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Race and Ethnicity and Preconception Folic Acid Supplement Use in Georgia: Pregnancy Risk Assessment Monitoring Survey (PRAMS), 2009-2011.

By

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MPH, Emory University, 2016

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An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Race and Ethnicity and Preconception Folic Acid Supplement Use in Georgia: Pregnancy Risk Assessment Monitoring Survey (PRAMS), 2009-2011

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BACKGROUND: The 1992 U.S. Public Health Service recommends that all women capable of becoming pregnant consume 400 mcg of folic acid daily to prevent neural tube defects in the offspring; however, compliance of supplement use is low. The current mandatory folic acid fortification policy in the U.S. does not enrich corn masa, a staple of Hispanic populations who have a high prevalence of neural tube defects. The purpose of this study was estimate the prevalence of preconception folic acid use, and its association with maternal race/ethnicity among women of reproductive age in Georgia.

METHODS: Using data from the 2009-2011 Georgia-Pregnancy Risk Assessment Monitoring Survey (GA-PRAMS), we examined the prevalence of preconception folic acid use, and its association with race and ethnicity among women aged 18-45 years (N=3277). We estimated adjusted odds ratios (aORs) and 95% confidence intervals using multivariable logistic regression, and accounting for the complex survey design.

RESULTS: Overall, only about 30% of all participants reported adequate supplemental folic acid intake (4-7 pills per week) before pregnancy. Specifically, 38.7% non-Hispanic whites, 21% non-Hispanic blacks, and 23.5% Hispanics reported taking folic acid prior to conception. Race-ethnicity was significantly associated with preconception folic acid intake. The odds of not taking folic acid before pregnancy were highest for Hispanics (aOR=2.15; 95% CI, 1.35-3.40) and African Americans (aOR=1.66; 95% CI, 1.18-2.32) compared to non-Hispanic whites, after controlling for maternal age, pregnancy intention, knowledge that folic acid prevents birth defects, preconception smoking and exercise, and parity.

CONCLUSIONS: Our analyses show that preconception educational programs that promote supplemental folic acid intake are failing in Georgia. Most Hispanic women are not taking recommended folic acid prior to conception and are at a disproportionately high risk for neural tube defects compared to their counterparts whose staple wheat-based diets are mandatorily enriched with folic acid. Our data support educational programs to promote intake of voluntarily fortified corn masa flour, and a push to implement mandatory fortification of the same.

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CHAPTER 1: INTRODUCTION

Background of the Problem:

Folic acid is a synthetic form of vitamin B9. Vitamin B9, in its natural form (known as folate), is found in green leafy vegetables and lentils (1). Folic acid plays an essential role as a coenzyme that transfers single carbon groups for nucleic acid and amino acid metabolism, and its deficiency results in impaired biosynthesis of DNA and RNA, thus reducing cell division, most apparent in cells with rapid multiplication rates. Thus, the role of folate in normal cell division makes it significant during embryogenesis (2).

Spina bifida and anencephaly are the two major and common types of neural tube defects (NTDs) affecting brain and spinal cord. They occur within the first 28 days of pregnancy as a result of improper closure of embryonic neural tube which can lead to death or varying degree of disability, most often before a women knows she is pregnant (3). Anencephaly is a fatal defect in which the cranial portion of neural tube fails to close correctly, and spina bifida is a defect in which the caudal portion of neural tube fails to close correctly. Spina bifida can cause lifelong complications ranging from paralysis of lower extremities to lack of bowel and bladder control, and can be fatal in some cases. In the United States, it has been estimated that each year 3,000 infants are born with NTDs (4). Latest population-based birth defects surveillance data from the United States report the birth prevalence of spina bifida and anencephaly combined to be about 5-7 per 10,000 live births, depending on the availability of prenatal assessments (5). More specifically, data from 21 population-based surveillance programs in the U.S reported the birth prevalence of spina bifida in post-mandatory folic acid fortification period in the U.S was estimated as 3.37 per 10,000 live births among non-Hispanics white, 2.90 per 10,000 live births among non-Hispanics blacks, and 4.18 per 10,000 live births among Hispanic women. For anencephaly, the birth prevalence for non-Hispanic whites, non-Hispanic blacks and Hispanics is estimated to be 1.98, 1.80, and 2.84 per 10,000 live births respectively (6).

Research has shown that if folic acid is taken prior to and during the first several months of pregnancy, it can reduce the risk of spina bifida and anencephaly significantly (up to 70% reduction) (7, 8). In a recent study using data of Maryland Pregnancy Risk Assessment Monitoring System (PRAMS) survey responses from 2009 – 2011, approximately 30% of the women reported daily folic acid use the month before pregnancy. The most common reason for folic acid non-use were “not planning pregnancy” (61%) and “didn’t think they need to take” (41%) (9).

The U.S. Preventive Services Task Force recommends that women of child bearing potential consume a daily supplement containing 400µg - 800µg of folic acid (10). Since 1998, the United States has been implementing a mandatory folic acid fortification program, which enables everyone who consume enriched cereal grain products to receive up to 140 mcg of folic acid per 100g of intake (11-13). In the U.S, proportions of women who consumed folic acid from enriched cereal grain products only, enriched cereal grain products plus ready-to-eat cereals, enriched cereal grain products plus supplements, and enriched cereal grain products plus ready-to-eat cereals plus supplements were 42%, 18%, 25%, and 15%, respectively (14). Although, fortification will likely to help increase folate intake among general population, it may not sufficiently increase intake among women in target population - women of reproductive age (15, 16).

Women are still at risk of folate deficiency if they are not eating adequately enriched diet or not taking recommended folic acid supplementation during pre-conceptional period. Additionally, about 50% of pregnancies in the U.S are unplanned, and these women are at high risk of not taking prenatal supplements (17).

Since mandatory folic acid fortification in U.S, overall 28% reduction was observed in the prevalence of spina bifida and anencephaly, 35% reduction was observed among programs with perinatal ascertainment, and 21% reduction in the prevalence was observed for the programs without prenatal ascertainment (5). However, the prevalence of spina bifida and anencephaly continues to be highest among Hispanic women. Hispanics are at significantly higher risk of delivering babies with spina bifida and anencephaly in the U.S compared to non-Hispanic whites and non-Hispanic black mothers (18). Specifically, Hispanic women are 1.21 times more likely to have a NTD-affected pregnancy than non-Hispanic white women (95% CI: 1.11-1.31) (18). The combined birth prevalence of spina bifida and anencephaly among Hispanics is approximately 6 per 10,000 live births (5).

It is important to focus on Hispanic population with regard to preventing spina bifida and anencephaly. According to a study by Prue et al., (2010), the Hispanic population is one of the fastest growing population in the United States, representing 14.2% of U.S. population (19). They are younger and they have higher fertility and birth rates than non-Hispanics. Additionally, they are more likely to have children at young age and continue having children into older age. Also, the rates of unintended pregnancies are significantly higher among Hispanic women. Only 17% of Hispanic women (95% CI; 11.5% - 22.8%) report consuming $\geq$ 400 μg of folic acid per day through fortified food or supplements as compare to 30% of non-Hispanic white women (95% CI: 25.6% - 35.0%) and 9% of non-Hispanic black women (95% CI: 4.4% - 13.9%) (5). Proposed reason to this difference in risk points to variations in the folic acid consumption (5). Acculturation has also been proposed to play a role in affecting the prevalence of NTDs among Hispanic population, where less acculturated Hispanic women are found to be at higher risk for NTDs compared to more acculturated counterparts (20).

