Does WIC Participation Predict Dental Care Usage for Pregnant Women?

By

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ABSTRACT

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Background: Good oral health status is especially important for pregnant women. A growing body of clinical research supports the connection between poor oral health during pregnancy and poor birth outcomes, including low birth weight. This connection is likely due to the changes in a woman's immunity during pregnancy, making her more susceptible to infection. Despite this connection between oral health and pregnancy outcomes, many women are not receiving the dental care they need during pregnancy. Already serving a large and diverse population, WIC may be an avenue for improving low-income women's awareness and access to dental care during her pregnancy. This analysis seeks to find whether WIC currently increases the likelihood pregnancy women are accessing dental care.

Methods: This analysis used data from the Pregnancy Risk Assessment Monitoring System (PRAMS) database from six states, Colorado, Hawaii, Maine, Missouri, New York and South Carolina, collected from 2004 – 2009. Women were determined to be eligible for WIC using their reported income and household size variables prior to giving birth. Using logistic regression models, we looked at whether participation in the WIC program during pregnancy increased the likelihood that a woman would go to a dentist, receive dental education or receive preventative dental care.

Results: Among all eligible women, WIC participation during pregnancy increased the odds that a woman would receive dental education by 12-14%. However, women not reporting a dental problem did not have increased odds that she would receive dental education at a statistically significant level. For both the total eligible population and women not reporting a dental problem, WIC participation did not increase the odds a woman would go to the dentist or receive preventative dental care during her pregnancy at a statistically significant level. A state-level analysis found that WIC participation did not increase the odds a woman would receive preventative care in any of the six states included in this analysis.

Discussion: This analysis provides a better picture of how WIC impacts the dental care utilization of its pregnant participants. Further research should be done to see if WIC programs in states not included in this analysis have a different impact on dental care utilization. Future research could also explore how WIC is increasing education among its pregnant participants to learn how to expand WIC to improve other areas of dental care access.

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List of Abbreviations

ADA – American Dental Association

CDC – Centers for Disease Control and Prevention

HIV – Human Immunodeficiency Virus

LBW – Low Birth Weight

Kotelchuck Index – The Adequacy of Prenatal Care Utilization Index

NHB – Non-Hispanic Black

NHW – Non-Hispanic White

PNC – Prenatal Care

PRAMS – Pregnancy Risk Assessment Monitoring System

WIC – The Special Supplemental Nutrition Program for Women, Infants and Children

I. INTRODUCTION

A growing body of clinical research finds a link between oral infections and poor birth outcomes for women, with a high prevalence among low-income women[1]. Finding avenues to reach this population in order to address poor oral health and increase education about the importance of preventative dental care is important to reducing the effect of oral infections on birth outcomes. While the clinical impact of oral infections on pregnancy outcomes is well documented in the literature[2,3], effective programs to improve oral health care use have not been identified[4]. One theorized opportunity to improve dental care in this population is through WIC clinics, which are expected to provide dental education and referrals for low-income, pregnant women. This study will explore whether WIC program participation increases the likelihood that a low-income pregnant woman accesses dental care during her pregnancy and/or receives education about preventive dental care. Findings from this study will inform stakeholders and policymakers about better opportunities to increase dental care usage among low-income pregnant women.

II. Literature Review

Low birth weight (LBW) babies have been a significant area of concern for the public health community for many decades in the United States. These infants are at increased risk for death and a wide range of short and long-term morbidities, including breathing and intestinal complications, bleeding in the brain, possible intellectual disabilities, behavioral problems, cerebral palsy, vision and hearing loss[5], contributing to the increasingly high health care costs in this country[6]. These costs are attributed to increased care needed during delivery, rising inversely to birth weight, and then accumulate at a faster rate through childhood than normal weight births due to ongoing health care and special education needs[7]. Medicaid finances four in ten births nationally[8], making LBW a concern of policymakers as well as clinicians as caring for LBW babies adds billions of dollars to publicly-funded deliveries.

While some of the factors for low birth weight are pre-determined, such as genetic, demographic or obstetric factors of the mother, other known factors for low birth weight are potentially modifiable, including prenatal nutrition, toxic exposure, maternal morbidity during pregnancy and antenatal care[9]. Among urban, unmarried mothers, there is a strong association between pregnancy health conditions and prenatal behaviors and LBW[10,11], suggesting that improving targeted health behaviors during pregnancy has the potential to reduce aggregate rates of LBW. One clinical risk factor associated with LBW is poor oral health status, specifically periodontal infection. First hinted at in a 1931 paper, serious consideration of this linkage was spurred by Offenbacher et al in a 1996 case-control study comparing periodontal examinations of women who delivered LWB babies to those women who delivered babies weighing above the 2500g threshold[12]. Oral health is a vital part of

anyone's overall health and well-being. Poor oral health practices can lead to gum diseases that have been shown to increase the risk for respiratory and cardiovascular disease as well as an increase in the likelihood of complications related to diabetes. Improving oral health for all citizens is a key goal area for Healthy People 2020, although oral health as it specifically relates to pregnancy is not included as an area of needed improvement[13].

The dominant hypothesis regarding the biological pathway that links oral health to higher pregnancy risks is the maternal shift in immunity during pregnancy; this change in cell-mediated immunity to antibody-mediated immunity, and decreased cell-mediated immunity is associated with a greater susceptibility to infections[14]. For women with existing poor oral health, hormonal and immunological changes may exacerbate the dental problems by increasing their risk for gingivitis and granuloma, a lump on gums that makes eating painful and increases the risk of bleeding[15]. Pregnancy also brings with it a greater appetite and the increased need for calories is often met by frequent snacking, which often leads to greater plaque build-up; along with vomiting and acid reflux experienced during pregnancy could compound existing gum disease[16].

