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FINAL PROJECT PROGRESS REPORT

Project title: Translation of Preconception Care Guidelines into Practice and Behavior During Pregnancy

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I. Introduction

A. Nature of the research problem

To date, emphasis on prenatal care has not resulted in national improvements in pregnancy outcomes (i.e., low birthweight and premature birth),[1] leading to the realization that care during pregnancy, even in early pregnancy, may be too late for primary prevention.[2] Preconception care (PCC) is a form of primary prevention for promoting health, assessing risk, and intervening to modify risk factors that may improve maternal and infant outcomes.[1] While the need to optimize prepregnancy health to improve pregnancy outcomes has gained recognition in recent years, corresponding increases in the provision of PCC and its association with favorable behavior change has not been evaluated.

B. Purpose, scope, and methods of the investigation

Given that much of the data on provision of PCC services precede the 2006 recommendations from the Centers for Disease Control and Prevention (CDC) and other agencies to improve health and health care for women before and between pregnancies,[1] there is a *critical need* to evaluate changes in the proportion of women receiving PCC, to determine if that care is reaching women at high risk of adverse outcomes, and to examine if provision of PCC produces positive behaviors. Such knowledge will estimate the degree to which PCC improves and optimizes health behaviors, resulting in healthier mothers and babies. We used data from the Pregnancy Risk Assessment Monitoring System (PRAMS) to answer our research questions. PRAMS is a serial, cross-sectional survey standardized across states, including data about pregnancy and the first few months after birth. PRAMS specifically asks about receipt of PCC, making it uniquely suited to estimate the change in the proportion of women delivering a liveborn infant who received this care in 2004-2010, just before and after the 2006 CDC recommendations.[1] Before accurate assessment of the relationship between PCC and maternal and infant outcomes, it is necessary to establish a baseline of provision of services, who is/is not receiving those services, and how effective PCC translates into a specific behavior before and during pregnancy (Figure 1).

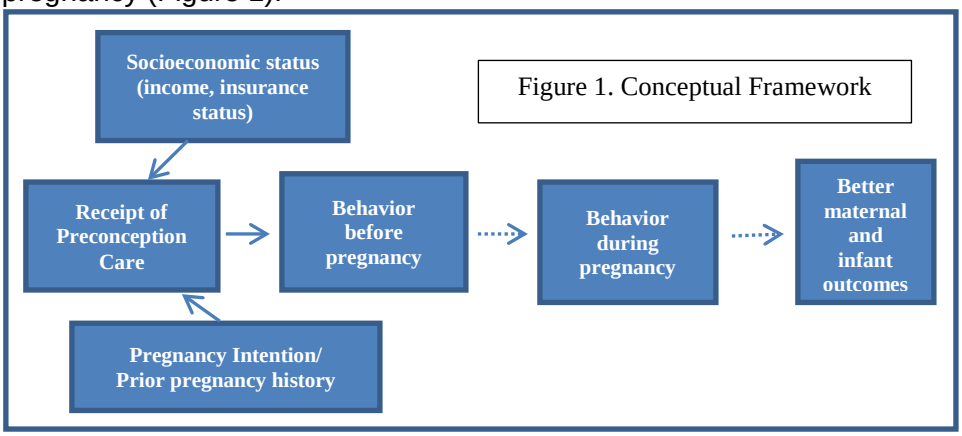

Figure 1. Conceptual Framework

C. Nature of the findings

Overall, only approximately one-third of women reported receipt of PCC, and this remained the same between 2004 (30.3%) and 2010 (32.6%) (p=0.08 for trend).[3] Women who were at increased risk for adverse birth outcomes and arguably need PCC the most do not appear to be receiving it at rates higher than the general population, with the exception of women with a prior history of preterm delivery.[3] On the contrary, women who typically experience healthier birth outcomes, such as those intending to become pregnant, were more likely to report receipt of PCC.[3]

The timing of when women receive preventive pregnancy health-related messages varied by message type, pregnancy intention, and maternal characteristics.[4] Specifically, mental health messages were received primarily prenatally only, compared with other messages which were primarily received both preconceptionally and prenatally.[4] The timing of receipt varies by pregnancy intention, such that women with unintended pregnancy report receiving messages both preconceptionally and prenatally more often than women intending pregnancy.[4] Finally, women who may be perceived to be at higher risk of adverse pregnancy outcomes and/or engaging in high risk behavior (minorities, lower education, lower income) appeared to be hearing messages early more often than other women.[4] Each of these main findings suggests messages are not reaching all women equally.[4]

Receipt of specific PCC messages had variable associations with maternal behavior before and during pregnancy.[5] Specific messages were associated with increased vitamin usage, but were also associated with

negative behaviors for smoking cessation among women who reported smoking in the 2 years preceding the survey.[5] Specific messages had no significant association with increasing dieting or exercising among women who were overweight or obese before pregnancy or decreasing alcohol consumption among women who reported drinking in the 2 years before the survey.[5]

Women with PDM reported PCC provision more often than women with NDM, followed by women with GDM.[6] However, women with GDM risk factors did not consistently have greater PCC provision: older women reported receiving PCC more often, but Hispanic and overweight women did not.[6] Conversely, in the adjusted analyses, Hispanic women were more likely to report receiving PCC than non-Hispanic White women. This may suggest that after accounting for several characteristics collectively, health care providers recognize the need to counsel Hispanic women.[6]

II. Review of the Literature

Preterm birth accounts for almost one-third of infant deaths, an increase of almost 30% since 1980,[7] making it the most frequent cause of infant mortality in the United States.[8] One reason for the lack of progress in reducing infant morbidity and mortality in the U.S. may be the continued emphasis on prenatal care, often initiated at week 11-12. Interventions initiated at the first prenatal care visit are too late for primary prevention considering many factors for adverse birth outcomes can be managed prior to conception.[2,9,10]

Women with greater belief in the adverse effects of risky behaviors (i.e. smoking and alcohol use) have been shown to be more likely to quit before pregnancy compared to women whose beliefs are not as strong,[11,12] indicating health education can play a role in motivating behavior change before conception.[13] Effective interventions take months to implement and therefore must begin before conception. However, the receipt and content of PCC is difficult to capture because many women transition from an internist or family practitioner to an obstetrician for most of their care during the periconceptional period, introducing an opportunity for poor care coordination and continuity.[14] Additionally, the effectiveness of a specific preconception message can only be measured by change in the specific behavior addressed in the message.

Recent emphasis on optimizing prepregnancy health has triggered the development of preconception clinical practice guidelines and recommendations by professional associations and expert groups.[2,9,15] In 2006, CDC in partnership with other national organizations, developed 10 recommendations for public health practitioners and clinicians to monitor and enhance preconception health and health care.[1] These recommendations were considered a turning point in PCC, generating increased interest in this area.[16] Combined with the clinical guidelines by American College of Obstetricians and Gynecologists and the American Academy of Pediatrics,[17] translation of these recommendations has yet to be evaluated despite a specific recommendation to integrate elements of PCC into every primary care visit with women of reproductive age.[1] Physician advice is a catalyst for behavioral change, including in the preconception period,[18] and is supported by providing targeted advice with supplemental education materials.[19] Yet, only one in six obstetricians/gynecologists and family physicians report providing PCC to women for whom they provided prenatal care.[20] Differences in the provision of messages provided before and during pregnancy is likely due to increased frequency of visits during pregnancy, however, PCC may be an equally critical component of women's wellness across the lifespan,[2] and physicians must take advantage of opportunities to provide positive health messages. While the evolution of PCC guidelines and standards have been well-documented,[2] corresponding documentation of changes in care has not followed.

Providing PCC to optimize health prior to pregnancy is particularly important both for women with prepregnancy diabetes (PDM; type 1 or type 2 diabetes) and women who develop gestational diabetes (GDM; first experienced and diagnosed during pregnancy that is not clearly prepregnancy diabetes[21]). Among women with PDM, proper blood glucose control prior to and during early pregnancy can mitigate the adverse health outcomes of diabetes during pregnancy, such as congenital anomalies and maternal and neonatal morbidity.[22-27] Among women at risk for GDM (i.e. women with higher prepregnancy body mass index (BMI), increased age, Hispanic ethnicity, or history of GDM in a prior pregnancy[28-31]), improving metabolic health through lifestyle changes prior to pregnancy can reduce risk of miscarriage and macrosomia.[32-34] Although there is consensus that PCC is important for these women,[35] previous studies examining provision of PCC among women with diabetes focused primarily on single clinics or communities and included only PDM, with prevalence ranging from 25-60%.[27,36-41] Using a larger, US population-based dataset, the study objectives were to determine provision of PCC among women with PDM or GDM and to examine the association between PCC receipt and diabetes status, adjusting for maternal characteristics.

III. Study Design and Methods

The research used multistate data from the PRAMS 2004-2010. In collaboration with CDC, PRAMS surveys are currently administered by 37 states and New York City, and one tribal-state partnership in South Dakota, and collectively, represent ~80% of all live births.[42,43] Each month, participating states select a stratified random sample of 100–300 women with recent liveborn deliveries from birth certificates. Self-administered questionnaires are mailed to a sample of mothers 2-3 months after delivery of a liveborn infant, and nonresponders are followed up with a telephone interview. Survey data are linked to selected birth certificate data and weighted for sample design, nonresponse, and noncoverage. All states use a standardized core questionnaire. Aim 1 used multistate data from 2004-2010, with data pooled by year. Aims 2 and 3 used multistate data from 2009-10, with data pooled overall. Two-tailed p-values of $\leq$ 0.05 for main effects and $\leq$ 0.10 for interaction were considered significant.

Aim 1: To estimate the change from 2004 to 2010 in the proportion of women delivering a liveborn infant who received preconception care. Trends in preconception care over seven years (2004-10) were modeled using multivariable logistic regression models, with time as the exposure included as an ordinal variable and the receipt of preconception care as the outcome and based on the survey question "*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?" We chose these years given the 2006 CDC recommendations. Models were built by including factors related to risk of poor pregnancy outcome, pregnancy-related behaviors[13] and pregnancy intention individually.