Pre-conceptional folic acid intake is an important consideration for optimal reproductive health of women in any racial and ethnic group. Overall 24% of non-pregnant U.S women of reproductive age are consuming the recommended usual intake (95% CI: 20% - 27%) (21). Hence, fortification becomes vital to meet the recommended daily dose of 400 mcg of folic acid among women of reproductive age. There are gaps in fortification intervention, as Hispanics are not receiving needed benefits through corn masa fortification. As Hispanics are at a disproportionately high risk for NTDs, it is important to understand their folic acid supplement intake, and target interventions as needed (22).

Goal of the study:

The goal of our study was to assess whether reproductive aged women (18-45 years) in Georgia are taking adequate prenatal folic acid supplements, and if there is an association between this behavior and race and ethnicity. Using data from Georgia PRAMS (2009-2011), we estimated the prevalence of preconception folic acid supplement use, and its association with maternal race and ethnicity among women of reproductive age in Georgia.

Research Questions:

- What is the prevalence of pre-conception folic acid supplement use among women of reproductive age in Georgia?
- Is pre-conceptional folic acid supplement use is associated with race and ethnicity among women of reproductive age in Georgia?

Importance of the study:

There are no current published studies on pre-conception folic acid use among women of reproductive age in Georgia. Also, current understanding of women's knowledge, attitude, and beliefs about pre-conception folic acid is important to determine factors associated with folic acid supplement intake. We expect our study to contribute timely data on the prevalence of pre-conception folic acid use in Georgia, disparities in intake among women of different racial and ethnic groups; and to understand various demographic and lifestyle factors that modify the association of pre-conception folic acid use and race and ethnicity among women of reproductive age in Georgia. Findings from this study will help identify current pre-conceptional reproductive health needs of women in Georgia, and inform prenatal folic acid supplementation programs in the State. Our goal is to reduce the incidence of folic acid-preventable neural tube birth defects in Georgia.

CHAPTER 2: LITERATURE REVIEW

Introduction:

This literature review will focus on: 1) prevalence of spina bifida and anencephaly in the U.S and specifically in Georgia; 2) the association between folic acid and neural tube defects; 3) women's knowledge, attitudes, and behaviors related to folic acid and its relation with neural tube defects; 4) factors predicting intake of preconception folic acid intake among women of reproductive age; 5) racial and ethnic disparities of folic acid intake among women of reproductive age.

Prevalence of Neural Tube Defects:

Neural tube defects are serious birth defects of brain and spinal cord as a result of improper closure of the embryonic neural tube, which can lead to death or paralysis. Following a 31% decline in the prevalence of spina bifida and a 16% decline in the prevalence of anencephaly in the period post-fortification with folic acid (October 1998-December 1999) (23), and spina bifida and anencephaly prevalence declined 10% from 1999-2004 (24). A study by Williams et al. in 2015 (5) using 19 population-based birth defects surveillance programs in U.S among deliveries occurring during 1995-2011, they found that immediately following mandatory fortification, the birth prevalence of NTDs has declined. The decline in the prevalence of NTDs had been observed for all three of the racial and ethnic groups examined between the pre-fortification and post-fortification periods. After the initial decrease, birth prevalence of NTDs has been found to be relatively stable in the post-fortification period. Folic acid fortification in the U.S had been estimated to prevent NTDs in about 1,300 births (CI: 1,122 - 1,531) each year or a total of approximately 15,000 prevented since 1999. Among all race and ethnic groups, Hispanics consistently had a higher prevalence NTDs (approximately 6-7 NTDs per 10,000 live births) compared with the other racial and ethnic groups, whereas NH-blacks had the lowest prevalence of about 4 NTDs per 10,000 live births. Prevalence reported for anencephaly from programs with prenatal ascertainment was consistently higher among all racial and ethnic groups compared with the programs without prenatal ascertainment, whereas the difference in the prevalence of spina bifida was not as pronounced among all racial and ethnic groups between the two types of programs. Specifically in Georgia, prevalence of spina bifida and anencephaly has reduced from 6.5% (pre-fortification) to 4.0 % (post-fortification) per 10,000 live births and 4.2% (pre-fortification) to 2.9% (post-fortification) per 10,000 live births, respectively. Also, combined prevalence of spina bifida and anencephaly has declined from 10.7% to 5.0% per 10,000 live births (5).

The impact of these births defects are immense. They not only have emotional costs associated with them but also economically expensive. The annual medical and surgical costs for all persons associated with spina bifida exceeded $200 million (25). The life time direct cost of care for one child born with spina bifida in the U.S is estimated to be $768,000 (26). This clearly indicates a high burden on health care even in high income countries. Up to 70% of all neural tube defects can be prevented if women of reproductive age consume a sufficient amount of folic acid around the time of conception and early in pregnancy (27).

Folic acid and Neural Tube Defects:

One of the most compelling studies that shows the association between folic acid and neural tube defects was published in the Lancet (1991) by International Medical Research Council (7). It was a double-blinded randomized controlled trial that was conducted at 33 centers of seven countries to determine whether supplementation with folic acid or a mixture of seven other vitamins (A, D, B1, B2, B6, C and nicotinamide) around the time of conception can prevent neural tube defects. A total of 1817 women were recruited and randomized into four supplement groups – folic acid, other vitamins, both, or neither. The women were to take the assigned supplement until the 12th week of their pregnancy. Their data showed 72% protective-effect for those in folic acid supplement group (RR: 0.28, 95% CI: 0.12, 0.71) while those in vitamin supplement group showed no protective effect (RR: 0.80, 95% CI: 0.32, 1.72). These data did not suggest that there was any demonstrable harm from folic acid supplementation, although the ability of the study to detect rare or slight adverse effects was limited. The evidence from the study concludes that prevention of neural tube defects was due to folic acid and not because of other vitamins tested in the study (7).

Women knowledge, attitude, behavior and pre-conception folic acid intake:

A study by Amy S. Kloeblen in 1999 to assess folate related knowledge and behaviors and folate intake from grain products among socioeconomically disadvantaged pregnant women (28). The study took place in the Maternal and Child Health Nutrition Department of Grady Health System, which serves primarily minority, indigent clients in metropolitan Atlanta, GA. The sample consisted of 251 low income pregnant women enrolled in, or eligible for and waiting to enroll in, the Special Supplemental Nutrition program for Women, Infants, and Children (WIC) during March through May 1997. The 58 item interview script examined subjects supplement use, health behaviors, knowledge and beliefs about folate, intake of grain products, and demographic characteristics. Results showed that more than 80% of the subjects did not take folic acid supplements preconceptionally. 57% of the subjects had heard of folate, but only 26% could correctly define folate and 30% list any food sources of folate. Most subjects (77%) will be able to achieve the goal of 400 µg folate per day exclusively through intake of fortified grain products. This study concludes that population of low income women is likely to benefit substantially from folate fortification of grain products. However, health education remains essential for those women who are still unable to meet their folate requirements (28).