In the 15 years since the Offenbacher study[17], many other researchers have looked into the possible link between oral health and birth weight outcomes, often refuting a primary criticism of this relationship that there are too many other risk factors correlated with poor oral health to see a true relationship[18]; the risk factors for periodontal disease include stress, tobacco and alcohol use, high sugar intake, diabetes and HIV[19], risk factors that can lead to LBW as independent factors. Mitchell-Lewis et al found in a case-control study of a low-income minority population that women who had higher oral bacterial loads were more likely to deliver LBW babies[20]. Pitiphat et al used preterm delivery and small-for-gestational age as

a measure for poor pregnancy outcomes among a middle-class, mostly white population and found that the link between periodontal disease and poor pregnancy outcomes holds true[21]. Lopez et al found that among pregnant women who had periodontal disease during pregnancy treatment of that disease during pregnancy was associated with lower odds of having a preterm low weight birth[22]. A recent meta-analysis by Xiong et al[23] found the majority of studies examining the oral health-pregnancy outcome connection found a positive association. Acknowledgment of this linkage by the American Dental Association (ADA), American Academy of Periodontology, and the National Institutes of Health's National Institute of Dental and Craniofacial Research has further enhanced the importance of good oral health leading to healthy birth outcomes. Specifically, the ADA recommends that every woman get a comprehensive exam and any necessary treatment during pregnancy[24].

There is recent evidence from studies of pregnant women that oral health concerns are not being addressed[25]. Adult periodontal infection affects as much as 40% of reproductive age women[26] and a similar rate has been found specifically among pregnant women[27]. Despite mounting evidence supporting the oral health-birth outcomes association[28], and the general impact having positive oral health status has on one's overall health status[29], dental care utilization by pregnant women is very low, mirroring trends in the overall population. In 2010, dental care spending accounted for only 4% of total healthcare spending in the United States[30], a decrease from an already-low 7.5% in 2004[31]. Part of this low utilization rate may be due to most states not providing dental coverage to adults enrolled in their Medicaid system and that many medical insurance plans do not include dental coverage[32]; even among privately-insured women, dental care rates were in the mid-fifties[33].

Lack of insurance, however, does not tell the entire story. Hunter and Yount looked at a low-income Hispanic community in San Diego California with over 92% enrolled in MediCal, California's Medicaid system, after California had expanded dental coverage for MediCal enrollees[34]. Despite high rates of periodontal disease, very few accessed the dental services available to them. Marchi et al[35] looked at a broader sample of pregnant women in California and found that, when controlling for other socioeconomic factors, dental care use was low for all races and income levels. Reasons given in the larger study included perceived lack of need for care, patient thought care was unsafe, and general "attitude barriers" were more significant reasons compared to "financial barriers" for most of the demographic grouping examined. Similarly, a study interviewing low-income pregnant teenagers in New York State, who also have access to dental care through New York's Medicaid system, found "old-wives-tales" and other myths surrounding dental care during pregnancy kept them from seeking care; these included the misperception that pregnancy causes the softening of teeth, tooth loss is due to the fetus "robbing" calcium from the mother and that bleeding gums are a normal part of pregnancy. Other fears expressed in this study that kept women from attending the dentist during pregnancy was the belief that x-rays and medications will harm the fetus, both of which are not supported by the medical literature[36]. Another survey in 2011 found about half of pregnant women did not understand the nature of dental health issues and did not know caries and periodontal disease are oral infections or that sugar can cause caries[37].

Provider disagreement may also be driving low dental care utilization rates among pregnant women. In a 2008 national survey of obstetricians, only 64% of respondents thought women should have an oral health screen during pregnancy, compared to 97% of

dentists. A 2011 survey found a majority of the obstetricians knew periodontal disease can have adverse effects on pregnancy and treating periodontal disease can improve birth outcomes, but most of these same respondents did not ask about their patients' oral health status during regular prenatal visits or advise their patients to see a dentist during their pregnancy[38]. Many of the obstetricians see oral exams as outside their routine practice, and note that dental care was not included in their medical education and is not a research area to which they pay much attention[39]. Medical, nursing and pharmacology students surveyed confirmed a lack of oral health information presented in their curriculums[40]. There is also some disagreement regarding when preventative measures and treatment of infections should occur during the pregnancy, although there is generally consensus that the second trimester is best as the risk of miscarriage drops but the mother will not be uncomfortable sitting for a long period[41]. Furthermore, the risk of women self-medicating if they have dental problems, such as a toothache, is far greater than any properly performed dental procedure[42].

For low-income women in particular, many of the studies advocated getting oral health services at any point during the pregnancy as Medicaid benefits only last 60 days postpartum and women are unlikely to seek care once they have delivered[43]. In addition to the health insurance coverage many women only receive during pregnancy, women may be more receptive to health behavior changes during pregnancy[44], making this an excellent time to introduce new health education. In another study of low-income, urban women, improvements in oral health behaviors and increased numbers of dentist visits were recorded when education was provided by nurses working with this population. One of the particular behavior changes recorded was a reduction in drinking sugared beverages and an increase in milk and water intake following education on how food affects teeth[45]. Nutrients such as

calcium and vitamin D, both found in milk, are important for healthy dentition and health pregnancy outcomes but pregnant women often have insufficient levels of in their bodies[46]. This is one example of the natural connection between nutrition and oral health; the American Dietetic Association supports the integration of oral health into nutrition services, education and research[47]. Investing resources into educating mothers during pregnancy about what affects oral health and important prevention behaviors has shown long-term benefits when their children were checked for caries and healthy teeth both as preschoolers and as early teenagers[48].