Aim #2: To compare the health messages received by women before pregnancy to those received during pregnancy and how these messages differ by important demographic characteristics such as age, race, and insurance status. Concordance of receipt was first assessed by comparing the proportion of women receiving each specific health message before and during pregnancy to factors related to poor pregnancy outcome and intention. Preliminary comparisons were made using χ^2-tests by each factor. Second, women were categorized into one of four groups: women who received messages before pregnancy only, during pregnancy only, both before and during pregnancy, and neither before or during pregnancy. These categories served as the outcome in a polytomous logistic regression to assess the association between when messages are received and factors related to poor pregnancy outcome and pregnancy intention. Separate models were constructed for each health message**.**

Aim #3: To evaluate the association between specific behaviors before and during pregnancy and receipt of specific preconception care messages. First, specific behaviors before and during pregnancy associated with receipt of specific preconception care messages were examined using separate multivariable or ordinal logistic regression, depending on the number of levels in the outcome. Behaviors were defined as follows: folic acid use in month before pregnancy (yes/no); healthy weight before pregnancy (yes/no); smoking in 3 months before/last 3 months of pregnancy (nonsmoker, light smoker, heavy smoker); alcohol consumption in 3 months before/last 3 months of pregnancy (nondrinker, light drinker, heavy drinker). Second, behavior during pregnancy will be examined by comparing women who did and did not receive specific preconception health messages, and corresponding behavior during pregnancy, as a proxy measure of pregnancy-related risk reduction.[44] Separate models will be run for each preconception health message, and each model will be built as outlined in Aim 2.

Aim #4: To determine the extent of provision of preconception care among women with prepregnancy diabetes or women who develop gestational diabetes compared with women without diabetes and to examine the association between preconception care receipt and diabetes status, adjusting for maternal characteristics. Weighted PCC rates by diabetes status were determined by combining data from all states and using weights calculated and provided by CDC. Multivariate logistic regression models were used to identify factors associated with self-reported receipt of PCC, with diabetes status as the primary exposure.

IV. Detailed Findings

Aim 1. **To estimate the change from 2004 to 2010 in the proportion of women delivering a liveborn infant who received preconception care.** We hypothesized that the proportion of women receiving such care increased between 2004 and 2010, particularly among women who are at increased risk of poor birth outcomes.

The sample consisted of 64,084 participants (Table 1). Receipt of PCC was reported more frequently by women who were/had: older, more educated, non-His- panic Asians, higher income, married, normal prepregnancy weight, low birthweight or preterm infant, prior preterm infant, no previous children, or intending to be pregnant. Report of PCC was less frequently reported by women who had their prenatal care paid for by Medicaid or were WIC participants.

Overall, only 30.8 percent of women reported receipt of PCC. PCC increased from 30.3 percent in 2004 to 32.6 percent in 2010 (Figure 2; test for trend [p = 0.08]). When year was modeled as an independent variable, fewer women reported receipt of PCC in 2008 compared to 2006 (OR 0.85 [CI 0.75–0.97]) after adjustment for maternal age, race/ethnicity, education, marital status, pregnancy intention, parity, preterm birth status, household income, and prepregnancy insurance status (Table 2). There were no other significant year to year associations.

Prevalences of reported PCC by all subgroups are shown in Table 1, with special emphasis on high risk subgroups. Many of these results were confirmed in regression analyses in Table 2. In general, women who were classified as high risk for adverse pregnancy out- comes were less likely to report PCC than their low risk counterparts. For example, women aged ≤ 19 years had a decreased odds of reporting PCC compared with women aged ≥ 35 years (23.5 vs 37.5%, p < 0.01 [Table 1]; OR 0.80 [CI 0.66–0.97] [Table 2]), as did women with a household income ≤ $19,999 compared with women with income of $50,000 or more (20.7 vs 45.2%, p < 0.01 [Table 1]; OR 0.63 [CI 0.56–0.71] [Table 2]), and women with no health insurance com- pared with women with government insurance (14.0 vs 28.0%, p < 0.01 [Table 1]; OR 0.33 [CI 0.29–0.38] [Table 2]). Although women with private/other insurance (37.2%) reported higher levels of PCC than women with government insurance (p < 0.01, Table 1), these women were less likely to report PCC in adjusted models (OR 0.71 [CI 0.63–0.82]). Furthermore, women with < 12 years of education reported less PCC compared with women with >12 years (23.5 vs 36.3%, p < 0.01 [Table 1]), but in adjusted models the direction of this association changed (OR 1.17 [CI 1.02–1.35] [Table 2]). A change in direction was also observed among non-Hispanic black women compared with non-Hispanic white women (28.6 vs 32.1%, p < 0.01 [Table 1]; OR 1.41 [CI 1.27–1.57] [Table 2]) and among non-Hispanic Asian women (35.8%, p < 0.01 [Table 1]; OR 0.85 [CI 0.76–0.95] [Table 2]). In analyses restricted to women with a previous live birth, women with a history of a preterm birth had an increased odds of reporting PCC than women without this history (32.5 vs 27.3%, p < 0.01 [Table 1]; OR 1.38 [CI 1.22–1.55]) (data not shown).

Other, non-high risk characteristics were also associated with PCC. Compared with married women, unmarried women had a decreased odds of reporting PCC (36.7 vs 20.6%, p < 0.01 [Table 1]; OR 0.68 [CI 0.62–0.75]). Women who intended to become pregnant had almost a three-fold increased odds of reporting PCC compared with women who did not intend to become pregnant (41.0 vs 16.8%, p < 0.01; OR 2.87 [CI 2.66–3.09]). Finally, women with no previous live births had increased odds of reporting PCC compared with women with one or more previous live births (34.7 vs 28.2%, p < 0.01; OR 1.63 [CI 1.52–1.75]).

Aim 2. **To compare the health messages received by women before pregnancy to those received during pregnancy and how these messages differ by demographic characteristics.** We hypothesized that women who received healthy behavior messages before pregnancy will be more likely to have also received such messages during pregnancy.

The majority of the n=3446 women (representing 222,479 women) included in the sample were between 25-34 years of age (60%), non-Hispanic white (63%), had more than a high school education (67%), had a family income of >$49,999 (55%), were married (69%), had previous children (56%), had private insurance (66%), had a normal preconception weight (52%), had adequate prenatal care (74%), and intended to become pregnant (71%) (Table 4).

Regardless of pregnancy intention, very few women reported receiving any of the specific pregnancy-related health messages *only* preconceptionally (range 2-6%) (Figure 3). For mental health, there were significant differences by timing of message receipt and pregnancy intention. Fifty-four percent of women intending pregnancy reported receiving messages prenatally only, while 28% of these women reported never receiving these messages (Figure 3, Panel A), compared with 51% and 16%, respectively, of women not intending pregnancy (χ^2 p<0.01) (Figure 3, Panel B). Conversely, for safe medications there were no significant differences by timing of message receipt and pregnancy intention, with the majority of both groups of women

reporting receiving the messages ***both*** before and during pregnancy (61% among intending and 65% among not intending, χ^2 p=0.3) (Figure 3). Finally, for smoking, alcohol, and illegal drugs, there were significant differences by pregnancy intention. While in both groups the majority of women reported receiving the messages preconceptionally and prenatally, the proportions of women in the two groups varied. Among women intending pregnancy, 52% (smoking), 55% (alcohol), and 46% (illegal drugs) reported receiving the messages early (Figure 3, Panel A), compared with 73% (smoking), 74% (alcohol), and 71% (illegal drugs) of women not intending pregnancy (each χ^2 p<0.01) (Figure 3, Panel B).

In multivariable analyses, there were no significant associations between timing of receipt and pregnancy intention, parity, preconception insurance status, or adequacy of prenatal care for any of the health messages. However, there were significant associations with other maternal characteristics for each message. For mental health, married women had decreased odds of receiving the message early compared with unmarried women (odds ratio (95% confidence interval): 0.54 (0.35-0.83)). Also, Hispanic women had increased odds compared with non-Hispanic white women (1.85 (1.20-2.84)) (Table 5).

For safe medications, all groups of women aged ≥25 years had decreased odds of receiving the message early compared with women aged ≤19 years (Table 5). Additionally for this outcome, Hispanic women had increased odds compared with non-Hispanic white women (1.65 (1.08-2.50)). For smoking, alcohol, and illegal drug messages, results were very similar. Hispanic women had increased odds of receiving these messages early compared with non-Hispanic white women (1.73 (1.10-2.71); 1.97 (1.26-3.09); 2.21 (1.41-3.45), respectively). Similarly, non-Hispanic Asian women had increased odds of receiving the smoking (1.48 (1.02-2.14)) and alcohol messages early (1.53 (1.05-2.22)). Non-Hispanic black women had increased odds of receiving the illegal drug messages early (1.42 (1.00-2.03)). For all three messages, women with high school education had increased odds of receiving the message early compared to women with more than high school education, and women with higher household incomes had decreased odds compared with women with lower household incomes (Table 5). Finally, for smoking, obese women had increased odds of receiving the smoking message early compared with normal weight women (1.42 (1.04-1.93)).

Aim 3. **To evaluate the association between specific behaviors before and during pregnancy and receipt of specific preconception care messages.** We hypothesized women who received specific preconception care messages are more likely to have corresponding healthier behaviors before and during pregnancy than women who did not.

The majority of the n=3446 women included in the sample were between 25-34 years of age, non-Hispanic white, had more than a high school education, had a family income of >$50,000, were married, had previous children, had private insurance, had at least adequate prenatal care, and intended to become pregnant (Table 4). Additionally, 45% of women were overweight or obese before pregnancy, 25% reported smoking at least one cigarette in the last two years and 71% reported drinking at least one alcoholic drink in the past 2 years.