A study by Chacko et al. in 2003 (29) to assess knowledge of NTD prevention by folic acid, frequency of intake of multi-vitamins and folic acid fortified food, and factors associated with knowledge and prevention practices among sexually active minority adolescents and young adult women. Young minority women (N=387) enrolled in a folic acid program at 3 urban health clinics were included in the study, and were assessed for NTD knowledge and preventive practices. These women were also dispensed with 3 month supply of multivitamins, and they were followed after three months of enrollment. At enrollment, clinics were found as a major source of information of NTD prevention (44%); 52% had heard of folic acid, 45% had heard of NTDs, and 50% had heard of birth defects prevention by multivitamins. Significantly more Hispanic than black young women had heard of NTDs (59% vs. 39%). Pregnancy history, regular birth control use, and education level for age were independently associated with knowledge. At enrollment, daily multivitamin intake was very low (9%) and folate-rich foods were consumed in inadequate amounts. Adequate folate diet was not associated with knowledge. The program follow-up survey indicated that 88% to 92% had knowledge of NTDs and folic acid, and 67% reported taking a daily multivitamin (29).

A study done by Lane et al., 2015 (30) to describe folic acid consumption among college students and to explore the relationship between folic acid intake and the variables of: age, gender, year in college, alcohol and tobacco use, and vitamin supplement intake . Data used for this study were obtained from responses of 1,921 students at 60 North Carolina colleges from 2002 to 2008. Following the educational intervention, college students were received a 90 day supply of a multivitamin that included 0.4 mg of folic acid. Post-tests at 3 months were used to evaluate the effectiveness of educational program. Of the 1,921 college students, 83.3% reported taking a vitamin supplement, but only 47.6% stated that the vitamin contained folic acid. A relationship was found between age, year in school, gender, and vitamin intake ($P < 0.001$). Alcohol ($P=0.775$) and cigarette (0.116) use were not significant predictors of folic acid consumption. They concluded that it is very important to identify the variables associated with folic acid, marketing and education should be focused to increase supplementation levels, and ultimately reduce the number of neural tube defects (30).

Determinants of pre-conception folic acid intake:

A study by Robbins et al. (31) in 2014 using population based surveillance system from PRAMS and Behavioral Risk factor Surveillance System (BRFSS) using 2009 data for non-pregnant women of reproductive age (aged 18-44 years). This report includes 39 of the 41 core state preconception health indicators for which data are available through

PRAMS or BRFSS. Overall, 88.9% of women of reproductive age reported good, very good, or excellent general health status and life satisfaction (BRFSS). A high school diploma or higher education 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 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). Although 43% of women reported that their most recent pregnancy was unintended and approximately 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. 24.7% of women were identified as being obese. Overall, 51.6% of women reported participation in recommended levels of physical activity per guidelines. NH-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%). Preconception health also varied by state, with southern states generally having the highest prevalence of preconception health problems and risky behaviors (31).

In a most recent study by Bixenstine et al., 2015 (9), to examine the relationship between folic acid preconception counselling and folic acid use and reason for non-use among women with recent live births analyzing Maryland PRAMS survey responses from 2009-2011 (n=4,226). Approximately 30% of women reported folic acid use the month before pregnancy with lowest rates among women of age less than 30, non-whites, unmarried, received WIC during pregnancy, had a stressful event before pregnancy, had an unplanned pregnancy, had previous live birth and smoked pre-pregnancy (P-value <0.05). Most common reasons for folic acid non-use were unintended pregnancy (61%) and the women didn't think they need to take folic acid (41%). Less than one third of the mothers reported daily folic acid use before pregnancy and only 27% of women reported folic acid pre-conception counselling, associated with three times the odds of folic acid use (OR=3.15, 95% CI=2.47,4.03) and half the odds of reporting didn't think they need to take folic acid before pregnancy (OR=0.47, 95% CI=0.28-0.78). The data support the initiatives to promote the provision of folic acid pre-conception counselling to all women of child bearing age (9).

Another study conducted by Khodr et al., 2014 (22) to identify the characteristics of women who do and do not take folic acid supplements during pregnancy from the control population of National Birth Defects Prevention Study (1997-2005). The mother of control infants were interviewed by phone, 6 weeks to 2 years after their estimated date of delivery. Women were asked about their dietary intake of supplements including folic acid and folic acid containing multivitamins from 3 months before conception through delivery. Women who reported taking folic acid supplements ≥5/week were considered to be compliant with the US Public Health Services recommendations regarding folic acid supplementation and were used as referent group, women who reported taking a folic acid supplement use ≤5/week were considered partially compliant and all other women were considered non-compliant. They found that race/ethnicity, education, age a delivery, nativity, employment, income, number of dependents, smoking, and birth control use were significantly associated with pre-conceptional folic acid supplement use. Based on the analysis, education, race/ethnicity and age were the most distinguishing factors between women with different pre-conceptional supplement patterns. These results demonstrate that efforts should be continued to increase folic acid supplementation among all women of reproductive age. However, the success of such efforts may be improved if maternal characteristics such as education, race/ethnicity and age, are considered in the development of future interventions (22).

Racial and ethnic disparity in pre-conception folic acid intake:

A report published by the CDC (32) in 2009 to update previously reported data and assess racial and ethnic differences. They analyzed birth certificate data for four periods during 1995-2005, pre-fortification (1995-1996), early post-fortification (1999-2000), mid post-fortification (2001-2002), and recent post-fortification (2003-2005). Birth during 1997-1998 were excluded because most conceptions during this period occurred before mandatory folic acid fortification. Race and Hispanic ethnicity of the mother are reported independently on birth certificates. Mothers who reported multiple race categories were assigned to one of the following four categories: NH-whites, NH-blacks, Hispanics, or all others. During the four comparison periods combined, infants with NH-white, NH-black, and Hispanic mothers accounted for 58.7%, 14.1%, and 21.0% of all births, respectively. An average of 767 cases of spina bifida were reported each year among all racial and ethnic populations. The prevalence of spina bifida during 2003--2005 was 2.00 per 10,000 live births among infants with NH- white mothers, 1.74 among infants with NH-black mothers, and 1.96 among infants with Hispanic mothers.

From the early post-fortification period to the most recent period of analysis, prevalence of spina bifida declined from 2.04% to 1.90% per 10,000 live births (PR: 0.93; 95% CI: 0.87,1.0). Prevalence fell from 2.17% to 1.74% per 10,000 live births (PR: 0.80; 95% CI: 0.67, 0.96) among infants with NH-black mothers, while prevalence among NH-whites and Hispanic mothers remained nearly constant (32).

.A study by Marchetta et al. (33) in 2014 using National Health and Nutrition Examination Survey (NHANES) survey data from 2001-2010, to assess differences in serum and red blood cell (RBC) folate concentrations between non-Hispanic white (NHW) women and Mexican Americans (MA) women and among MA women by acculturation factors. There were a total of 4985 NHW and MA pregnant women. The impact of folic acid supplement use on blood folate concentration was also examined. The study identified that MA women with lower acculturation factors had lower serum folate ($p < 0.05$) and RBC folate ($p<0.05$) concentrations compared with NHW women and to their more acculturated MA counterparts. Consuming a folic acid supplement can minimize these disparities, but MA women, especially lower acculturated MA women, were less likely to report using supplements ($P<0.05$). Public health efforts to increase blood folate concentrations among MA women should consider acculturation factors when identifying appropriate interventions (33).