One important source of nutrition education is the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), established in 1974 in response to a plateau in the rate of low birth weight babies in the U.S. by providing nutritious food and education on nutrition to low-income women[49]. To qualify for WIC benefits, one has to be at or below the income threshold of 185% of the federal poverty line as well as demonstrate that she is at "nutritional risk;" most who apply do qualify under one of the many factors that determine one is at "nutritional risk"[50]. In addition to providing food vouchers to participants, the WIC program includes education to participants on health and nutrition-related topics as well as some medical referrals. Recent studies in Washington State and New Jersey found that WIC was associated with a reduction in adverse pregnancy outcomes for high risk women[51]; the New Jersey study specifically found these results associated with receiving WIC after controlling for social, behavioral, psychosocial and demographic factors[52]. Another study found WIC reduced risk among racial/ethnic minorities[53].

Despite these positive associations with WIC, overall rates of low birth weight babies have not shown any significant decline in the past two decades, hovering around 8% for the

overall population and over 13% for African Americans[54]. Part of this may be due to a new plateau being reached among pregnant WIC participants as possible gains to nutrition may have been reached, particularly since WIC funding was expanded a few years ago in the federal budget and most eligible women can participate[55]. However, simply changing the make-up of the food package in WIC a couple of years ago found benefits among both WIC recipients and the general community by requiring WIC-approved vendors carry the basket of food[56]. Those in the policy community suggest using WIC offices as a non-medical and non-dental setting to educate parents about the importance of healthy oral behaviors and dental services because it is a place pregnant women go frequently[57]. It is important to help women understand why these services are essential to good health, as a referral or even an appointment made for a pregnant woman is not a guarantee that she will go to that appointment[58]. However, WIC cannot be used as a catch-all for all prenatal education beyond its scope, as evidenced by the poor results seen through smoking cessation programs administered through WIC[59].

The literature illustrates two main points. First is the growing evidence that there is a true association between oral infection during pregnancy and poor birth outcomes, specifically low birth weight and preterm delivery. The second is that, despite great awareness among the dental and prenatal communities, there is a missing link connecting pregnant women to adequate prenatal dental care and education. While some states and professional organization have developed guidelines regarding oral health care during pregnancy, these guidelines are meaningless if they are not translated to everyday clinical use[60]. There is also evidence to show that WIC participation increases dental care usage among children enrolled in the program[61], so WIC nutrition education may also increase the

utilization of dental care services among women enrolled during their pregnancy. Most state Medicaid programs do not provide coverage for dental care beyond emergency services nor do they include education programs, so finding a source of education and access to dental services for the low-income population beyond Medicaid is important in filling the current access gap.

This study specifically focuses on whether WIC does have an impact on the odds that a pregnant woman goes to the dentist during her pregnancy, receives education about how to care for her own oral health, and if the woman receives a preventative cleaning during her pregnancy. Our research questions are as follows:

Research Question: Among WIC-eligible women delivering live birth, does participation in the WIC program during pregnancy affect the likelihood that a woman will seek dental care during that pregnancy?

H_1: Participation in WIC increases the likelihood that a woman seeks dental care during her pregnancy.

Research Question: Among WIC-eligible women delivering live birth, does participation in the WIC program during pregnancy affect the likelihood that a woman without a reported dental problem will seek dental care during that pregnancy?

H_2: Participation in WIC increases the likelihood that a woman without a dental problem seeks preventative dental care during her pregnancy.

III. METHODS

This study aims to determine if a low-income woman who participates in the WIC program during her pregnancy will be more likely to seek dental care during her pregnancy than a woman who is income-eligible for WIC but does not participate in WIC during her pregnancy.

Dataset

Data for this study comes from the Pregnancy Risk Assessment Monitoring System (PRAMS), a joint data collection effort between the Centers for Disease Control and Prevention (CDC) and individual states who choose to participate. With input from the participating states CDC has developed a core questionnaire that every state administers to survey participants, as well as a set of 185 additional optional questions that each state chooses from to create a state-specific survey instrument. The PRAMS survey is currently in its 6th (most recent) phase; data for this study comes from Phase 5 of the survey (2004 - 2008), as well as the first year of data available from Phase 6 (2009). Linked data from infant birth certificates is also included in the final dataset.

Participants in this survey are mothers of randomly selected live births in each participating state selected from the birth certificate records during a given year; between 1,300 and 3,400 women are contacted each year in each participating state. Certain minority populations are oversampled in order to ensure all demographics are represented in the sample. The sample does include multiple gestation infants, but does not include stillbirths, fetal deaths, induced abortions births of adopted infants, births via surrogates and births where the mother is not a resident of the state in which she gave birth.

Women selected to participate are sent a series of mailings between 2 and 4 months following delivery, including an introductory letter, an initial questionnaire packet and a

reminder letter; if the mother does not respond after the reminder letter, she is sent up to two more questionnaire packets. If the mother does not respond to the questionnaire via mail, she is called and the survey is administered over the phone.

The women in the sample are assigned a survey id number and no identifying information, such as name, address, social security number or phone number, are available to researchers using PRAMS data. The data for the PRAMS survey is collected once from each participant, creating a cross-sectional dataset.

The proposal to conduct this data analysis was approved by the CDC as well as granted exemption by the Internal Review Board of Emory University.

Study Design

Research Question: Among WIC-eligible women delivering live birth, does participation in the WIC program during pregnancy affect the likelihood that a woman will seek dental care during that pregnancy?

H_1: Participation in WIC increases the likelihood that a woman seeks dental care during her pregnancy.

Research Question: Among WIC-eligible women delivering live birth, does participation in the WIC program during pregnancy affect the likelihood that a woman without a reported dental problem will seek dental care during that pregnancy?