Women who received the message on taking vitamins with folic acid before pregnancy reported taking vitamins significantly more often in the month before pregnancy compared to women who did not receive the message (77% vs 40%, p-value < 0.01│Figure 4, Panel A). Among overweight and obese women, there was no difference in dieting or exercising between those who received the message about being a healthy weight before pregnancy and those who did not (dieting: 41% vs 39%, p-value = 0.58│Figure 4, Panel B; exercising: 43% vs 40%, p-value = 0.42│Figure 4, Panel C). Among smokers, women who received the message regarding how smoking during pregnancy can affect the baby smoked more often during the last 3 months of pregnancy than women who did not receive the message (47% vs 27%, p-value < 0.01│Figure 4, Panel D). We also were able to examine the number of women that reported quitting smoking during pregnancy, and found similar results; fewer women who received the message regarding how smoking during pregnancy can affect the baby quit smoking during pregnancy (39%) compared with women who did not receive the message (53%) (data not shown). Among drinkers, the same percentage of women who did and did not receive the message on how drinking alcohol during pregnancy can affect the baby drank in the last 3 months of pregnancy (13% vs 13%, p-value = 0.86│Figure 4, Panel E).

In multivariable adjusted models, women who received the message on taking vitamins with folic acid before pregnancy were at increased odds of taking a vitamin in the month before pregnancy, adjusting for marital status, parity, prepregnancy insurance, and pregnancy intention (odds ratio: 2.99; 95% confidence interval (2.24-4.00)) (Table 7). Among overweight and obese women, there was no significant difference in dieting (adjusting for income and parity) or exercising (adjusting for prenatal care) among women who received

the message on being a healthy weight before pregnancy compared to those who did not receive the message (dieting: 1.06 (0.77-1.47); exercising: (1.10 (0.81-1.51)). Among smokers, women who received the message on the effects of smoking during pregnancy were more likely to smoke during the last 3 months of pregnancy, adjusting for prepregnancy BMI and prenatal care (2.22 (1.21-4.09)). Among drinkers, there was no significant difference between women who did or did not receive the message on the effects of alcohol use during pregnancy on alcohol use during the last 3 months of pregnancy, adjusting for maternal race and income (0.95 (0.65-1.38)).

For all behaviors, except vitamin consumption, results did not change based on pregnancy intention (results not shown). Although there was a significant interaction between PCC messages on vitamin use and pregnancy intention, the direction of the relationship did not change; among both women who did and did not intend to be pregnant, those who received PCC were more likely to take vitamins before pregnancy than those who did not receive PCC (results not shown).

Aim 4. **To determine the extent of provision of preconception care among women with prepregnancy diabetes or women who develop gestational diabetes compared with women without diabetes and to examine the association between preconception care receipt and diabetes status, adjusting for maternal characteristics.** We hypothesized that women with prepregnancy diabetes will more often report receiving preconception care than either women without diabetes or women with gestational diabetes. Although gestational diabetes is diagnosed during, not before, pregnancy, women who go on to develop gestational diabetes in the pregnancy of interest often have specific risk factors (i.e. older age, overweight or Hispanic ethnicity); thus, we expect women with these characteristics to report higher rates of preconception care than women without diabetes.

From 2009-2010 (n=23386), 8.6% of women reported having GDM in their most recent pregnancy and 1.5% reported PDM. The majority of survey respondents were older than 25, non-Hispanic White, married, multiparous, were not enrolled in WIC and gave birth to a term infant (Table 8). Most women had a greater than high school education, intended to be pregnant, were of a normal prepregnancy BMI, had private insurance and an income less than $25,000 a year. Most women also identified as non-smokers and reported having at least one alcoholic drink in the 3 months before becoming pregnant.

Overall, 31% of women reported receiving PCC. The highest rates were among women with PDM (53%), while women with GDM and NDM had lower rates (32% and 31%, respectively) (Table 8). Regarding women with GDM risk factors, older women reported receiving PCC more often than younger women, Hispanic women reported PCC less often than all other races, and overweight and obese women reported PCC less often than women with a normal prepregnancy BMI. Women with an intended pregnancy and women who had an income of at least $50,000/year reported the highest rates of PCC; women with no insurance and women with unintended pregnancies reported the lowest rates.

In the adjusted model, there was no difference in reported PCC receipt among NDM and GDM women (Odds Ratio (OR): 1.1; 95% Confidence Interval (CI): 0.9, 1.3), while women with PDM were significantly more likely (OR: 2.2; 95% CI: 1.5, 3.3) (Table 8) to report PCC receipt than NDM. Among GDM risk factors, only race was a significant predictor of PCC provision in the adjusted model: non-Hispanic Black (OR: 1.4; 95% CI: 1.2, 1.6) and Hispanic (OR: 1.3; 95% CI: 1.1, 1.5) women were more likely to report receiving PCC than non-Hispanic White women.

V. Discussion and Interpretation of Findings

A. Conclusions to be drawn from findings (with reference to data supporting each).

Aim #1. Overall, only approximately one-third of women reported receipt of PCC. Women who were at increased risk for adverse birth outcomes and arguably need PCC the most do not appear to be receiving it at rates higher than the general population, with the exception of women with a prior history of preterm delivery. On the contrary, women who typically experience healthier birth outcomes, such as those intending to become pregnant, were more likely to report receipt of PCC. Although previous work showed similar low rates of PCC,[45] this study improves upon existing literature by including data from additional states and years and by examining trends over a 7-year period allowing evaluation of the impact of national recommendations to increase provision of PCC. Based on our findings, it seems PCC recommendations may not be integrated into clinical practice as recommended, particularly among women who need PCC the most. An explanation for the observed decrease in report of PCC in 2008 could be attributed to the economy in 2008, which led to

downward trends in health care use relative to the period before the recession[46] and specifically resulted in many women not having insurance.[47]

Preconception care was less frequently reported among most high risk subgroups compared with both their counterparts and the overall population, possibly suggesting these groups of women do not have adequate access to health care or seek out PCC. However, further analyses revealed some high risk groups (African-American, lower educated, and covered by Medicaid during the prepregnancy period) were more likely to self-report PCC. After examining each confounder individually, we found no single confounder accounted for these changes in directions of associations, indicating that multivariable adjustment led to the directionality changes. This may suggest that, after accounting for several characteristics collectively, health care practitioners acknowledge that certain groups (such as the ones listed above) tend to have worse pregnancy outcomes than others. Many high risk women may not have a primary care practitioner, and physicians seeing these patients in any clinical setting (i.e., emergency departments, neighbor- hood health centers, free clinics, etc.) should take advantage of any opportunity to provide PCC. Only women who had a previous preterm infant reported PCC more frequently than the overall population. This is the only group categorized by a medical condition, suggesting that physicians may fail to recognize the need for PCC among women in other high risk groups associated with social factors. An additional explanation might be that these women received additional counseling at the time of the prior preterm delivery and/or the experience itself provided the stimulus for these women in particular to seek PCC. Women with higher parity would also benefit from receiving additional PCC, as indicated by lower levels of reported PCC compared with women with lower parity. Previous research has also indicated that higher parity is related to less favorable health behaviors.[48,49] Rather than develop a complicated risk stratification for provision of PCC, physicians should provide general PCC to all women (if they currently are not). We found a strong association between pregnancy intention and PCC. Women who are intending to become pregnant are more willing to seek out early prenatal care,[50] which may also extend to PCC. The significant association between PCC and pregnancy intention may be attributed to health care workers who suspect or are aware of patient plans to become pregnant now or in the future, and thus are prompted to provide PCC.

Aim #2. We found that the timing of when women receive preventive pregnancy health-related messages varied by message type, pregnancy intention, and maternal characteristics. Specifically, mental health messages were received primarily prenatally only, compared with other messages which were primarily received both preconceptionally and prenatally. The timing of receipt varies by pregnancy intention, such that women with unintended pregnancy report receiving messages both preconceptionally and prenatally more often than women intending pregnancy. Finally, women who may be perceived to be at higher risk of adverse pregnancy outcomes and/or engaging in high risk behavior (minorities, lower education, lower income) appeared to be hearing messages early more often than other women. Each of these main findings suggests messages are not reaching all women equally, but future prospective studies are needed to confirm these preliminary findings.

Women planning a pregnancy are more likely to report healthier preconception behaviors,[51-53] and may initiate conversations about PCC with their health care provider(s). Providers may not perceive women intending pregnancy, who may have already disclosed adoption of healthy behaviors, as needing preventive health messages. However, in our results, pregnancy intention was not significantly associated with receipt of specific messages. This is in line with one study that showed that provision of preconception care is beneficial for all women of reproductive age, regardless of pregnancy intention.[45] Another study also had a similar conclusions, citing that women with unintended pregnancies often have additional psychosocial risk factors and would benefit from additional counseling.[54]

Addressing mental health during the preconception and prenatal periods has been associated with improved pregnancy outcomes.[55] However, previous studies indicate that prenatal care providers view psychosocial risk prevention, such as mental health, as “challenging” and described inconsistent practice patterns and uncertainty about success.[54,56] Moreover, when compared with compliance with laboratory tests and physical examinations, evaluations of prenatal care records demonstrate significantly lower rates of compliance with psychosocial risk factor assessment and counseling.[57,58] This failure to identify and address psychosocial risk during pregnancy has been attributed to an underestimation of the prevalence of psychosocial risk factors, inadequate training, time constraints, and a belief by providers that many interventions are ineffective.[56,59,60]

Similar to our findings, previous studies[54,61-63] have also found that women perceived to be at higher risk of adverse pregnancy outcomes (minorities, teenagers, low income, low education) are more likely to receive specific messages prenatally (ie smoking, alcohol, pregnancy intention, and intimate partner violence). This is likely because increased rates of such psychosocial risk factors have been documented in these populations.[61-63] We found these women were also more likely to receive these messages preconceptionally, which may be a function of where these women go for care (ie neighborhood health clinics, Federally Qualified Health Centers, etc). These sites may more frequently screen and refer women with psychosocial needs to outside services than some private practice offices. Converse to previous reports examining frequency of prenatal messages on smoking, alcohol, and illegal drugs,[57,64] our results indicate higher rates of receipt of these messages, likely because we examined the combination of receipt of messages both preconceptionally and prenatally. An interesting finding from this study was that mainly demographic factors were associated with early receipt of health messages: age, race/ethnicity, education, income. Conversely, factors such as intention, parity, insurance status, BMI, and adequacy of prenatal care were not associated with early receipt. This may be an indication that providers are basing provision of preventive messages on demographic characteristics or differences in geographic locations/clinical setting as opposed to providing messages to all women, regardless of characteristics such as access to care.