A study done in 2013 by Hamner et al. (20) to assess whether fortification of corn masa flour with folic acid could selectively increase folic acid intake among Mexican-American (MA) with lower acculturation in U.S. Using dietary intake and dietary supplement data from the National Health and Nutrition Examination Survey 2001-2008, to estimate the amount of additional total folic acid that could be consumed if products considered to contain corn masa flour were fortified at 140mg of folic acid per 100 g of corn masa flour. The analysis showed that MA women who reported speaking Spanish had a relative percentage change in usual daily folic acid intake of 30.5% (95% CI: 27.8, 33.4) compared with 8.3% (95% CI 7.3-9.4) for MA women who reported speaking English. An increase of 6% points in the number of MA women who would achieve the recommended intake of ≥400 μg of folic acid /day occurred with fortification of corn masa flour, compared with the increase of 1.1% points for NH-whites and 1.3% points for NH-blacks. An even greater percentage point increase was observes among MA women who reported speaking Spanish. These results demonstrate that fortification of corn masa flour could selectively increase total folic acid intake among MA women, especially targeting MA with lower acculturation, and result in a decrease in the number of pregnancies affected by NTDs (20).

A community based feasibility study done by deRosset et al. (34) in 2014 to assess the utility of the *promotora de salud* model to promote consumption of supplement folic acid for the prevention of NTDs among Spanish-speaking Hispanic women in Wake and Johnston counties of North Carolina . During 2003-2007, the combined prevalence of anencephaly and spina bifida for Hispanics in Wake and Johnston counties was 12.2 per 10,000 live births. The study consisted of an educational intervention given by a *promotora*, also known as community health workers. Data collection was done at baseline and four months post-intervention to measure changes in knowledge and behavior. They found the results that self-reported daily multivitamin consumption increased from 24% at baseline to 71% four months post-intervention. During the same time frame, awareness of folic acid increased from 78% to 98% and knowledge of the role of folic acid in prevention of birth defects increased from 82% to 92%. Results indicated that the *promotora de salud* model may be effective in reaching a subpopulation of women with the folic acid message (34).

Conclusion:

Our literature review points to the importance of folic acid in prevention of spina bifida and anencephaly. Women of child-bearing age should receive adequate folic acid prior to their pregnancy. Current mandatory folic acid fortification efforts have gaps and efforts to increase folic acid consumption in women of all race and ethnicities should be researched and implemented.

CHAPTER 3: METHODS

Data Source:

We analyzed data from the 2009-2011 Pregnancy Risk Assessment Monitoring Survey in Georgia (GA-PRAMS). PRAMS was initiated in 1987, and is a surveillance project monitored by the Centers of Disease Control and Prevention (CDC) and selected state health departments (See appendix for the list of 41 participating PRAMS states). PRAMS collects state-specific, population-based data on maternal attitudes and experiences before, during, and shortly after pregnancy. PRAMS surveillance currently covers about 78% of all U.S. live births. Georgia has been a part of PRAMS since January, 1993.

The sampling strategy in PRAMS considers all women who had a live birth recently. Thus, findings from PRAMS can be applied to the state's entire population of women who have recently delivered a live-born infant. Additionally, data which are not available from other sources about pregnancy and first few months after birth are available in PRAMS. Standard methodology of PRAMS allows cross-state comparison among participating states.

PRAMS survey methodology combines two modes of data collection: 1) a mailed survey with multiple follow up attempts; and 2) a telephone survey. Selected women are first contacted by mail and if there is no response to repeated mailings, women are contacted and interviewed by telephone. The sequence of contacts for PRAMS surveillance is as follows:

Pre-letter. This letter introduces PRAMS to the mother and informs her that a questionnaire will soon arrive.

- **Initial Mail Questionnaire Packet**. This packet is sent to all sampled mothers 3 to 7 days after the pre-letter.
- **Tickler.** The tickler serves as a thank you and a reminder note. It is sent 7 to 10 days after the initial mail packet.
- **Second Mail Questionnaire Packet.** This packet is sent to all sampled mothers who have not yet responded 7 to 14 days after the tickler has been sent.
- **Third Mail Questionnaire Packet.** This third packet is sent to all remaining non-respondents 7 to 14 days after the second questionnaire.
- **Telephone Follow-up.** Telephone follow-up is initiated for all mail non-respondents 7 to 14 days after mailing the last questionnaire.

Details regarding the PRAMS design and methods has been previously published and also available at www.cdc.gov/PRAMS/index.htm.

Study Population:

We conducted a secondary data analysis using Phase 6 GA-PRAMS, 2009-2011. Eligible women were aged 18-45 years at the time they completed the survey. Women with missing information on preconception folic acid intake and/or race and ethnicity were excluded from our analysis.

Dependent variable – Preconception Folic Acid Use:

Preconception folic acid use was assessed using the response to the question: “During the month before you got pregnant with your new baby, how many times a week did you take a multivitamin, a prenatal vitamin, or a folic acid vitamin?” The original responses to this questions were ‘no use’, ‘1-3 times per week’, ‘4-6 times per week’, ‘every day of the week’. For our analysis, we re-categorized the responses to preconception folic acid by combining ‘no use’ and ‘1-3 times per week’ as ‘No - preconception folic acid use’; and pooling ‘4-6 times per week’ and ‘everyday per week’ as ‘Yes – preconception folic acid use’. The rationale behind considering ‘no use’ and ‘3 times weekly’ as ‘No – preconception folic acid use’ was the understanding that women who take folic acid supplements less than 3 times a week are not adequately benefitting from folic acid.

<u>Independent variable – Race and ethnicity:</u>

For our analysis, primary independent variable was maternal race and ethnicity. We examined 4 categories: 1) White Non-Hispanic 2) Black Non-Hispanic 3) Hispanic 4) Others. Specifically, ‘Others” comprised of Asian, American Indian, Chinese, Japanese, Filipino, and mixed race.

<u>Co-variables:</u>

We examined following co-variables in our analysis: 1) maternal demographic variables: age in years (18-24, 25-34, 35-45), and marital status (married, other); 2) maternal socio-economic variables: insurance status before pregnancy (No, Public, Private or Other), receipt of Women’s Infants and Children (WIC) benefits during pregnancy (no, yes), annual income level in US dollars (<20,000, 20,000-34,999, >35,000), and educational attainment (less than 12 grade, 12 grade, some college, college degree or more); 3) pregnancy/obstetric variables: previous live birth (no, yes), parity (0, 1, 2 plus), pregnancy intention (sooner/then, later, never), and knowledge that folic acid prevents birth defects (no, yes); 4) maternal co-morbidities: active smoking three months prior to pregnancy (no, yes), alcohol use 3 months before pregnancy (no, yes), body mass index (kg/m^2) (<18.5, 18.5-24.9, 25.0-29.9, >30); 5) lifestyle variables: pre-pregnancy dieting (no, yes), pre-pregnancy exercise (no, yes), language (English, Spanish), and residence (urban, rural). Co-variables were selected based on literature review of published studies.