H_2: Participation in WIC increases the likelihood that a woman without a dental problem seeks preventative dental care during her pregnancy.

Sample

Only some of the states that participate in PRAMS choose to include the supplemental questions about oral health during pregnancy and many of the states do not ask all of the oral health questions. From the states that asked all of the questions in both Phase 5

and Phase 6 of the survey, six states were chosen for the study sample, with an eye towards including geographic and political diversity in the sample population. The states included in this study are Colorado, Hawaii, Maine, Missouri, New York and South Carolina. Colorado, Hawaii and Maine are represented in all six years of data, New York has data for 2004 - 2008, South Carolina has data for 2004 -2007, and Missouri has data for 2007 and 2009. The data for each state in each year has been pooled into one multi-year dataset for each state used in the state-level models as well as one large dataset used for the primary analysis.

Due to the complex survey design used for PRAMS to approximate the general population additional variables were created to identify subpopulations of interest in the dataset. First, a variable identifying women as eligible or not eligible for WIC was created based on household size and reported income over the past year using the Federal WIC income guidelines for 2008-2009. The income variable provided in the dataset is categorical and not set to the same cut-off points as the Federal Poverty Levels so an exact match of household size and income was not possible; as close a match of household size and income was made. Women who reported participating in WIC during their pregnancy were also labeled as eligible for WIC; it is assumed that they were allowed to participate because they were eligible based on household size and annual income. Of the women with income and household size data available, only 1.79% of these women were mislabeled as not eligible for WIC when they did in fact use WIC during their pregnancy using this sorting procedure; they were then moved to the eligible subpopulation. There were also a small number of women who did not report household size or income information who did participate in WIC during their pregnancy. These women were missed in the initial sorting procedure that excluded women with these variables missing, but were added to the final eligible subpopulation,

increasing the eligible subpopulation by 6%. The final subpopulation of eligible women used in this analysis was comprised of 92% determined by income and 8% only by their participation in WIC during their pregnancy.

A second variable was created to identify the women eligible for WIC and who did not report a dental problem. This variable was used in the second set of regression models and in the state-level models. Observations with data missing for the variables included in the regression models were not used in the regressions.

Dependent Variables

There are two supplemental questions in PRAMS that ask about dental care use and oral health during the pregnancy. The first question asks three things: did the woman experience a dental problem during her pregnancy?; did she go to a dentist?; and did a dental professional talk to her about how to care for her teeth? The second question asks if the woman received a dental cleaning during her pregnancy. Copies of the questions are found in the Appendix. Each of these questions will serve as a separate dichotomous variable.

Key Independent Variables

The characteristic of interest in this study is whether a WIC-eligible mother used WIC during her pregnancy. This information is captured in the core PRAMS survey by asking the respondent "During your most recent pregnancy, were you on WIC (the Special Supplemental Nutrition Program for Women, Infants and Children)?" The response options are No or Yes, creating a dichotomous variable.

Covariates for Regression

Selected demographic variables about the mother are included in this analysis based on whether they are expected to have an impact on health behavior choices before and during pregnancy which could impact birth outcomes. Previous research has shown basic demographic factors to impact birth outcomes, so demographic variables, including age at

time of delivery, highest level of education achieved, and race, will be included in the statistical models. Specific descriptions and categorical groupings of these variables are described in Table 1 below.

Other variables speak to the health risks taken during pregnancy and the healthy behaviors engaged in to ensure a healthy birth outcome. Smoking behavior is included as a descriptive variable because of the impact smoking has on oral health and it is an indicator of risk behavior. The Adequacy of Prenatal Care Utilization Index, known as the Kotelchuck Index, is a measure of access and use of general prenatal care services, which could play a role as to whether dental care, a narrow aspect of a broader prenatal care regimen, is accessed. Previous live birth is also included to account for the health education mothers may receive after delivering a baby that could impact the success of later pregnancies.

The PRAMS data also includes a composite variable describing stress during pregnancy, which has been shown to impact level of prenatal care access a woman seeks during pregnancy[62,63]. The stressors included in the core questionnaire that contribute to the composite variable include ill family members, separation or divorce, moving, homelessness, self or partner losing job, arguing with partner, partner not supportive of pregnancy, partner went to jail, self in a physical fight, cannot pay bills, and someone close to woman had drug problem or died. The variable used in this analysis counts the number of stressors a woman reported and grouped them as 1 - 2 stressors, 3- 5 stress and 6 or more stressors.

Insurance status before pregnancy and during pregnancy is included. Having insurance prior to pregnancy is a proxy for pre-conception care, which is not directly available in the data. Health insurance Perceived and actual access to care can impact whether a woman will received necessary prenatal care during her pregnancy.

Finally, a year variable is included to absorb any changes that may have occurred during each year of the survey that could have affected whether a mother sought dental care and a state variable is included to absorb the differences in state-level factors that are present among the states included in this analysis.

Table 1: Study Variables

Variable	Description
Mother's Age	≤ 17 years 18 – 19 years 20 – 24 years 25 – 29 years 30 – 34 years 35 – 39 years 40+ years
Level of Maternal Education	< 12 years (Some HS) 12 years (Completed HS) 13 - 15 years (Some college) 16 or more years (Completed college)
Race/Ethnicity	Non-Hispanic White (NHW) Non-Hispanic Black (NHB) Hispanic Asian (Including Chinese, Japanese, Filipino, Hawaiian) Native American (Including Native Alaskan) Other/Mixed Race
Smoking during Pregnancy	Yes or No
Multivitamin Use (Times taken each week)	Did not take a vitamin 1 – 3 times per week 4 – 6 times per week Every day of the week
Previous Live Birth	Yes or No
Insurance Before Pregnancy	None Medicaid Private/Other
Prenatal Care Paid By	None Medicaid Private/Other
Kotelchuck Index	Inadequate Intermediate Adequate Adequate Plus
Stress Indicator (Number of Stress Events During Pregnancy)	None 1 – 2 3 – 5 6 or more
Year	Year Questionnaire was completed
State	State of Residence

Statistical Analysis

All outcome variables included in this study are dichotomous, which leads us to use a logistic regression model for each analysis.