Aim #3. Receipt of specific PCC messages had variable associations with maternal behavior before and during pregnancy. Specific messages were associated with increased vitamin usage, but were also associated with negative behaviors for smoking cessation among women who reported smoking in the 2 years preceding the survey. Specific messages had no significant association with increasing dieting or exercising among women who were overweight or obese before pregnancy or decreasing alcohol consumption among women who reported drinking in the 2 years before the survey.

There are many possible explanations for our results. First, taking a multivitamin or folic acid is arguably the easiest behavior change of the five behaviors studied: folic acid has minimal side effects, is easily available, and is relatively inexpensive.[65] Counseling on folic acid is straightforward and the evidence for its benefits is abundant and definitive.[66] We may have overestimated the relationship between PCC and vitamin consumption by not restricting the analysis to women who took vitamins daily, which is the clinical recommendation. This overestimation is likely limited, though, because the majority of women who took any vitamins did indeed take them daily (76%). Additionally, our findings are similar to those found by Elsinga et al.[18] and Williams et al.,[45] in which general preconception counseling was associated with significantly increased vitamin use. Even so, nearly 60% of women who reported not receiving folic acid PCC and 25% of women who did report receiving folic acid PCC, reported not taking folic acid prior to pregnancy. Despite the apparent ease and affordability of folic acid, barriers to supplementation still exist. For example, knowledge, perceived non-necessity for women not planning a pregnancy, or simple forgetfulness might contribute to decreased usage.[67-69]

Dieting and exercising have a history of poor long-term adoption and adherence,[70] making them a more difficult behavior change, especially among overweight and obese women, who may have had other health concerns (e.g. diabetes, hypertension) that superseded their concern about their weight. Also, dieting and exercising can be time-consuming and/or costly behaviors that women may feel they do not have the time and/or resources to adopt.[71,72] Overweight and obese women who received the specific PCC on diet and exercise may have lacked the knowledge of how to begin adopting these behavior changes, a topic on which doctors do not often provide extensive counseling, possibly due to time constraints.[73,74] Additionally, because the data is cross-sectional, it is difficult to determine when the woman received PCC; if it was shortly before becoming pregnant, she may not have had time to adopt these behaviors. Conversely, if the PCC was provided longer than 12 months ago, the women may have adopted the behaviors briefly, but abandoned them over time.

Aim #4. Women with PDM reported PCC provision more often than women with NDM, followed by women with GDM, as hypothesized. However, women with GDM risk factors did not consistently have greater PCC provision: older women reported receiving PCC more often, but Hispanic and overweight women did not. Conversely, in the adjusted analyses, Hispanic women were more likely to report receiving PCC than non-Hispanic White women. This may suggest that after accounting for several characteristics collectively, health care providers recognize the need to counsel Hispanic women.

Because women with PDM have a pre-existing chronic condition, increased PCC provision is both expected and necessary. No other study has evaluated the provision of PCC by diabetes status within the same population: prior research has been among only women with PDM, without a NDM comparison group. The PCC provision (53%) found in our study falls within the range of these previous studies (25-60%).[27,36-41]

Women with risk factors for developing GDM can be identified prior to pregnancy and educated to lower risk. Our results are largely consistent with the limited research on PCC and GDM risk factors. A study that also used data from PRAMS found that older women more often reported receiving PCC, while Hispanic women reported PCC less often.[75] In a study of PCC by weight status, overweight and obese women were less likely to receive counseling on reproductive care,[76] while in our study PCC provision did not significantly differ by prepregnancy BMI. Given that overweight women were nearly twice as likely to develop GDM and obese women nearly three times as likely (data not shown), there is a true need for greater PCC among overweight and obese women. Although overweight/obese women who went on to develop GDM more often reported PCC receipt compared with women without diabetes (32.4% vs. 29.6%), this difference was not significant ($p>0.05$).

Women with intended pregnancies were significantly more likely to report receiving PCC. However, because about half of the pregnancies in the US are unintended,[77] it is particularly important to provide reproductive counseling beginning at puberty[78] and to emphasize good metabolic control in all PDM women and healthy lifestyle practices among women at high risk for GDM regardless of pregnancy intention. Studies show that women are receptive to health education.[79,80]

B. Explanation of study limitations

Limitations to this study are related to the survey itself. The question used to measure PCC was very broad, could have been interpreted in various ways, and may underestimate PCC receipt if women did not categorize care they received as being oriented toward preparing for pregnancy. Also, the question does not measure the length or quality of the care. A woman that responds affirmative to the survey question may have had extensive counseling prior to pregnancy or may only have had a single discussion with their healthcare provider. Furthermore, women may not answer the question correctly outside of the context of pregnancy intention. The low prevalence of self-reported PCC may also be due to women not perceiving receipt of PCC, and therefore not reporting it, or women may not recall receiving PCC. PRAMS is administered to women a median of 105 days after delivery (range 62–307), requiring women to recall receipt of PCC anywhere from 11 to 19 months before the survey was administered and could contribute to recall bias. Such bias could have increased or decreased our effect measures of interest. The survey is also susceptible to social desirability bias, especially for sensitive questions regarding smoking and alcohol use before and during pregnancy. Recall could be differential by behavior as well; for example, a woman that smoked may better remember her doctor speaking to her about smoking before/during pregnancy.

Also, women who do not reveal practicing certain negative health behaviors (truthfully or not) may not be offered advice, and these women may have been less likely to report PCC receipt. The same characteristics that lead women to seek out PCC may lead them to healthier pregnancies, but the care itself may not be causal. Additionally, we cannot differentiate whether women did not report receiving messages because they did not access medical care during the preconception period and did not have the opportunity to receive messages or if providers did not address the messages during any type of health care encounter. In order to determine this, the survey should have included a question on primary care or preconception care visit(s) (regardless of provider seen) in the year prior to pregnancy. Finally, PRAMS data are limited to women who experienced a recent live birth, and women who experienced miscarriages or stillbirths are not included, limiting the generalizability of PCC among all pregnancies. For Aims 2 and 3, results may not be generalizable to all states because only 4 states asked the specific health message questions of interest. A limitation specific to our analyses was the small sizes requiring four categories to be collapsed into 2 categories (‘early’ versus ‘late’). For Aim 4, there was no data collected on GDM in a prior pregnancy, which is a significant risk factor for GDM in the current pregnancy[31] and may influence receipt of PCC.

Despite its limitations, PRAMS is a unique and reliable[81] data source to answer each of the 4 research questions. These strengths encompass the reasons the CDC and Healthy People 2020 identify PRAMS as the main data source to monitor national progress toward preconception care objectives.[1,82] Because provision of health messages preconceptionally and/or prenatally may not be the only influences on behavior change, and individual level characteristics influence behavior changes during pregnancy, PRAMS includes questions to allow analyses to control for these factors and isolate preconception care as the main exposure of

interest.These strengths should be used to encourage all states participating in PRAMS to add these questions to their state surveys. Finally, each state follows the same data collection protocol ensuring data are collected in a standardized manner.

C. Comparison with findings of other studies

Previous studies, similar to our data, have found that general PCC was not associated with smoking cessation.[18,45] This may be because smoking cessation is very difficult given the physically and psychologically addictive components of tobacco. Extensive work has been done on the difficulty of smoking cessation,[83] including among pregnant women.[84] Previous research showed that the majority of women received the specific PCC message regarding smoking; specifically, women with unintended pregnancies had significantly higher rates of specific PCC than women with intended pregnancies.[4] Related to our results, women with intended pregnancies were less likely to be smoking 3 months prior to pregnancy (results not shown) than women with unintended pregnancies. It may be that if a woman discloses that she smokes to a healthcare provider, she is more likely to be counseled about smoking cessation, thus the higher rates of smoking in the PCC group may simply be an indication that these women were more likely to receive the PCC.

Our results on alcohol consumption are more difficult to interpret. The health messages regarding alcohol abstinence during pregnancy are not definitive and vary culturally,[85-89] which may have contributed to the lack of observed positive behavior in this study. Nationally, approximately 10% of women report alcohol use during pregnancy.[90] Although the rates in this study are higher, it may be due to restricting our analyses to women who reported drinking in the last 2 years versus the general population. It would have been beneficial to look at binge drinking frequencies, but sample size limitations prevented these additional analyses. Our results differ from Williams et al., in which general PCC was associated with drinking cessation,[45] but align with Elsinga et al., in which there was no significant difference in alcohol use among women who did and did not receive PCC.[18] This may be because Williams et al. studied general PCC, whereas Elsinga et al. and our study examined the effect of specific PCC. Similar to smoking, if a woman disclosed alcohol use to a healthcare provider, she may have been more likely to receive the specific PCC.

Previous work has identified barriers to provision of PCC. For example, due to time and or reimbursement constraints, providers may decide not to provide PCC.[10] Additionally, doctors may feel unqualified and patients uncomfortable to discuss sensitive topics such as weight.[73,74,91] However, it is possible that provision of PCC will increase with the Affordable Care Act, which reduces insurance coverage concerns and gives clinicians an opportunity to provide more preventive health counseling. Furthermore, for high-risk behaviors, such as drinking and smoking, doctors may not provide specific PCC messages if the woman does not disclose the behavior, emphasizing the importance of providing consistent PCC to all women, regardless of risk profile.[1] Since nearly half of pregnancies in the US are unintended,[77] PCC should be provided to all women of child-bearing age, regardless of pregnancy intention. This is further supported by our results, in which pregnancy intention was not associated with behavior.