We also examined descriptive variables available in GA-PRAMS including source of knowledge of folic acid use (magazine or newspaper, radio or television, healthcare provider, book, friends/family) and promoters of folic acid use (did not eat right, prevents heart disease, good for health, healthy baby, friends/family idea, doctor or nurse recommends).

<u>Statistical analysis:</u>

Accounting for the complex survey sampling of GA-PRAMS, we compared demographic, socio-economic, pregnancy/obstetric, co-morbidities, and lifestyle factors between women with and without preconception folic acid intake using Rao-Scott chi square test. Significance was set at *alpha* of 0.05. Frequencies and weighted percentages were tabulated.

We examined weighted percents and standard errors of different sources of knowledge of folic acid use, and promoters of folic acid use, stratified by race and ethnicity (White Non-Hispanic, Black Non-Hispanic, and Hispanic)

We examined the association between maternal preconception folic acid use and maternal race and ethnicity using logistic regression (PROC SURVEYLOGISTIC). We computed weighted unadjusted prevalence odds ratios (ORs) and 95% confidence intervals. Adjusted analyses were conducted to estimate weighted ORs and 95% confidence intervals, adjusting for maternal age, previous knowledge that folic acid prevents birth defects, pregnancy intention, body mass index, residency, preconception smoking and exercise, and parity. Reduced models were built using multiple approaches: 1) backward selection procedure, dropping co-variables that were least significant ($P >$ 0.05); 2) all possible subsets approach using all possible subsets of confounding variables from the full model; and 3) *a priori* model where co-variables were selected based on knowledge from previous literature. For all possible subset approach, models were run with all possible subsets of confounding variables from our full model. Estimated ORs were compared to full model. Candidate models were selected with ORs within 10% of our full model and then precision was checked for those selected candidate models. Precision was checked by dividing upper confidence limit with lower confidence limit. Best model was selected that provides the most meaningful gain in precision among all candidate models. Multi-collinearity was examined and was not a factor for any of the models.

All analyses was conducted accounting for the complex survey data design using SAS survey procedures on SAS version 9.3 (SAS Institute Inc., Cary, NC. The study was approved by Internal Review Boards of both Emory University and Georgia Department of Public Health.

CHAPTER 4: RESULTS

A total of 3584 women participated in GA-PRAMS during survey phase 6 (2009-2011). From this group, we excluded those that were not eligible for our study (n=218; 6.1%) and few others with incomplete responses on preconception folic acid use and/or race and ethnicity (n=89; 2.5%). The final analytic sample for our study included 3277 women, which is 91.4% of the original sample. To assess bias due to exclusions, we compared selected demographic factors between women who were excluded from our analysis due to missing information, and women who were a part of our final sample. We found no significant differences between the two groups, except for the participation in WIC (P value 0.05) and insurance status (P value 0.05), which achieved a borderline significance.

Of the 3277 women that were examined in our study, 871 (30.6%) reported adequate supplemental folic acid intake (4-7 pills per week) prior to pregnancy. Among women who reported preconception folic acid use, 505 (58.7%) were non-Hispanic whites, 236 (21.6%) were non-Hispanic blacks, 75 (12.7%) were Hispanic, and 55 (7%) were from other race. We noted a significant difference in the racial and ethnic characteristics among women with and without preconception folic acid use in our study ($P < 0.05$) **(Table 1).** In our unadjusted analysis, the odds of not taking preconception folic acid was highest for non-Hispanic blacks (OR: 2.44, 95% CI: 1.81, 3.28) and Hispanics (OR: 2.08, 95% CI: 1.40, 3.09) compared to non-Hispanic whites **(Table 1)**. There were several demographic and socio-economic differences between women with and without preconception folic acid use. Preconception folic acid use was not prevalent among women who were younger (18-24 years), unmarried, education less than 12 grade, had unintended pregnancy, overweight/obese (BMI ≥ 25), smoke or used alcohol preconceptionally, with family income of less than 20,000, rural residency, had two or more previous live births, spoke Spanish, received WIC during pregnancy, and had no insurance or had public health insurance. All these factors were significantly different between women with and without preconception folic acid use (*P*-values < 0.05) **(Table 1).**

The racial and ethnic differences in knowledge and promoters of preconception folic acid use are summarized from our descriptive analysis (**Table 2)**. We noted that among women who reported taking preconception folic acid, the sources of knowledge including magazines or newspapers, books, friends and family differed significantly by race and ethnicity (P < 0.05). For promoters of preconception folic acid use, significant racial and ethnic differences were seen based on a woman's perception that she did not eat right (p-value: 0.005), folic acid prevents heart disease (p-value: 0.001), folic acid was good for health (p-value: 0.01), and taking preconception folic acid was an idea promoted by their friends and family (p-value: 0.02) (**Table 2**).

Results from the multivariate logistic regression model are summarized in **Table 3**. We found that race and ethnicity was significantly associated with preconception folic acid intake after controlling for several potential confounders. In our full model, the odds of not taking folic acid before pregnancy were significantly increased for both Hispanics (aOR=2.05; 95% CI: 1.21-3.48) and African Americans (aOR=1.73; 95% CI, 1.21-2.48) compared to non-Hispanic whites, after controlling for previous knowledge that folic acid prevents birth defects, maternal age, pregnancy intention, BMI, pre-pregnancy smoking and exercise, maternal residence, and parity **(Table 3).** We found similar results in our reduced model, using backward elimination, where the odds of not taking preconception folic acid were increased for Hispanics (aOR=2.15; 95% CI: 1.35-3.40), and non-Hispanics blacks (aOR=1.66; 95% CI: 1.18-2.32) in relation to non-Hispanics whites, controlling for knowledge that folic acid prevents birth defects, maternal age, pregnancy intention, pre-pregnancy smoking and exercise, and parity **(Table 3).** An alternate reduced model obtained by all possible subset approach also showed similar results as the reduced model using backward elimination procedure **(Table 3).** Additionally, findings from our a-priori model were consistent with the findings from other aforementioned regression models, further confirming the association between race and ethnicity and use of preconception folic acid among women of reproductive age in Georgia **(Table 3).**

CHAPTER 5: DISCUSSION

Based on our data from a population-based survey in Georgia, we identified the prevalence and racial/ethnic disparity in preconception folic acid use among women of reproductive age. We found that maternal race-ethnicity was significantly associated with preconception folic acid use among women of reproductive age. To our knowledge, our study is the first study to examine the association between maternal race/ethnicity and preconception folic acid intake in Georgia. Only 30% of women of reproductive age reported adequate supplemental folic acid preconceptionally (4-7 pills/week) in our study. Specifically, 38.7% non-Hispanic whites, 21% non-Hispanic blacks, and 23.5% Hispanics reported taking folic acid prior to conception.