Logistic Model: $$logit(P_i) = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_j x_j + \varepsilon$$

Analysis 1a: Using the answer to question Y1b, we used a logistic regression to examine if participation in WIC predicts whether or not a woman went to see a dentist or dental clinic during her pregnancy.

Model: P(Saw Dentist) = $\beta_0 + \beta_1$[WIC] + β_2[age] + β_3[education] + β_4[race] + β_5[smoking] + β_6[stress] + β_7[Insurance Before] + β_8[Insurance During] + β_9[Kotelchuck] + β_{10}[Year] + β_{11}[State]

Analysis 1b: Using the same model as above, but also including whether or not the woman answered positively to question Y1a to see if having a dental problem had an impact on the likelihood the woman went to the dentist.

Model: P(Saw Dentist if Problem) $\beta_0 + \beta_1$[WIC] + β_2[age] + β_3[education] + β_4[race] + β_5[smoking] + β_6[stress] + β_7[Insurance Before] + β_8[Insurance During] + β_9[Kotelchuck] + β_{10}[Year] + β_{11}[State]+ β_{12}[Dental Problem]

Analysis 2a: Using the answer to question Y1c, we examined if participating in WIC increased the likelihood that a woman was taught to take care of her teeth.

Model: P(Learned Oral Health Techniques) = $\beta_0 + \beta_1$[WIC] + β_2[age] + β_3[education] + β_4[race] + β_5[smoking] + β_6[stress] + β_7[Insurance Before] + β_8[Insurance During] + β_9[Kotelchuck] + β_{10}[Year] + β_{11}[State]

Analysis 2b: Using the same model as above, but also including whether or not the woman answered positively to question Y1a to see if having a dental problem had an impact the likelihood the woman went to the dentist.

Analysis 3a: Using the answer to question Y3, we examined if participating in WIC increased the likelihood of a women getting her teeth cleaned during her pregnancy, a preventative service.

Model: $P(\text{Teeth Cleaning}) = \beta_0 + \beta_1[\text{WIC}] + \beta_2[\text{age}] + \beta_3[\text{education}] + \beta_4[\text{race}] + \beta_5[\text{smoking}] + \beta_6[\text{stress}] + \beta_7[\text{Insurance Before}] + \beta_8[\text{Insurance During}] + \beta_9[\text{Kotelchuck}] + \beta_{10}[\text{Year}] + \beta_{11}[\text{State}]$

Analysis 3b: Using the same model as above, but also including whether or not the woman answered positively to question Y1a to see if having a dental problem had an impact the likelihood the woman went to the dentist.

Analysis 4: This analysis used the models in Analyses 1a, 2a and 3a for the subpopulation of women who were eligible for WIC and did not report a dental problem to see if WIC participation among women without a dental problem impacted the odds a woman went to the dentist, received dental education and received preventative care from a dental cleaning.

Analysis 5: This analysis used the model from Analysis 3a for each of the six state datasets to see if the odds that a woman received preventative dental care during her pregnancy differed between the six states and if any of the states saw a significant increase in the odds a woman would receive preventative care.

For all models, an alpha level of 0.05 was used to determine statistical significance. Data cleaning, variable creation, data management and regression analyses were performed using SAS v9.3 (SAS Institute, Cary, NC, 2010). The Proc Survey Logistic function was

used to generate the regression results; survey weights included with the dataset from the CDC were used to maintain the weighting in the original dataset; domain analysis was used to analyze the subpopulations of interest (WIC Eligible and WIC Eligible with No Dental Problem) in each regression model.

IV. RESULTS

Descriptive Statistics

The sample population is comprised of 27,235 women eligible for WIC based on their household size and income 12 months prior to giving birth and or if they reported participating in the WIC program during their pregnancy. Of the women eligible, 17,120 (62.9%) participated in WIC during their most recent pregnancy. Table 2 below summarizes the descriptive statistics for the entire study population as well as the two participation subgroups. A Chi-Square test of each variable found a significant difference between the Participated group and Not Participated group at the $p < 0.0001$ for all variables except Survey year ($p = 0.09$) and the Kotelchuck Index ($p = 0.0004$). There are many variables with missing values, though only the outcome variable asking about dental cleanings during pregnancy had a large percent of the observations missing data (37.1%); all other independent and outcome variables had less than 5% of the observations missing data.