D. Possible application of findings to actual MCH health care delivery situations (including recommendations when appropriate)

One of our main findings that can be applied to MCH health care delivery situations is that women who reported receiving the message on taking vitamins with folic acid before pregnancy, also reported taking vitamins more often in the month before pregnancy compared to women who did not receive the message. Thus, having a provider tell a woman of reproductive age to take a vitamin with folic acid actually results in the desired behavior. This is a very simple message that all providers can reasonably achieve. Second, for high-risk behaviors, such as drinking and smoking, doctors may not provide specific PCC messages if the woman does not disclose the behavior, emphasizing the importance of providing consistent preconception care to all women, regardless of risk profile. Third, since nearly half of all pregnancies in the US are unintended, preconception care should be provided to all women of child-bearing age, regardless of pregnancy intention. Finally, while all women of reproductive age should receive PCC, it is vital that women with known risk factors, such as those with PDM and with risk factors for GDM, are counseled prior to pregnancy to optimize maternal and infant health outcomes. While it is encouraging that women with PDM report receiving PCC more often than average, PCC messages are still not reaching all of these women. Providing PCC to women with PDM and women with risk factors for GDM can help increase risk awareness among women at high risk of adverse pregnancy outcomes.

E. Policy implications

To fully inform assessment of the relationship between preconception are and maternal and infant outcomes, it is necessary to compare against existing recommendations and gauge who is/is not receiving those services. Provision of preconception care has been identified as not only a national public health priority, but also an important aspect of clinical care,[92] both of which emphasize optimizing the general health of reproductive aged women. Our population-based study suggests provision of PCC (or recognition of PCC receipt) remains suboptimal. This is important considering preconception health status among U.S. women of reproductive age is also suboptimal.[81] Continued efforts to monitor receipt of such messages are needed to determine if national recommendations on providing messages during any primary care visit with women of reproductive age are being met,[1] and more importantly if improvements in preventive counseling and preconception health are resulting in improved maternal and infant outcomes.

F. Suggestions for further research

Continued efforts to monitor receipt of such messages are needed to determine if national recommendations on providing messages during any primary care visit with women of reproductive age are being met,[1] if women with the highest need are receiving the appropriate care, and more importantly if improvements in preventive counseling and preconception health are resulting in improved maternal and infant outcomes.

VI. List of products

Published Peer Reviewed Articles

1. Oza-Frank R, Kachoria R, Keim SA, Lynch CD, Klebanoff MA. Receipt and timing of pregnancy-related health messages vary by message type and maternal characteristics. Am J Health Promot. 2014 Nov 5. [Epub ahead of print].

2. Oza-Frank R, Kachoria R, Keim SA, Klebanoff MA. Provision of specific preconception care messages and associated maternal health behaviors before and during pregnancy. Am J Obstet Gynecol. 2014 Oct 19. [Epub ahead of print].

3. Oza-Frank R, Gilson E, Keim SA, Lynch CD, Klebanoff MA. Trends and Factors Associated with Self-Reported Receipt of Preconception Care: PRAMS, 2004-2010. Birth. 2014 Dec;41(4):367-73. Epub 2014 Jul 4.

4. Kachoria R, Oza-Frank R. Receipt of preconception care among women with prepregnancy and gestational diabetes. Diabet Med. 2014 Dec;31(12):1690-5. Epub 2014 Jul 23.

Conference Presentations

1. Kachoria R, Oza-Frank R. Receipt of Preconception Care among Women with Prepregnancy and Gestational Diabetes. American Diabetes Association 74th Scientific Sessions, San Francisco, CA. June 2014.

2. Oza-Frank R, Kachoria R. Provision of Preconception Care and Behavior During Pregnancy. Pediatric Academic Societies Annual Meeting, Vancouver, Canada. May 2014.

3. Oza-Frank R, Kachoria R, Keim SA, Lynch CD, Klebanoff MA. Receipt and timing of preconception care messages varies by maternal characteristics. 2014 AMCHP Annual Conference, Washington, DC. Jan 2014.

4. Oza-Frank R, Kachoria R, Keim SA, Lynch CD, Klebanoff MA. Timing of pregnancy-related health message delivery varies by message type. 2014 AMCHP Annual Conference, Washington, DC. Jan 2014.

Invited National Presentations

1. Translation of Preconception Care Guidelines into Practice and Behavior During Pregnancy. Centers for Disease Control and Prevention, Maternal and Child Health Epidemiology Program, Atlanta, GA. June 2014.

2. Translation of Preconception Care Guidelines into Practice and Behavior During Pregnancy Academic Pediatric Association, Research Executive Committee. March 2014.

Invited Statewide Presentation

1. Preconception Care in Ohio: PRAMS 2005-2010. Ohio Department of Health, Preconception Care Strategic Performance Measure Work Group. August 2013.

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4. Oza-Frank R, Kachoria R, Keim SA, Lynch CD, Klebanoff MA. Receipt and Timing of Pregnancy-Related Preventive Health Messages Vary by Message Type and Maternal Characteristics. *American journal of health promotion.* Nov 2014. [Epub ahead of print]
5. Oza-Frank R, Kachoria R, Keim SA, Klebanoff MA. Provision of specific preconception care messages and associated maternal health behaviors before and during pregnancy. *American Journal of Obstetrics and Gynecology.* Oct 2014. [Epub ahead of print]
6. Kachoria R, Oza-Frank R. Receipt of preconception care among women with prepregnancy and gestational diabetes. *Diabet Med.* Dec 2014;31(12):1690-5.
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Table 1. Weighted distributions of maternal and infant characteristics, PRAMS 2004 to 2010

		Self-Reported PCC Receipt (n=20392)	Did Not Self-Report PCC Receipt (n=43692)
		n (%)	n (%)
Sociodemographic and Health Characteristics			
Maternal Age (years)*	≤ 19 [a]	1270 (23.5)	4332 (76.5)
	20 - 24	3371 (20.8)	11827 (79.2)
	25 - 29	5927 (31.3)	12330 (68.7)
	30 - 34	5862 (38.1)	9012 (61.9)
	≥ 35	3962 (37.5)	6191 (62.5)
	Missing	0	0
Education (years)*	< 12 [a]	2341 (23.5)	7584 (76.5)
	12	4608 (23.6)	14129 (76.4)
	> 12	13224 (36.3)	21361 (63.7)
	Missing	219	618
Race/Ethnicity*	Non-Hispanic White	11841(32.0)	24112(68.0)
	Non-Hispanic Black [a]	2651(28.8)	6188(71.2)
	Non-Hispanic Asian	1603(36.0)	2639(64.0)
	Non-Hispanic Other	609(30.8)	1324(69.2)
	Hispanic	1748(24.7)	5595(75.3)
	Missing	1940	3834
Household Income*	≤$19,999 [a]	4402 (20.7)	15856 (79.3)
	$20,000-<$50,000	4644 (23.5)	12860 (76.5)
	$50,000 or more	9579 (45.2)	10816 (54.8)
	Missing	1767	4160
Marital Status*	Not Married	5061 (20.6)	18685 (79.4)
	Married	15314 (36.7)	24961 (63.3)
	Missing	17	46
Prepregnancy BMI (kg/m^2)*	Underweight (<18.5)	896 (27.6)	2331 (72.4)
	Normal (18.5 - 24.9)	10422 (32.2)	21005 (67.8)
	Overweight (25 - 29.9)	4345 (30.2)	9463 (69.8)
	Obese (≥30)	3664 (29.2)	8267 (70.8)
	Missing	1065	2626
Infant Birth Weight*	<2500g	5873 (33.8)	11085 (66.2)
	2500 - <4000g	13134 (30.5)	29689 (69.5)
	≥4000g	1385 (31.3)	2918 (68.7)
	Missing	0	0
Preterm Infant*	≥ 37 weeks	15377 (30.2)	34692 (69.8)
	< 37 weeks	4997 (36.8)	8915 (63.2)
	Missing	18	85
Parity*	0	9265 (34.7)	17272 (65.3)
	≥ 1	11033 (28.2)	26216 (71.8)
	Missing	94	204
Previous Preterm Infant*	No	8431 (27.3)	21275 (72.7)
	Yes [a]	1919 (32.5)	3740 (67.5)
	Missing	10042	18677
Pregnancy Intention*	Unintended	4423 (16.8)	21145 (83.2)
	Intended	15742 (41.0)	21780 (59.0)
	Missing	227	767
Access to Care Characteristics			
Prepregnancy Insurance Status*	Medicaid (no private) [a]	2648 (28.0)	6572 (72.0)
	Private/Other	15026 (37.2)	23495 (62.8)

	None[a]	2071 (14.0)	12141 (86.0)
	Missing	647	1484
WIC Participant	No	13836 (36.3)	22775 (63.7)
	Yes [a]	6341 (22.7)	20451 (77.3)
	Missing	215	466

*Indicates overall chi-squared values significant at $p<0.01$;

[a]Indicates subgroups of women shown to be at high risk of adverse birth outcomes

Weighted, unadjusted estimates; Sample sizes reflect actual frequencies in the dataset; Data are from PRAMS 2004 to 2010 and include data from 12 states (Hawaii, Louisiana, Maryland, Maine, Michigan, Minnesota, New Jersey, Ohio, Tennessee, Utah, Vermont and West Virginia); Vermont did not release information about race/ethnicity therefore Vermont data are not included in the sample sizes and percentages for race/ethnicity.