Our results are consistent with the findings from other studies reporting that approximately two-thirds of the U.S women of reproductive age continue to report not taking folic acid recommended by Institute of Medicine (27). Taking a daily folic acid supplement the month before pregnancy was reported by approximately 30% of women in reproductive age using Maryland PRAMS survey response from 2009-2011 (9). Moreover, the proportion of the women who daily consumed folic acid (≥ 400 micro gram/day) varied significantly by race-ethnicity, ranging from 19.1% in non-Hispanic black to 21.0% in Hispanic women to 40.5% in non-Hispanic white women (27, 31), consistent with our study showing similar prevalence of preconception folic acid use in other states and nationally. Proportion of women aged 15-44 years who consume ≥ 400 micro gram/day folate has increased since fortification, but has not yet reached the FDA's 50% target and varies by race-ethnicity. More non-Hispanic whites took supplements containing folic acid than did non-Hispanics blacks and Hispanics. Non-Hispanic black and Hispanic women still lagged behind non-Hispanic white in total consumption and may be target populations for additional fortification or supplementation policies (35).

Our results suggest that number of maternal characters were associated preconception folic acid use, with lower use among women who were younger (3, 9, 22), education less than 12 grade (3, 22, 29), had a previous live birth (9, 31), smoking and drinking pre-pregnancy (9, 22, 36), unintended pregnancies (36, 37), unmarried (22, 37), received WIC during pregnancy (9), low income level (3, 22), and had public insurance or no insurance (36), also consistent with previous studies. Previous knowledge that folic acid can prevent birth defects when taken preconception was associated with increased use of it (3). Our results indicated that despite the fact that some women learn about benefits of preconception folic acid use from their health care provider, they are not following their advice even though they might feel the recommendation is important (3). Findings from this study can be used to develop public health programs to increase the number of women of child-bearing age consuming preconception folic acid daily. Demographic, social, cultural, and environmental factors impact behavior and more attention must be given be given to them.

The primary strength of our study is that the PRAMS surveillance system is the standardized data collection methodology. This standardized approach allows for comparisons among states and for optimal use of the data for single-state or multistate analysis. Another strength of our study is large sample size and its high representativeness to its target population. Also, PRAMS were collected over a period of 3 years, and then weighted to represent the state population and account for non-response and non-coverage provides additional strength to our study. Last but not the least, PRAMS data provide wealth of information on various risk factors, various confounders and effect modifiers.

Despite high quality of our data, results of this study should be viewed in light of some limitations. This analysis uses data from a single state, and our results may not be generalizable to other states or regions of the U.S. PRAMS data are self- reported and therefore subject to reporting or recall bias which could lead to inaccurate estimates. However, PRAMS interviews are conducted very close to the index pregnancy and might not affect recall significantly. Using PRAMS data, we can only measure pre-conceptional supplement use, but cannot necessarily infer anything about overall pre-conceptional folic acid intake which also include folic acid intake through diet. Positive maternal behaviors such as preconception folic acid use and exercise before pregnancy are likely to be over-reported and negative behaviors such as smoking and alcohol are likely to be underreported. PRAMS only surveys women who delivered live births, it does not represent data for women who had miscarriages or still births, which are women who might have poorer preconception health (31).

Public Health Implications:

Our analyses showed that preconception educational programs that promote supplemental folic acid intake are failing in Georgia. Hispanic women are least likely to take recommended folic acid prior to conception, the stopgap intervention to address the supplement use is grain fortification. But because Hispanic women are more likely to use corn masa than cereal grains, they may be missing out on this public health intervention, which places Hispanic women at a disproportionately higher risk for neural tube defects compared to their counterparts whose staple wheat-based diets are enriched with folic acid. Because we see higher prevalence of NTDs among Hispanics, it is critical that public health efforts focus on increasing total folic acid intake among Mexican American women, emphasizing those with lower acculturation factors, especially those who report speaking Spanish only, or Spanish and English equally, all or most of the time.

The U.S. Food and Drug Administration has recently approved voluntary fortification of corn masa, where manufactures can voluntarily add up to 0.7 milligrams of folic acid per pound of corn masa flour, consistent with the levels of others enriched cereal grains. Corn masa is a staple of Hispanic populations who have a high prevalence of neural tube defects. Hispanic women also have a lower prevalence of preconception folic acid supplement use as has been consistently shown in several studies, including ours. While voluntary fortification of corn masa flour can be a beneficial intervention for Hispanic populations, it may not be as wide-reaching and efficient as a mandatory policy. Until we know that all women of reproductive age are equitably receiving the benefits of folic acid fortification, pre-conception folic acid supplement use remains as an important recommendation to prevent neural tube defects among vulnerable populations. Additionally, public health messages should aim at educating people, especially Hispanic women, to purchase fortified corn masa, and a push to implement mandatory fortification of the same.

Conclusion:

We analyzed PRAMS data in Georgia and found that only 12.7 percent of Hispanic women in Georgia are following the U.S. Public Health Service recommendation that all women capable of becoming pregnant consume 400 mcg of folic acid daily to prevent spina bifida and anencephaly in their offspring. Also only 58.7

percent of non-Hispanic white and 21.6 percent of African Americans are also consuming folic acid supplements 4 or more days a week before pregnancy. Thus, Hispanic women in Georgia are at especially high risk for having babies with folic acid preventable spina bifida and anencephaly because such a low proportion of them are regularly consuming folic acid supplements and because the foods they commonly eat (e.g., corn masa) are not fortified.

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Table 1. Pre-conception folic acid use and selected maternal characteristics, Georgia PRAMS, 2009-2011.