Table 2: Independent Variables Included in Regression Models

Variable	Total (n=27,235)	%	Participated in WIC (n=17120)	%	Did not Participate in WIC (n=10116)	%
Mother's Age						
17 or younger	1063	0.04	886	0.05	177	0.01
18 - 19	2436	0.09	1985	0.12	451	0.03
20 - 24	8593	0.32	6089	0.36	2504	0.15
25 - 29	7323	0.27	4407	0.26	2916	0.17
30 - 34	4642	0.17	2366	0.14	2276	0.13
35 - 39	2536	0.09	1137	0.07	1399	0.08
40 or older	642	0.02	249	0.01	393	0.02
Education						
Less than 12 Years	5457	0.20	4380	0.26	1077	0.11
Completed HS	10284	0.38	6955	0.41	3329	0.33
Some College	7486	0.28	4337	0.26	3149	0.32
Completed College	3665	0.14	1230	0.07	2435	0.24
Race						
NH White	13587	0.50	7745	0.45	5842	0.58
NH Black	3195	0.12	2578	0.15	617	0.06
Hispanic	4963	0.18	3616	0.21	1347	0.13
Asian	2177	0.08	1086	0.06	1091	0.11
Hawaiian/Pacific Islander	2864	0.11	1792	0.10	1072	0.11
Other/Mixed	404	0.01	272	0.02	132	0.01
Smoked						
No	22822	0.84	13923	0.81	8899	0.88

Yes	4365	0.16	3168	0.19	1197	0.12
Vitamin Use						
Did Not Take	17260	0.64	11553	0.68	5707	0.57
1 - 3 per week	2314	0.09	1305	0.08	1009	0.10
4 - 6 per week	1246	0.05	603	0.04	643	0.06
Everyday	6323	0.23	3596	0.21	2727	0.27
Stressors (Grouped)						
None	5877	0.22	3249	0.19	2628	0.26
1 - 2 events	10894	0.40	6524	0.38	4370	0.43
3 - 5 events	7915	0.29	5410	0.32	2505	0.25
6 or more events	2338	0.09	1782	0.11	556	0.06
Previous Live Birth						
No	10957	0.41	7526	0.45	3431	0.34
Yes	15925	0.59	9319	0.55	6606	0.66
Insurance Before Pregnancy						
None	9001	0.33	6520	0.38	2481	0.25
Medicaid	4968	0.18	4051	0.24	917	0.09
Private/Other	13139	0.48	6447	0.38	6692	0.66
Prenatal Care Paid By						
None	1861	0.07	1097	0.07	764	0.08
Medicaid	12986	0.50	10507	0.64	2479	0.26
Private/Other	11165	0.43	4800	0.29	6365	0.66
Kotelchuck Index						
Inadequate	3976	0.15	2549	0.15	1427	0.14
Intermediate	3464	0.13	2040	0.12	1424	0.14
Adequate	9329	0.35	5586	0.34	3743	0.38
Adequate Plus	9806	0.37	6483	0.39	3323	0.34
Needed to See Dentist for Problem						
No	14663	0.69	11394	0.68	7432	0.75
Yes	6461	0.31	5338	0.32	2492	0.25
Year of Survey						
2004	5180	0.19	3199	0.19	1981	0.20
2005	4904	0.18	3108	0.18	1796	0.18
2006	3915	0.14	2393	0.14	1522	0.15
2007	5714	0.21	3645	0.21	2069	0.20
2008	3684	0.14	2292	0.13	1392	0.14
2009	3839	0.14	2483	0.15	1356	0.13
State						
Colorado	7213	0.26	4281	0.25	2932	0.29
Hawaii	7374	0.27	4181	0.24	3193	0.32
Maine	4171	0.15	2534	0.15	1637	0.16
Missouri	1851	0.07	1240	0.07	611	0.06
New York	2588	0.10	1840	0.11	748	0.07
South Carolina	4039	0.15	3044	0.18	995	0.10

Outcome Variables

Table 3 summarizes the distribution of the study population by each outcome variable of interest.

Table 3: Study Population by Outcomes of Interest for Regressions

Variable		Total	%	Participated in WIC	Row %	Did not Participate in WIC	%
Went to a dentist or dental clinic							
	No	14392	68.5	11546	80.2	2846	19.8
	Yes	6629	31.5	5090	76.8	1539	23.2
Dental Professional Talked about Oral Care							
	No	13347	63.8	10516	78.8	2831	21.2
	Yes	7578	36.2	6057	79.9	1521	20.1
Dental Cleaning during Pregnancy[+]							
	No	10379	74.8	8278	79.8	2101	20.2
	Yes	3491	25.2	2587	74.1	904	25.9

+ More than 30% missing

Analysis 1: Went to Dentist

The first regression model finds the odds of a woman going to the dentist increased by 10.5% when she participates in WIC [95%: 0.989, 1.235], a number that approaches statistical significance (p=0.078) at the 0.05 threshold. The odds ratio and 95% confidence intervals for each descriptive variable are listed below in Table 4. In addition, having a college degree, taking a daily multivitamin, getting better quality prenatal care and having private insurance coverage before pregnancy or any type of insurance during pregnancy did increase the odds of going to the dentist at a statistically significant level. Notably, Hawaiian women had significantly lower odds of going to the dentist.

The second model (Model 2) also looks at whether WIC participation predicted going to the dentist, but included the variable "having a dental problem" to see if having a major oral problem during pregnancy impacted the odds of going to the dentist. This change reduced the odds ratio for whether participating in WIC increased the likelihood to going to the dentist to 1.055 [95%: 0.938, 1.187], moving the results away from statistical significance (p=0.265). However, for women experiencing a dental problem, the odds of going to the dentist during pregnancy approached five times that of women who did not experience a problem (p<0.0001). Similar to the first model, vitamin use, a college education, insurance coverage and more prenatal visits increased the odds of going to the dentist. Most of the age

groups and women experiencing major stress events during pregnancy saw significantly lower odds of visiting the dentist. The results for this model are found in Table 4 below.

