (0.754, 1.005)	0.86 (0.744, 0.984)	0.86 (0.745, 0.983)
No	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference	1.00 Reference
Fit statisitc									
AIC	N/A	478896.75	480764.87	482109.62	491301.7	510295.52	541384.2	569372.92	575164.55

Model 0: crude association with outcome (failure to receive preconception counseling)

Model 1: fully adjusted model (gold standard)

Model 2: drops stressors category

Model 3: drops stressors and previous birth outcomes categories

Model 4: drops stressors, previous birth outcomes, and pre-pregnancy insurance status categories

Model 5: drops stressors, previous birth outcomes, pre-pregnancy insurance status, and health conditions categories

Model 6: drops stressors, previous birth outcomes, pre-pregnancy insurance status, health conditions, and behavioral conditions categories

Model 7: drops stressors, previous birth outcomes, pre-pregnancy insurance status, health conditions, behavioral conditions, and maternal characteristics categories

Model 8: drops stressors, previous birth outcomes, pre-pregnancy insurance status, health conditions, behavioral conditions, maternal characteristics categories, and maternal education

APPENDIX

Table 4. Preconception health indicators by domain and sub-domain for women aged 18-44 years. Table originally presented in (14). Indicators measured by PRAMS are bolded.

Domain	Sub-domain	Indicator	Data Sources
General health status and life satisfaction	Self-rated health	Percentage of women who report good, very good or excellent health	BRFSS
Social determinants of health	Education	Percentage of women with a high school education/GED or greater	BRFSS
	Poverty	Percentage of women who live at or below 200% of the Federal Poverty Threshold	ASEC
Health care	Access to and utilization of health care	Percentage of women who currently have some type of health care coverage	BRFSS
		Percentage of women having a live birth who had health care coverage during the month prior to pregnancy	**PRAMS**
		Percentage of women who had a routine checkup in the past year	BRFSS
		Percentage of women having a live birth who had a postpartum checkup	**PRAMS**
	Access to dental care	**Percentage of women having a live birth who had their teeth cleaned during the 12 months prior to pregnancy**	**PRAMS**
	Reproductive health care	Percentage of women who had a pap test within the past 3 years	BRFSS
	Content and quality of care	**Percentage of women having a live birth who received preconception counseling about healthy lifestyle behaviors and prevention strategies from a health care provider prior to pregnancy**	**PRAMS**
Reproductive health and family planning	Previous preterm birth	Percentage of women having a live birth who had a previous preterm birth	NVSS
		Percentage of women having a live birth who had their Previous live birth more than 3 weeks before the due date	**PRAMS**
	Previous fetal death, miscarriage, or stillbirth	**Percentage of women who experienced a miscarriage, fetal death or stillbirth in the 12 months prior to getting pregnant with their most recent live born infant**	**PRAMS**
	Inter-pregnancy interval/birth spacing	Percentage of women having a live birth who had less than 18 months between their previous live birth and the start of the most recent pregnancy	NVSS

	Pregnancy intention/ wantedness	**Percentage of women having a live birth who reported having an unintended or unwanted pregnancy**	**PRAMS**
		Unintended pregnancy: percentage of women who said that just before their most recent pregnancy, they wanted to be pregnant later or didn't want to be pregnant then or at any time in the future	**PRAMS**
		Unwanted pregnancy: percentage of women who said that just before their most recent pregnancy they didn't want to be pregnant then or at any time in the future	**PRAMS**
	Contraception (access, availability, and use)	**Percentage of women having a live birth who were not trying to get pregnant at the time of conception and neither they nor their husbands or partners were doing anything to keep from getting pregnant**	**PRAMS**
		Percentage of women having a live birth who reported that they or their husbands or partners were currently doing something to keep from getting pregnant	**PRAMS**
	Use of assisted reproductive technology	**Percentage of women having a live birth who used fertility drugs or received any medical procedures from a doctor, nurse, or other health care worker to help them get pregnant**	**PRAMS**
Tobacco, alcohol and substance use	Smoking	Percentage of women who currently smoke every day or some days	BRFSS
		Percentage of women having a live birth who smoked cigarettes during the 3 months prior to a pregnancy	**PRAMS**
	Alcohol consumption	Percentage of women who participated in heavy drinking on at least one occasion within the past month	BRFSS
		Percentage of women who participated in binge drinking on at least one occasion in the past month	BRFSS
		Percentage of women having a live birth who drank any amount of alcohol during the 3 months prior to pregnancy	**PRAMS**
		Percentage of women years having a live birth who participated in binge drinking during the 3 months prior to pregnancy	**PRAMS**