Maternal Characteristics	Total (N=3277) n (%)	Pre-conception Folic Acid Use: No (0-3 times/wk) (n=2406) n (%)	Yes (4-7 times/wk) (n=871) n (%)	Crude OR (95% CI)	P-value
Preconception folic acid use					
None	2169 (61.3)	--	--	--	--
1-3 times/wk.	237 (8.1)	--	--	--	
4-6 times/wk.	107 (4.1)	--	--	--	
Every day/wk.	764 (26.5)	--	--	--	
Race/Ethnicity					<0.0001
White, Non-Hispanic	1428 (46.3)	923 (40.8)	505 (58.7)	Reference	
Black, Non-Hispanic	1344 (31.5)	1108 (35.8)	236 (21.6)	**2.44 (1.81, 3.28)**	
Hispanic	350 (16.5)	275 (18.2)	75 (12.7)	**2.08 (1.40, 3.09)**	
Other	155 (5.7)	100 (5.2)	55 (7.0)	1.10 (0.66, 1.83)	
Knowledge FA prevents birth defects					<0.0001
Yes	2182 (73.2)	1464 (67.8)	718 (85.4)	Reference	
No	1010 (26.8)	870 (32.2)	140 (14.6)	**2.78 (2.01, 3.85)**	
Age (years)					<0.0001
18-24	1368 (35.7)	1177 (43.2)	191 (18.5)	**2.92 (2.15, 3.95)**	
25-34	1523 (51.9)	1020 (48.3)	503 (60.2)	Reference	
35-45	386 (12.4)	209 (8.5)	177 (21.3)	**0.50 (0.35, 0.70)**	
Marital status					<0.0001
Married	1578 (53.5)	954 (44.2)	624 (74.8)	Reference	
Other	1697 (46.5)	1450 (55.8)	247 (25.2)	**3.75 (2.84, 4.95)**	
Education					<0.0001
Less than 12 grade	574 (18.0)	486 (21.7)	88 (9.4)	**1.61 (1.02, 2.54)**	
12 grade	1069 (32.3)	868 (35.6)	201 (24.6)	Reference	
Some college	836 (23.8)	652 (25.5)	184 (19.7)	0.90 (0.63, 1.29)	
College degree or more	696 (25.9)	335 (17.2)	361 (46.3)	**0.26 (0.19, 0.36)**	
Pregnancy Intention					<0.0001
Sooner/Then	1444 (48.2)	840 (37.7)	604 (72.4)	Reference	
Later	1312 (39.3)	1111 (46.8)	201 (22.1)	**4.09 (3.06, 5.44)**	
Never	482 (12.5)	429 (15.5)	53 (5.5)	**5.35 (3.24, 8.84)**	
Body Mass Index (kg/m^2)					0.0357
Underweight (<18.5)	128 (3.3)	98 (3.8)	30 (2.3)	1.93 (0.89, 4.19)	
Normal (18.5-24.9)	1432 (46.7)	1009 (43.9)	423 (52.9)	Referent	
Overweight (25.0-29.9)	789 (27.3)	595 (28.5)	194 (24.6)	**1.39 (1.03, 1.89)**	
Obese (≥ 30)	718 (22.7)	549 (23.8)	169 (20.2)	**1.43 (1.03, 1.98)**	
Smoking (3 months pre-pregnancy)					<0.0001
No	2658 (81.6)	1900 (78.2)	758 (89.4)	Referent	
Yes	607 (18.4)	499 (21.8)	108 (10.6)	**2.36 (1.64, 3.41)**	
Pre-pregnancy exercise (3+ days/wk)					<0.0001
Yes	1087 (35.9)	672 (30.6)	415 (47.9)	Referent	
No	2177 (64.1)	1723 (69.4)	454 (52.1)	**2.09 (1.63, 2.67)**	
Alcohol-3 months before pregnancy					<0.0001
No	2137 (60.5)	1646 (64.5)	491 (51.3)	Referent	
Yes	1118 (39.5)	744 (35.5)	374 (48.7)	**1.73 (1.35, 2.21)**	
Family Income (US dollars)					<0.0001
<20,000	1406 (45.1)	1189 (56.5)	217 (21.9)	**1.86 (1.22, 2.84)**	
20,000-34,999	469 (16.5)	361 (18.1)	108 (13.1)	Referent	
>35,000	941 (38.4)	456 (25.4)	485 (65.0)	**0.28 (0.19, 0.42)**	

Maternal Characteristics (Continued)

	Total (N=3277) n (%)	Pre-conception folic acid use: No (0-3 times/wk) (n=2406) n (%)	Yes (4-7 times/wk) (n=871) n (%)	Crude OR (95% CI)	P-value
Residence					0.0083
Urban	2133 (74.3)	1487 (72.1)	646 (79.3)	Referent	
Rural	1144 (25.7)	919 (27.9)	225 (20.7)	**1.48 (1.11, 2.01)**	
Previous live births					0.0023
No	1459 (41.2)	994 (38.4)	465 (47.7)	Referent	
Yes	1783 (58.8)	1390 (61.6)	393 (52.3)	**1.46 (1.15, 1.87)**	
Parity					0.0208
0	1404 (40.4)	978 (38.2)	426 (45.6)	Referent	
1	910 (30.2)	667 (30.2)	243 (30.0)	1.20 (0.90, 1.60)	
2 plus	906 (29.4)	726 (31.6)	180 (24.4)	**1.55 (1.14, 2.11)**	
Language					0.0195
English	3055 (89.7)	2228 (88.2)	827 (93.1)	Referent	
Spanish	222 (10.3)	178 (11.8)	44 (6.9)	**1.79 (1.10, 2.93)**	
WIC enrollment					<0.0001
No	1269 (43.9)	699 (31.8)	570 (71.7)	Referent	
Yes	1979 (56.1)	1691 (68.2)	288 (28.3)	**5.44 (4.15, 7.12)**	
Maternal Health Insurance					<0.0001
No	1119 (34.5)	957 (41.3)	162 (19.3)	**4.01 (2.94, 5.47)**	
Public	709 (17.8)	581 (21.2)	128 (10.5)	**3.80 (2.60, 5.57)**	
Other	1382 (47.7)	810 (37.5)	572 (70.2)	Referent	

CI, confidence interval; Kg, Kilograms; m, Meter; n, number; PRAMS, Pregnancy Risk Assessment Monitoring Survey; WIC, Women, Infants and Children.
Other race/ethnicity includes Asian, American Indian, Chinese, Japanese, Filipino, Other race and mixed race.
Reported numbers represent un-weighted data, percentages represent weighted data.
Frequency may not equal to total count due to missing data.
Statistical significance is defined at p-value<0.05 (Rao-Scott Chi Square test).
Reported odds ratio and confidence intervals are weighted.

Table 2. Descriptive characteristics of knowledge and factors related to pre-conception folic acid use among women with and without pre-conception folic acid intake, by race/ethnicity, Georgia PRAMS 2009-2011.