Table 2. Factors associated with self-reported receipt of preconception care (PCC), PRAMS 2004 to 2010

Characteristics		Adjusted OR of Self-Reported Receipt of PCC	95% CI
Year	2004	1.03	0.91 – 1.16
	2005	0.99	0.87 – 1.13
	2006	Ref	-
	2007	0.92	0.81 – 1.04
	2008	**0.85**	**0.75 – 0.97**
	2009	0.93	0.82 – 1.05
	2010	0.97	0.85 – 1.10
Maternal Age (years)	≤ 19	**0.80**	**0.66 – 0.97**
	20 - 24	**0.76**	**0.67 – 0.86**
	25 - 29	**0.91**	**0.83 – 0.99**
	30 - 34	1.03	0.94 – 1.13
	≥ 35	Ref	-
Maternal Education	<12 years	**1.17**	**1.02 – 1.35**
	12 years	0.94	0.87 – 1.02
	>12 years	Ref	-
Race/Ethnicity	Non-Hispanic White	Ref	-
	Non-Hispanic Black	**1.41**	**1.27 – 1.57**
	Non-Hispanic Asian	**0.85**	**0.76 – 0.95**
	Non-Hispanic Other	1.27	1.00 – 1.60
	Hispanic	**1.16**	**1.03 – 1.30**
Not Married		**0.68**	**0.62 – 0.75**
Intended Pregnancy		**2.87**	**2.66 – 3.09**
Parity	0	**1.63**	**1.52 – 1.75**
	≥1	Ref	-
Term infant (vs. preterm infant)		**0.72**	**0.66 – 0.79**
Household Income	≤$19,999	**0.63**	**0.56 – 0.71**
	$20,000-<$50,000	**0.54**	**0.50 – 0.59**
	$50,000 or more	Ref	-
Prepregnancy insurance status	Medicaid (no private)	Ref	-
	Private/Other	**0.71**	**0.63 – 0.82**
	None	**0.33**	**0.29 – 0.38**

Data are from PRAMS 2004 to 2010 and include data from 12 states (Hawaii, Louisiana, Maryland, Maine, Michigan, Minnesota, New Jersey, Ohio, Tennessee, Utah, Vermont and West Virginia); Odds ratio (OR); Confidence Interval (CI); Model was adjusted for all the variables in the table, including state (data not shown); Vermont was excluded from the race/ethnicity statistics per CDC guidelines.

Table 3. Survey questions pertaining to health messages received before and/or during pregnancy, PRAMS 2009-2010

***Before* you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk with you about any of the things listed below?**	***During any of your prenatal care visits*, did a doctor, nurse, or other health care worker talk with you about any of the things listed below?**
Getting counseling or treatment for depression or anxiety	What to do if I feel depressed during my pregnancy or after my baby is born
The safety of using prescription or over-the-counter medicines during pregnancy	Medicines that are safe to take during my pregnancy
How smoking during pregnancy can affect a baby	How smoking during pregnancy could affect my baby
How drinking alcohol during pregnancy can affect a baby	How drinking alcohol during pregnancy could affect my baby
How using illegal drugs during pregnancy can affect a baby	How using illegal drugs could affect my baby

Table 4. Respondent characteristics, PRAMS 2009-2010

		N	%[a]	SE[a]
Maternal Age (years)	< 20	249	7.2	0.6
	20-24	512	16.7	0.9
	25-29	841	29.6	1.1
	30-34	862	29.0	1.0
	>34	982	17.6	0.8
	Missing	0		
Race and ethnicity	Non-Hispanic White	1611	63.1	0.8
	Non-Hispanic Black	958	19.0	0.5
	Non-Hispanic Asian	286	5.1	0.3
	Hispanic	299	10.8	0.5
	Non-Hispanic Other	44	2.0	0.4
	Missing	248		
Education	Less than High school	433	12.4	0.8
	High School	692	20.9	1.0
	More than High School	2297	66.8	1.1
	Missing	24		
Household Income ($/year)	<25,000	1018	30.7	1.1
	25,000-34,999	207	5.9	0.5
	35,000-49,999	234	8.3	0.7
	≥50,000	1758	55.1	1.1
	Missing	229		
Marital Status	Married	2318	69.1	1.0
	Unmarried	1127	30.9	1.0
	Missing	1		
Parity	No Previous Live Births	1516	44.4	1.2
	One or more Previous Live Births	1907	55.6	1.2
	Missing	23		
Prepregnancy Insurance	Medicaid	579	16.4	0.9
	Private	2192	66.0	1.1
	None	275	8.7	0.7
	Other	362	8.9	0.6
	Missing	38		
Prepregnancy BMI	Underweight (<18.5 kg/m^2)	137	4.0	0.5
	Normal (18.5-24.9 kg/m^2)	1671	51.5	1.2
	Overweight (25.0-29.9 kg/m^2)	783	23.6	1.0
	Obese (≥30.0 kg/m^2)	705	21.0	1.0
	Missing	150		
Adequacy of Prenatal Care[b]	Inadequate	384	11.7	0.8
	Intermediate	399	14.9	0.9
	Adequate	1215	44.7	1.2

	Adequate Plus	1188	28.7	1.0
	Missing	260		
Pregnancy Intention	Intentional	2432	71.2	1.1
	Unintentional	973	28.8	1.1
	Missing	41		
Smoking in the past 2 years	No	2593	75.2	1.0
	Yes	809	24.8	1.0
	Missing	44		
Alcohol in the past 2 years	No	1127	29.2	1.0
	Yes	2269	70.8	1.0
	Missing	50		

Based on 2009-2010 data from MD, MI, NJ, OH. Restricted to women who answered yes to the question "Before you got pregnant with your new baby, did you talk with a doctor, nurse, or other health care worker to prepare for a healthy pregnancy and baby?" were asked to answer the questions on specific preconception counseling messages received *before* pregnancy (32% of the total sample).

[a] Weighted

[b] Determined by calculating the Kotelchuck index,[28] a composite score summarizing prenatal care based on the number and timing of prenatal visits

Table 5. Adjusted associations between receipt and timing of specific pregnancy-related health messages (early vs. late), PRAMS 2009-2010

		Depression			Medications			Smoking			Alcohol			Illegal Drugs		
		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Mother's Age (years)	< 20	1.00			1.00			1.00			1.00			1.00		
	20-24	0.76	0.41	1.43	0.62	0.30	1.28	0.94	0.34	2.57	1.10	0.39	3.08	0.89	0.33	2.36
	25-29	0.64	0.33	1.27	**0.29**	**0.14**	**0.59**	0.63	0.24	1.67	0.53	0.20	1.41	0.49	0.19	1.27
	30-34	0.64	0.32	1.30	**0.34**	**0.16**	**0.71**	0.61	0.23	1.63	0.52	0.19	1.41	0.48	0.18	1.27
	>34	0.73	0.35	1.54	**0.29**	**0.14**	**0.63**	0.49	0.18	1.36	0.47	0.17	1.32	0.38	0.14	1.03
Mother's Race	Non-Hispanic White	1.00			1.00			1.00			1.00			1.00		
	Non-Hispanic Black	0.85	0.57	1.26	0.90	0.65	1.25	1.21	0.85	1.71	1.29	0.90	1.84	**1.42**	**1.00**	**2.03**
	Non-Hispanic Asian	1.28	0.80	2.04	1.25	0.86	1.81	**1.48**	**1.02**	**2.14**	**1.53**	**1.05**	**2.22**	1.44	0.99	2.09
	Hispanic	**1.85**	**1.20**	**2.84**	**1.65**	**1.08**	**2.50**	**1.73**	**1.10**	**2.71**	**1.97**	**1.26**	**3.09**	**2.21**	**1.41**	**3.45**
	Non-Hispanic Other	2.40	0.72	8.01	0.31	0.10	1.01	0.67	0.23	1.99	0.79	0.25	2.42	1.11	0.35	3.49
Mother's Education	More than High School	1.00			1.00			1.00			1.00			1.00		
	High School	1.27	0.84	1.94	1.35	0.94	1.95	**1.96**	**1.32**	**2.91**	**2.11**	**1.41**	**3.16**	**2.17**	**1.46**	**3.21**
	Less than High School	1.32	0.76	2.30	0.62	0.35	1.07	1.42	0.69	2.93	1.15	0.57	2.32	1.29	0.65	2.55
Family Income ($/year)	<25,000	1.00			1.00			1.00			1.00			1.00		
	25,000-34,999	0.96	0.53	1.75	**0.54**	**0.32**	**0.93**	**0.43**	**0.24**	**0.78**	**0.41**	**0.23**	**0.74**	**0.55**	**0.31**	**0.99**
	35,000-49,999	0.86	0.47	1.57	0.97	0.55	1.72	0.56	0.31	1.03	0.63	0.34	1.18	0.77	0.41	1.45
	>49,999	0.61	0.35	1.09	0.85	0.50	1.43	**0.48**	**0.28**	**0.83**	**0.49**	**0.28**	**0.86**	**0.54**	**0.32**	**0.93**
Marital Status	Unmarried	1.00			1.00			1.00			1.00			1.00		
	Married	**0.54**	**0.35**	**0.83**	0.88	0.57	1.36	0.89	0.56	1.41	0.88	0.55	1.41	0.82	0.52	1.28
Pregnancy Intention	Unintentional	1.00			1.00			1.00			1.00			1.00		
	Intentional	0.93	0.66	1.32	1.25	0.92	1.70	0.83	0.60	1.15	0.93	0.67	1.30	0.92	0.66	1.27
Parity	No Previous	1.00			1.00			1.00			1.00			1.00		