	Secondhand smoke exposure	**Percentage of women having a live birth who reported that smoking is currently allowed in their home**	**PRAMS**
Nutrition and physical activity	Fruit and vegetable consumption	Percentage of women who consume fruits and vegetables at least five times per day	BRFSS
	Obesity and overweight	Percentage of women who are overweight or obese based on body mass index (BMI)	BRFSS
		Overweight: percentage of women with a BMI ≥ 25 kg/m2 but < 30 kg/m2	BRFSS
		Obesity: percentage of women with a BMI ≥ 30 kg/m2	BRFSS
		Percentage of women having a live birth who were overweight or obese based on BMI at the time they became pregnant	**PRAMS**
		Overweight: percentage of women with a pre-pregnancy BMI ≥ 25 kg/m2 but < 30 kg/m2	**PRAMS**
		Obesity: percentage of women with a pre-pregnancy BMI ≥ 30 kg/m2	**PRAMS**
	Folic acid supplementation	**Percentage of women having a live birth who took a multivitamin, prenatal vitamin, or a folic acid supplement every day of the month prior to pregnancy**	**PRAMS**
	Exercise/physical activity	Percentage of women who participate in enough moderate and/or vigorous physical activity in a usual week to meet the recommended levels of physical activity	BRFSS
Mental health	General mental distress	Percentage of women who report that their mental health was not good for at least 14 out of the past 30 days	BRFSS
	Anxiety and depression	**Percentage of women having a live birth who visited a health care provider to be checked or treated for anxiety or depression during the 12 months prior to pregnancy**	**PRAMS**
	Postpartum depression	**Percentage of women having a live birth who experienced depressive symptoms after pregnancy**	**PRAMS**
Emotional and social support	Domestic abuse (physical and mental)	**Percentage of women having a live birth who were physically abused by their partner during the 12 months prior to pregnancy**	**PRAMS**
		Percentage of women having a live birth who were mentally abused by their partner during the 12 months prior to pregnancy	**PRAMS**

	Adequacy of support	Percentage of women who always or usually get the social and emotional support they need	BRFSS
		Percentage of women having a live birth who reported that they had adequate social and emotional support available to them after delivering their baby	**PRAMS**
Chronic conditions	Diabetes	Percentage of women who have ever been told by a health care provider that they had diabetes, not including gestational diabetes	BRFSS
		Percentage of women having a live birth who before their most recent pregnancy had ever been told by a health care provider that they had Type I or Type II diabetes	**PRAMS**
	Hypertension	Percentage of women who have ever been told by a health care provider that they had hypertension, not including hypertension during pregnancy	BRFSS
		Percentage of women having a live birth who reported that they had hypertension during the 3 months before their most recent pregnancy	**PRAMS**
	Asthma	Percentage of women who currently have asthma	BRFSS
Infections	HIV	**Percentage of women having a live birth who were tested for HIV within a year prior to their most recent pregnancy**	**PRAMS**
	Sexually transmitted infections	Rates of chlamydia, gonorrhea, and syphilis (cases per 100,000 women aged 18–44 years)	NSTD
	Immunizations	Percentage of women who received an influenza vaccination within the past year	BRFSS