Table 4: Logistic Regression Models of Going to Dentist during Pregnancy

	Model 1: Went to Dentist			Model 2: Went to Dentist		
	OR	95% CI		OR	95% CI	
WIC Participation						
No	ref					
Yes	1.105	0.989	1.235	1.055	0.938	1.187
Experienced Dental Problem						
No				ref		
Yes				4.77***	4.235	5.373
Mother's Age						
17 or younger	ref					
18 - 19	0.892	0.657	1.211	0.791	0.57	1.097
20 - 24	0.744*	0.559	0.991	0.626**	0.461	0.849
25 - 29	0.73	0.54	0.986	0.549**	0.4	0.756
30 - 34	0.793	0.579	1.086	0.594**	0.426	0.828
35 - 39	0.83	0.592	1.164	0.7*	0.491	0.997
40 or older	0.802	0.51	1.26	0.625*	0.391	0.999
Education						
Less than 12 Years	ref					
Completed HS	0.976	0.839	1.137	1.03	0.879	1.208
Some College	1.101	0.933	1.301	1.187	0.997	1.414
Completed College	1.436**	1.178	1.75	1.698***	1.372	2.102
Race						
NH White	ref					
NH Black	0.868	0.722	1.043	0.836	0.689	1.015
Hispanic	0.765	0.655	0.893	0.817*	0.693	0.964
Asian	0.778	0.602	1.006	0.728*	0.561	0.944
Hawaiian/PI	0.611***	0.512	0.731	0.615***	0.513	0.739
Other/Mixed	0.969	0.66	1.421	0.899	0.597	1.354
Smoked During Preg.						
No	ref					
Yes	1.014	0.875	1.175	0.885	0.758	1.033
Vitamin Use						
Did Not Take	ref					
1 - 3 per week	1.267**	1.069	1.501	1.262*	1.049	1.519
4 - 6 per week	1.352**	1.081	1.691	1.353*	1.059	1.729
Everyday	1.298***	1.148	1.467	1.397***	1.228	1.59
Stressors (Grouped)						
None	ref					
1 - 2 events	0.888	0.78	1.009	0.817**	0.714	0.935
3 - 5 events	0.783**	0.679	0.902	0.615***	0.529	0.715
6 or more events	0.861	0.702	1.056	0.607***	0.489	0.755
Previous Live Birth						
No	ref					
Yes	0.959	0.851	1.081	0.875*	0.772	0.991
Insurance Before Pregnancy						
None	ref					
Medicaid	1.182*	1.007	1.388	1.276**	1.076	1.514
Private/Other	1.32**	1.134	1.536	1.553***	1.32	1.828
Prenatal Care Paid By						
None	ref					
Medicaid	1.39**	1.122	1.723	1.18	0.939	1.483

Private/Other	1.573***	1.248	1.981	1.442**	1.126	1.846
Kotelchuck Index						
Inadequate	ref					
Intermediate	1.374**	1.137	1.66	1.416**	1.16	1.727
Adequate	1.261**	1.075	1.479	1.34**	1.131	1.587
Adequate Plus	1.336**	1.133	1.576	1.356**	1.138	1.616
Year of Survey						
2004	ref					
2005	0.931	0.788	1.1	0.967	0.812	1.152
2006	0.999	0.837	1.193	0.974	0.806	1.178
2007	1.021	0.865	1.205	1.021	0.857	1.218
2008	1.094	0.908	1.317	1.131	0.929	1.378
2009	1.116	0.939	1.326	1.218	1.013	1.463
State						
Colorado	ref					
Hawaii	1.223**	1.059	1.412	1.166*	1.004	1.354
Maine	0.945	0.829	1.077	0.954	0.83	1.098
Missouri	0.823*	0.688	0.984	0.767**	0.635	0.928
New York	1.372***	1.185	1.588	1.366***	1.17	1.596
South Carolina	1.029	0.87	1.217	1.009	0.845	1.206

* P < 0.05 ** P < 0.01
*** P <0.0001

Analysis 2: Dental Education

The second question asked if participating in WIC improved the likelihood of a dental or healthcare worker talking to the woman about how to take care of her teeth and gums. The odds for someone talking to a woman about oral care increased by 16% among the women participating in WIC compared to those who did not participate [95%: 1.039, 1.296], a result that is significant at the 0.05 level (p=0.008). When the variable about having a dental problem was included in the model (Model 4), WIC participation variable still shows a statistically significant increase in the odds a woman will receive dental education, but at a slightly lower odds of 12% (p=0.042). Among the other descriptive variables, a woman was also more likely to talk to a healthcare worker about her oral health if she had insurance before and during pregnancy, was non-Hispanic Black or took a multivitamin daily. Again, having a dental problem more than doubled a woman's odds of receiving information about oral health care (p<0.0001) A woman was less likely to have someone talk to her about oral care if she had a higher number of stressors during pregnancy, had completed high school or

some college, or smoked. The odds of receiving dental education decreased significantly at the 0.05 level as the woman aged. The full results for these models are below in Table 5.

Table 5: Logistic Regression Models of Receiving Dental Education during Pregnancy