	Children															
	Previous Children	1.18	0.87	1.61	1.13	0.89	1.45	0.82	0.64	1.05	0.81	0.63	1.04	0.95	0.74	1.22
Prenatal Insurance	Medicaid	1.00			1.00			1.00			1.00			1.00		
	Private	1.15	0.66	2.01	1.04	0.61	1.75	0.71	0.39	1.29	0.80	0.44	1.48	0.65	0.35	1.18
	None	1.28	0.71	2.29	1.06	0.59	1.91	1.11	0.53	2.30	1.22	0.59	2.53	1.07	0.53	2.19
	Other	1.35	0.78	2.32	0.93	0.54	1.61	0.79	0.42	1.51	0.78	0.41	1.49	0.66	0.35	1.24
Prepregnancy BMI	Underweight (<18.5 kg/m^2)	0.78	0.41	1.49	1.76	0.96	3.24	1.03	0.58	1.82	1.06	0.59	1.89	1.14	0.65	2.01
	Normal (18.5-24.9 kg/m^2)	1.00			1.00			1.00			1.00			1.00		
	Overweight (25.0-29.9 kg/m^2)	1.09	0.78	1.53	1.13	0.85	1.51	1.12	0.83	1.52	1.24	0.92	1.68	1.01	0.75	1.37
	Obese (>30.0 kg/m^2)	0.96	0.66	1.40	1.27	0.94	1.71	**1.42**	**1.04**	**1.93**	1.20	0.88	1.63	1.20	0.88	1.63
Kotelchuck Index	Inadequate	1.35	0.84	2.16	1.52	1.00	2.30	0.94	0.59	1.49	1.00	0.63	1.59	0.90	0.56	1.42
	Intermediate	1.01	0.67	1.52	1.21	0.85	1.71	1.04	0.73	1.50	1.00	0.69	1.44	0.98	0.68	1.42
	Adequate	1.00			1.00			1.00			1.00			1.00		
	Adequate Plus	1.13	0.82	1.56	1.20	0.93	1.56	1.09	0.84	1.43	1.05	0.81	1.37	1.21	0.92	1.58

OR=odds ratio; 95% CI=95% confidence interval; Based on 2009-2010 data from MD, MI, NJ, OH. Only women that answered yes to the question "Before you got pregnant with your new baby, did you talk with a doctor, nurse, or other health care worker to prepare for a healthy pregnancy and baby?" were asked to answer the questions on specific preconception counseling messages received *before* pregnancy (32% of the total sample); Women were grouped into two outcome categories based on when the health message was received: (1) before only/both before and during (preconception and prenatal, referred to as "early"); (2) during only/never (prenatal only and never, referred to as "late" and designated as the reference group); Each model was additionally adjusted for preconception insurance status, parity, adequacy of prenatal care, and pregnancy intention but because these variables were not significant in any of the models, data is not shown.

Table 6. Survey questions pertaining to preconception care messages and corresponding behaviors, PRAMS 2009-2010

***Before* you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk with you about any of the things listed below?**	***Corresponding behavior/characteristic***
Taking vitamins with folic acid before pregnancy	During the month before you got pregnant with your new baby, how many times per week did you take a multivitamin, a prenatal vitamin, or a folic acid vitamin?[a]
Being a healthy weight before pregnancy[b]	At any time during the 12 months before you got pregnant with your new baby, did you do any of the following things? - Option a: I was dieting (changing my eating habits) to lose weight - Option b: I was exercising 3 or more days of the week[c]
How smoking during pregnancy can affect a baby	During the last 3 months of pregnancy, did you smoke cigarettes?
How drinking alcohol during pregnancy can affect a baby	During the last 3 months of pregnancy, did you drink any alcohol?

[a]Categorized as took vitamins at least once weekly or did not take a vitamin at all
[b]Respondents could check all items that applied among a list of 8 items and each choice listed here was coded as a separate dichotomous variable (yes/no)
[c]Categorized as did or did not exercise 3 or more days a week

Table 7. Adjusted associations between receipt of specific PCC messages and maternal behaviors before and during pregnancy, PRAMS 2009-2010

Maternal Health Behavior	Receipt of message	OR	95% CI	
Taking vitamins with folic acid before pregnancy[a]	No	Reference		
	Yes	2.99	2.24	4.00
Dieting to lose weight before pregnancy[b]	No	Reference		
	Yes	1.06	0.77	1.47
Exercising before pregnancy[c]	No	Reference		
	Yes	1.10	0.81	1.51
Smoking in last 3 months of pregnancy[d]	No	Reference		
	Yes	2.22	1.21	4.09
Alcohol use in the last 3 months of pregnancy[e]	No	Reference		
	Yes	0.95	0.65	1.38

OR=odds ratio; 95% CI=95% confidence interval; Based on 2009-2010 data from MD, MI, NJ, OH. Only women that answered yes to the question "Before you got pregnant with your new baby, did you talk with a doctor, nurse, or other health care worker to prepare for a healthy pregnancy and baby?" were asked to answer the questions on specific preconception counseling messages received *before* pregnancy (32% of the total sample);

[a]Exposure based on the PCC question: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about taking vitamins with folic acid before pregnancy?" and the outcome based on the corresponding response to the behavior: "During the month before you got pregnant with your new baby, how many times per week did you take a multivitamin, a prenatal vitamin, or a folic acid vitamin?"; Model adjusted for marital status, parity, prepregnancy insurance, and pregnancy intention.

[b]Exposure based on the PCC question: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about being a healthy weight before pregnancy?" and the outcome based on the corresponding responses to the following questions: "At any time during the 12 months before you got pregnant with your new baby, did you do any of the following things? I was dieting (changing my eating habits) to lose weight" (yes/no); Model adjusted for income and parity.

[c]Exposure based on the PCC question: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about being a healthy weight before pregnancy?" and the outcome based on the corresponding responses to the following questions: "At any time during the 12 months before you got pregnant with your new baby, did you do any of the following things? I was exercising 3 or more days of the week" (yes/no); Model adjusted for prenatal care.

[d]Responses based on the PCC question: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how smoking during pregnancy can affect a baby?" and the outcome based on the corresponding response to the behavior: "During the last 3 months of pregnancy, did you smoke cigarettes?"; Model adjusted for maternal prepregnancy BMI and prenatal care.

[e]Responses based on the PCC question: "Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how drinking alcohol can affect a baby?" and the outcome based on the corresponding response to the behavior: "During the last 3 months of pregnancy, did you drink any alcohol?"; Model adjusted for maternal race and income.

Table 8. Demographics; Provision of PCC; and Odds ratios

		%	SE	PCC %	SE	Regression		
		N = 23386		31.0	0.5	OR	95% CL	
Diabetes Status[b]	No Diabetes Mellitus	89.9	0.3	30.5	0.5	1.0		
	Gestational Diabetes Mellitus	8.6	0.3	31.8	1.6	1.1	0.9	1.3
	Prepregnancy Diabetes Mellitus	1.5	0.1	52.6	4.0	**2.2**	**1.5**	**3.3**
Mother's Age[b] (years)	< 20	8.5	0.3	27.9	1.7	NA[a]		
	20-24	22.4	0.4	25.6	0.9			
	25-29	30.1	0.5	31.7	0.8			
	30-34	24.7	0.4	35.0	0.9			
	>34	14.3	0.3	32.6	1.1			
Race	Non-Hispanic White	65.4	0.4	31.4	0.6	1.0		
	Non-Hispanic Black	14.4	0.2	31.2	1.2	**1.4**	**1.2**	**1.6**
	Non-Hispanic Asian	4.8	0.1	31.1	1.5	0.8	0.7	1.0
	Hispanic	11.8	0.2	28.0	1.3	**1.3**	**1.1**	**1.5**
	Non-Hispanic Other	3.6	0.2	31.6	2.2	1.2	1.0	1.6
Education[b]	< 12 years	14.1	0.4	28.7	1.3	**1.3**	**1.1**	**1.5**
	12 years	26.3	0.4	26.3	0.9	**1.1**	**1.0**	**1.3**
	> 12 years	59.6	0.5	33.6	0.6	1.0		
Marital Status[b]	Other	38.4	0.5	23.9	0.7	1.0		
	Married	61.6	0.5	35.4	0.6	**1.4**	**1.2**	**1.6**
Intention[b]	Unintended	42.5	0.5	20.7	0.6	1.0		
	Intended	57.5	0.5	38.8	0.6	**2.2**	**2.0**	**2.5**
Prepregnancy BMI	Underweight	4.4	0.2	30.5	2.2	NA[a]		
	Normal	50.8	0.5	31.9	0.7			
	Overweight	24.1	0.4	30.6	1.0			
	Obese	20.7	0.4	30.3	1.0			
Parity[b]	Primiparous	40.1	0.5	34.1	0.7	1.0		
	Multiparous	59.9	0.5	28.9	0.6	**0.7**	**0.6**	**0.8**
Current Preterm Infant[b]	No	92.2	0.2	30.7	0.5	NA[a]		
	Yes	7.8	0.2	34.8	1.4			
Income[b] ($/year)	<25,000	40.8	0.5	24.3	0.7	**0.6**	**0.5**	**0.7**
	25,000-34,999	9.3	0.3	23.4	1.3	**0.5**	**0.4**	**0.6**
	35,000-49,999	10.8	0.3	27.5	1.4	**0.6**	**0.5**	**0.7**
	>49,999	39.1	0.5	40.8	0.8	1.0		
WIC Participation[b]	No	56.6	0.5	34.7	0.6	NA[a]		
	Yes	43.4	0.5	26.0	0.7			
Prepregnancy Insurance[b]	Medicaid	15.9	0.4	32.2	1.2	1.0		
	Private	55.7	0.5	35.7	0.6	**0.6**	**0.5**	**0.8**
	None	18.4	0.4	15.8	0.9	**0.3**	**0.3**	**0.4**
	Other	10.0	0.3	30.9	1.5	**0.7**	**0.6**	**0.9**

Smoking 3 months prior to pregnancy[b]	No	73.5	0.5	33.0	0.5	NA[a]		
	Yes	26.5	0.5	25.2	0.9			
Drinking 3 months prior to pregnancy	No	45.1	0.5	31.6	0.7	1.0		
	Yes	54.9	0.5	30.5	0.6	**0.9**	**0.8**	**1.0**