	Folic acid use one month before pregnancy							
	No (0-3 times/wk) Race/Ethnicity				Yes (4-7 times/wk) Race/Ethnicity			
	White, NH (N = 923) % (SE)	Black, NH (N =1108) % (SE)	Hispanic (N =275) % (SE)	P-value	White, NH (N = 505) % (SE)	Black, NH (N = 236) % (SE)	Hispanic (N = 75) % (SE)	P-value
Source of Knowledge								
Magazine/News paper				0.8255				**0.0279**
No	45.8 (2.8)	35.0 (2.7)	19.2 (2.3)		59.1 (4.1)	26.2 (3.7)	14.7 (3.2)	
Yes	46.7 (3.5)	32.5 (3.3)	20.8 (2.9)		71.6 (3.6)	13.8 (2.7)	14.6 (3.0)	
Radio/television				**<0.0001**				0.1097
No	47.0 (2.5)	37.3 (2.4)	15.7 (1.9)		65.2 (3.2)	22.0 (2.7)	12.8 (2.4)	
Yes	43.0 (4.6)	22.4 (3.9)	34.6 (4.6)		67.2 (5.4)	12.8 (3.5)	20.0 (4.9)	
Healthcare provider				0.3720				0.0781
No	40.2 (5.9)	41.7 (6.0)	18.1 (4.9)		54.0 (8.2)	19.2 (6.3)	26.8 (7.7)	
Yes	47.0 (2.3)	32.9 (2.2)	20.1 (2.0)		67.4 (2.9)	19.8 (2.4)	12.8 (2.2)	
Book				0.2516				**0.0001**
No	43.7 (2.7)	36.5 (2.6)	19.8 (2.3)		52.6 (4.3)	28.5 (3.9)	18.9 (3.6)	
Yes	50.6 (3.7)	29.5 (3.4)	19.9 (3.1)		76.3 (3.4)	12.5 (2.5)	11.2 (2.6)	
Family/Friends				0.0709				**<0.0001**
No	43.8 (2.7)	37.6 (2.6)	18.6 (2.2)		63.1 (3.8)	28.6 (3.6)	8.3 (2.3)	
Yes	50.5 (3.7)	27.4 (3.3)	22.1 (3.1)		68.6 (3.9)	9.6 (2.4)	21.8 (3.7)	
Factors promoting use								
Did not eat right				**0.0487**				**0.0059**
No	47.6 (2.6)	36.4 (2.5)	16.1 (2.1)		70.4 (3.2)	18.9 (2.7)	10.7 (2.3)	
Yes	39.5 (2.3)	39.0 (2.3)	21.5 (2.0)		53.1 (4.1)	29.2 (3.7)	17.6 (3.3)	
Prevents heart disease				0.0726				**0.0095**
No	46.9 (2.4)	34.9 (2.3)	18.2 (2.0)		69.0 (3.1)	18.6 (2.5)	12.4 (2.3)	
Yes	38.7 (2.5)	41.1 (2.5)	20.2 (2.1)		52.7 (4.4)	31.5 (4.1)	15.8 (3.5)	
Good for health				0.9627				**0.0114**
No	42.3 (3.2)	38.4 (3.1)	19.3 (2.7)		53.3 (5.5)	23.1 (4.6)	23.6 (4.9)	
Yes	43.4 (2.1)	37.5 (2.0)	19.1 (1.7)		66.2 (2.9)	23.3 (2.5)	10.5 (2.0)	
Healthy baby				0.3593				0.1034
No	43.9 (4.1)	33.4 (3.8)	22.6 (3.6)		52.6 (8.2)	22.4 (6.4)	25.0 (7.6)	
Yes	42.8 (1.9)	38.8 (1.9)	18.3 (1.6)		64.3 (2.7)	23.3 (2.3)	12.3 (1.9)	
Friends/family idea				0.2387				**0.0200**
No	46.1 (2.6)	35.0 (2.4)	18.9 (2.1)		70.0 (3.3)	19.3 (2.8)	10.7 (2.4)	
Yes	40.3 (2.4)	40.3 (2.5)	19.4 (2.0)		55.1 (3.9)	27.8 (3.5)	17.1 (3.1)	
Doctor/nurse idea				0.5108				0.3180
No	41.6 (3.6)	36.3 (3.4)	22.1 (3.2)		58.3 (5.5)	22.9 (4.6)	18.8 94.7)	
Yes	43.5 (2.0)	38.2 (1.9)	18.2 (1.6)		64.5 (2.9)	23.3 (2.6)	12.1 (2.1)	

N, number; NH, Non-Hispanic; PRAMS, Pregnancy Risk Assessment Monitoring Survey; SE, Standard error.
Reported percentages are weighted.
N for individual characteristics may not equal to total count because of some missing data
Statistical significance is defined at p-value<0.05 (Rao-Scott Chi Square test).

Table 3: Adjusted logistic regression analysis examining the association of preconception folic acid intake (0-3 times/wk vs. 4-7 times/wk) and selected maternal characteristics, GA-PRAMS 2009-2011

Maternal Characteristics	Model 1 (Full model)	Model 2 (Reduced model) (Backward Selection)	Model 3 (Reduced model) (All possible subset approach)	Model 4 (Reduced model) (*A-priori* model)
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95%CI)
Race/Ethnicity				
White, Non-Hispanic	Referent	Referent	Referent	Referent
Black, Non-Hispanic	**1.73 (1.21, 2.48)**	**1.66 (1.18, 2.32)**	**1.71 (1.23, 2.39)**	**1.71 (1.22, 2.39)**
Hispanic	**2.05 (1.21, 3.48)**	**2.15 (1.35, 3.40)**	**2.19 (1.39, 3.44)**	**1.89 (1.20, 2.99)**
Others	1.49 (0.77, 2.89)	1.49 (0.80, 2.81)	1.43 (0.78, 2.65)	1.43 (0.77, 2.68)
Knowledge folic acid prevents birth defects				
Yes	Referent	Referent	-	-
No	1.53 (1.03, 2.27)	1.52 (1.04, 2.20)	-	-
Age (years)				
18-24	2.08 (1.43, 3.03)	2.20 (1.53, 3.13)	2.29 (1.61, 3.26)	2.66 (1.87, 3.77)
25-34	Referent	Referent	Referent	Referent
35-45	0.77 (0.51, 1.18)	0.69 (0.45, 1.03)	0.63 (0.42, 0.94)	0.60 (0.41, 0.90)
Pregnancy intention				
Sooner/Then	Referent	Referent	Referent	Referent
Later	3.08 (2.19, 4.47)	3.04 (2.19, 4.21)	3.04 (2.18, 4.15)	2.95 (2.14, 4.05)
Never	3.20 (1.87, 5.50)	3.26 (1.92, 5.54)	3.66 (2.17, 6.19)	3.63 (2.17, 6.07)
BMI (kg/m^2)				
Underweight (<18.5)	1.85 (0.77, 4.47)	-	-	-
Normal (18.5-24.9)	Referent	-	-	-
Overweight(25.0-29.9)	1.22 (0.86, 1.72)	-	-	-
Obese (≥30)	1.21 (0.83, 1.77)	-	-	-
Smoking 2 months before pregnancy				
No	Referent	Referent	Referent	-
Yes	2.26 (1.47, 3.45)	2.29 (1.51, 3.48)	2.27 (1.51, 3.43)	-
Pre-pregnancy exercise (3+days/wk)				
Yes	Referent	Referent	Referent	-
No	1.72 (1.28, 2.31)	1.69 (1.27, 2.26)	1.72 (1.29, 2.27)	-
Residence				
Urban	Referent	-	-	Referent
Rural	1.26 (0.86, 1.79)	-		1.34 (0.96, 1.88)
Parity				
0	Referent	Referent	Referent	Referent
1	1.67 (1.18, 2.36)	1.64 (1.17, 2.29)	1.62 (1.17, 2.26)	1.61 (1.16, 2.24)
≥2	1.47 (0.99, 2.18)	1.54 (1.06, 2.23)	1.57 (1.08, 2.28)	1.71 (1.18, 2.47)

CI, confidence interval; aOR, Adjusted Odds ratio; PRAMS, Pregnancy Risk Assessment Monitoring Survey.
Other race/ethnicity includes Asian, American Indian, Chinese, Japanese, Filipino, Other race and mixed race.
Reported adjusted odds ratio and confidence intervals are weighted
Each variable is adjusted for all other variables presented in in each model.

APPENDIX A

List of participating PRAMS states in the US:

1) Alabama
2) Alaska
3) Arkansas
4) Colorado
5) Connecticut
6) Delaware
7) Florida
8) Georgia
9) Hawaii
10) Illinois
11) Iowa
12) Louisiana
13) Maine
14) Maryland
15) Massachusetts
16) Michigan
17) Minnesota
18) Mississippi
19) Missouri
20) Nebraska
21) New Hampshire
22) New Jersey
23) New Mexico
24) New York
25) New York City
26) North Carolina
27) Ohio
28) Oklahoma
29) Oregon
30) Pennsylvania
31) Rhode Island
32) South Carolina
33) Tennessee
34) Texas
35) Utah
36) Vermont
37) Virginia
38) Washington
39) West Virginia
40) Wisconsin
41) Wyoming