PCC = Preconception Care; SE = Standard Error; OR = Odds Ratio

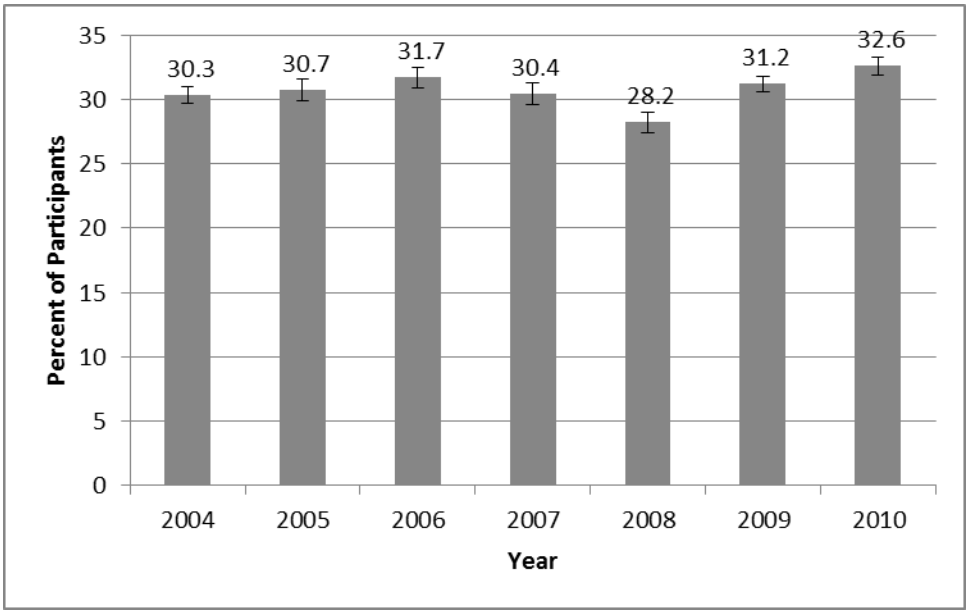
[a] Not significant at $p<0.05$ in the model and thus not included

[b] Chi-square test significant at $p<0.05$

Bolded values significant before rounding

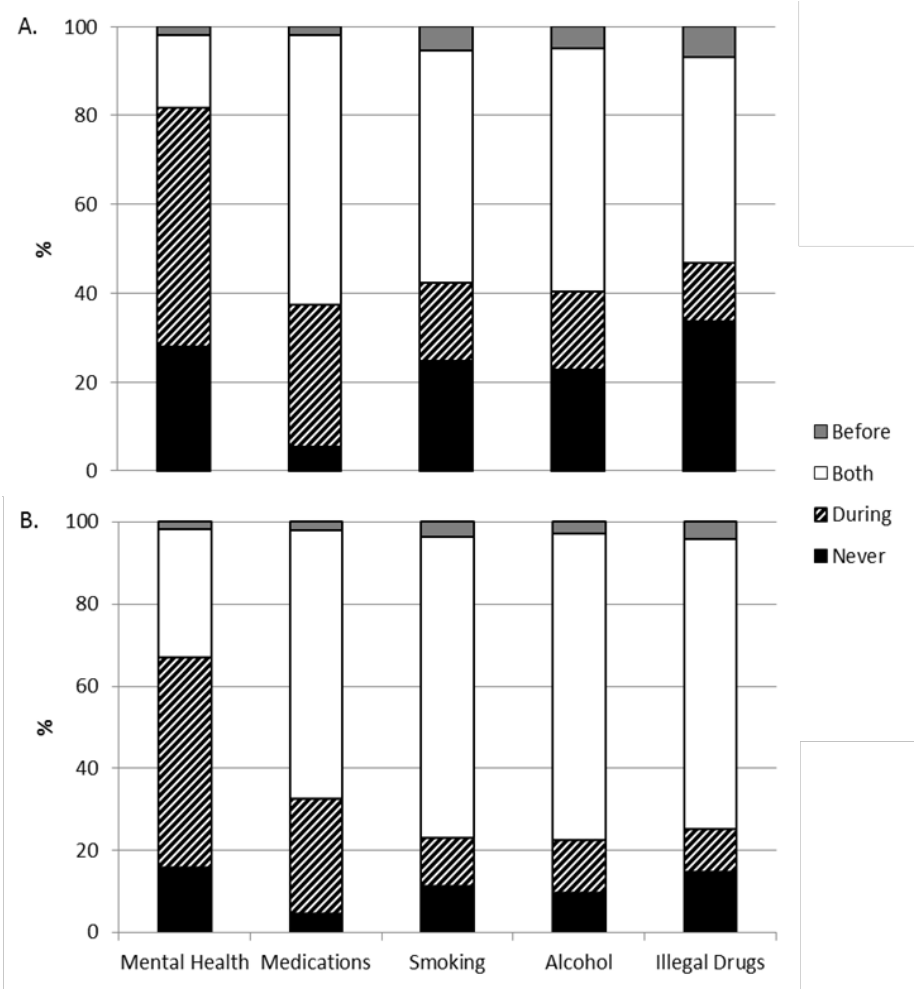
Missing values: Diabetes status (0), Mother's age (0), Race (870), Education (275), Marital status (27), Intention (296), Prepregnancy BMI (973), Parity (87), Current preterm infant (45), Income (1451), WIC participation (58), Prepregnancy insurance (250), Smoking 3 months prior to pregnancy (109), Drinking 3 months prior to pregnancy(254).

Figure 2. Percentage of participants self-reporting receipt of preconception care (PCC), PRAMS 2004 to 2010



Weighted, unadjusted estimates; Data are from PRAMS 2004 to 2010 and include data from 12 states (Hawaii, Louisiana, Maryland, Maine, Michigan, Minnesota, New Jersey, Ohio, Tennessee, Utah, Vermont and West Virginia); Error bars represent standard error of the percent.

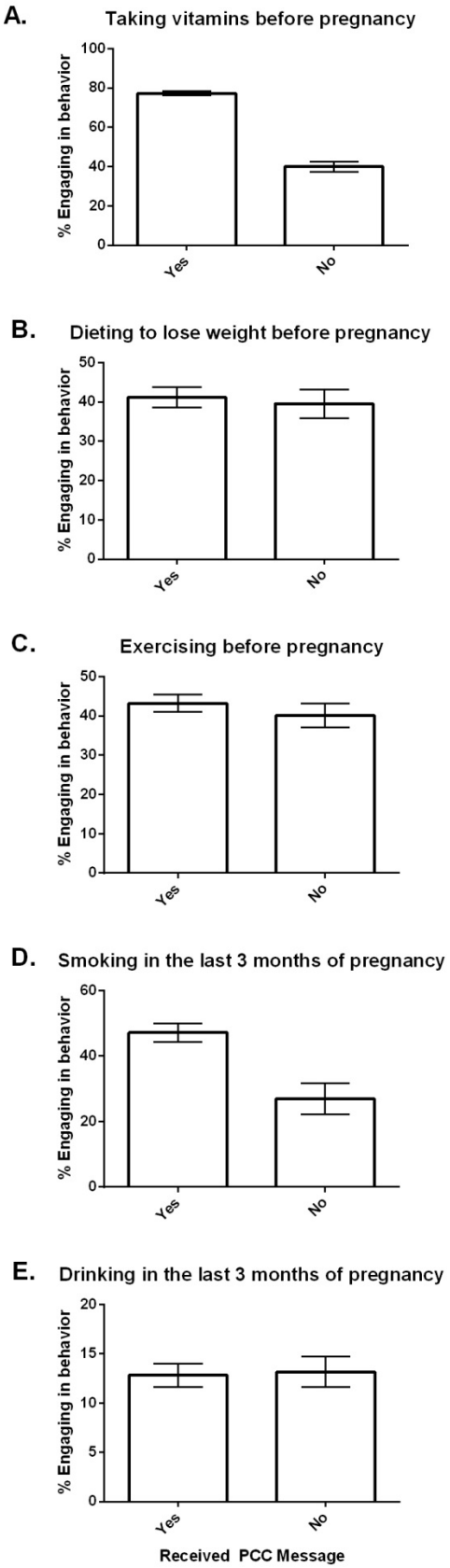
Figure 3. Proportion of participants reporting receipt of specific pregnancy-related health messages by timing and pregnancy intention, PRAMS 2009-2010



Panel A: Intended pregnancy
Panel B: Unintended pregnancy

Data are from PRAMS 2004 to 2010 and include data from 4 states (Maryland, Michigan, New Jersey, Ohio); Women were grouped into 1 of 4 categories: messages received only before pregnancy (preconception), both before and during pregnancy (preconception and prenatal), only during pregnancy (prenatal), or never; All chi-squared p-values for each message comparing proportions of respondents by pregnancy intention were $p<0.01$, except for 'Medications' which was not significant ($p=0.3$).

Figure 4. Association between preconception care and maternal health behaviors



Panel A. Preconception care (PCC) based on the question: “Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about taking vitamins with folic acid before pregnancy?” Corresponding behavior based on the question: “During the month before you got pregnant with your new baby, how many times per week did you take a multivitamin, a prenatal vitamin, or a folic acid vitamin?”

Panel B. Among women overweight or obese before pregnancy, PCC based on the question: “Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about being a healthy weight before pregnancy?” Corresponding behavior based on the question: “At any time during the 12 months before you got pregnant with your new baby, did you do any of the following things? I was dieting (changing my eating habits) to lose weight.”

Panel C. Among women overweight or obese before pregnancy, PCC based on the question: “Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about being a healthy weight before pregnancy?” Corresponding behavior based on the question: “At any time during the 12 months before you got pregnant with your new baby, did you do any of the following things? I was exercising 3 or more days of the week.”

Panel D. Among women who reported smoking at least one cigarette in the past 2 years, PCC based on the question: “Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how smoking during pregnancy can affect a baby?” Corresponding behavior based on the question: “During the last 3 months of pregnancy, did you smoke cigarettes?”

Panel E. Among women who reported drinking at least one alcoholic beverage in the past 2 years, PCC based on the question: “Before you got pregnant with your new baby, did a doctor, nurse, or other health care worker talk to you about how drinking alcohol can affect a baby?” Corresponding behavior based on the question: “During the last 3 months of pregnancy, did you drink any alcohol?”

Error bars represent standard error