	Model 3: Dental Education			Model 4: Dental Education		
	OR	95% CI		OR	95% CI	
WIC Participation						
No	ref					
Yes	1.16**	1.039	1.296	1.124*	1.004	1.259
Experienced Dental Problem						
No				ref		
Yes				2.491***	2.23	2.783
Mother's Age						
17 or younger	ref					
18 - 19	0.785	0.586	1.052	0.74	0.548	1
20 - 24	0.743*	0.565	0.977	0.682**	0.515	0.904
25 - 29	0.669**	0.501	0.892	0.58**	0.431	0.78
30 - 34	0.67**	0.495	0.907	0.576**	0.422	0.787
35 - 39	0.608	0.439	0.843	0.556**	0.398	0.777
40 or older	0.676	0.437	1.047	0.592*	0.378	0.926
Education						
Less than 12 Years	ref					
Completed HS	0.828**	0.718	0.956	0.848*	0.733	0.982
Some College	0.793**	0.676	0.93	0.82*	0.697	0.964
Completed College	0.972	0.801	1.179	1.058	0.867	1.291
Race						
NH White	ref					
NH Black	1.308**	1.098	1.559	1.298**	1.085	1.552
Hispanic	1.003	0.865	1.163	1.065	0.915	1.239
Asian	0.85	0.669	1.08	0.828	0.653	1.049
Hawaiian/PI	0.916	0.767	1.095	0.95	0.789	1.144
Other/Mixed	1.318	0.896	1.941	1.279	0.85	1.922
Smoked During Preg.						
No	ref					
Yes	0.941	0.815	1.087	0.871	0.754	1.007
Vitamin Use						
Did Not Take	ref					
1 - 3 per week	1.266**	1.071	1.497	1.235*	1.038	1.469
4 - 6 per week	1.178	0.937	1.48	1.147	0.903	1.456
Everyday	1.366***	1.21	1.542	1.4***	1.238	1.583
Stressors (Grouped)						
None	ref					
1 - 2 events	0.901	0.793	1.024	0.86*	0.755	0.979
3 - 5 events	0.845*	0.735	0.972	0.744***	0.644	0.858
6 or more events	0.749**	0.612	0.916	0.618***	0.505	0.757
Previous Live Birth						
No	ref					
Yes	0.941	0.838	1.057	0.899	0.799	1.011
Insurance Before Pregnancy						
None	ref					
Medicaid	1.123	0.964	1.309	1.176*	1.006	1.376
Private/Other	1.094	0.945	1.268	1.19*	1.023	1.383
Prenatal Care Paid By						
None	ref					
Medicaid	1.25*	1.027	1.522	1.115	0.911	1.365

Private/Other	1.488**	1.196	1.85	1.385**	1.106	1.734
Kotelchuck Index						
Inadequate	ref					
Intermediate	1.121	0.936	1.342	1.134	0.945	1.36
Adequate	1.027	0.882	1.195	1.059	0.906	1.238
Adequate Plus	1.152	0.985	1.348	1.157	0.985	1.359
Year of Survey						
2004	ref					
2005	1.02	0.867	1.2	1.043	0.884	1.23
2006	0.929	0.78	1.107	0.905	0.756	1.083
2007	0.964	0.819	1.134	0.966	0.819	1.14
2008	1.029	0.858	1.233	1.038	0.861	1.251
2009	1.114	0.939	1.321	1.157	0.972	1.377
State						
Colorado	ref					
Hawaii	1.295**	1.124	1.491	1.262**	1.092	1.457
Maine	0.954	0.838	1.086	0.959	0.84	1.096
Missouri	0.763**	0.639	0.911	0.737**	0.616	0.883
New York	1.019	0.881	1.178	0.995	0.858	1.154
South Carolina	0.904	0.768	1.066	0.887	0.75	1.05

* P < 0.05 ** P < 0.01
*** P <0.0001

Analysis 3: Preventative Care

The next set of models looked at preventative dental care during pregnancy, specifically if participating in WIC during pregnancy led to getting one's teeth cleaned during pregnancy. Like the first two outcomes, participation in WIC shows a trend of increasing odds that a woman receives preventative dental care during her pregnancy. However, the effect is not large and neither model approaches the 0.05 threshold for significance for those women who participate in WIC during their pregnancy (Model 5: p=0.241, Model 6: p=0.431). Like receiving increased dental education, a woman's odds of receiving preventative care doubles if she experiences a dental problem (p<0.001). Trends in other variables in the models follow similar patterns of increasing or decreasing odds of receiving care as the previous models. All results are found below in Table 6.

Table 6: Logistic Regression Models of Receiving a Preventative Dental Cleaning during Pregnancy

	Model 5: Cleaning During Pregnancy			Model 6: Cleaning During Pregnancy		
	OR	95% CI		OR	95% CI	
WIC Participation						
No	ref					
Yes	1.087	0.946	1.249	1.059	0.919	1.22
Experienced Dental Problem						
No				ref		
Yes				2.016***	1.749	2.324
Mother's Age						
17 or younger	ref					
18 - 19	0.799	0.553	1.153	0.779	0.534	1.136
20 - 24	0.609**	0.431	0.859	0.593**	0.417	0.843
25 - 29	0.593**	0.412	0.854	0.541**	0.373	0.785
30 - 34	0.613*	0.419	0.897	0.558**	0.378	0.823
35 - 39	0.691	0.459	1.042	0.663	0.437	1.005
40 or older	0.715	0.403	1.27	0.689	0.388	1.222
Education						
Less than 12 Years	ref					
Completed HS	1.019	0.837	1.24	1.036	0.849	1.265
Some College	1.074	0.873	1.322	1.1	0.89	1.359
Completed College	1.556**	1.212	1.998	1.66***	1.284	2.146
Race						
NH White	ref					
NH Black	0.782*	0.627	0.977	0.764*	0.609	0.959
Hispanic	0.891	0.734	1.083	0.907	0.744	1.105
Asian	0.499*	0.292	0.852	0.475**	0.272	0.83
Hawaiian/PI	0.502**	0.319	0.791	0.457**	0.274	0.762
Other/Mixed	1.131	0.698	1.833	1.112	0.686	1.802
Smoked During Preg.						
No	ref					
Yes	0.762**	0.631	0.921	0.71**	0.586	0.859
Vitamin Use						
Did Not Take	ref					
1 - 3 per week	1.237	0.999	1.532	1.244	0.996	1.554
4 - 6 per week	1.243	0.952	1.624	1.292	0.972	1.716
Everyday	1.358***	1.163	1.586	1.421***	1.213	1.664
Stressors (Grouped)						
None	ref					
1 - 2 events	0.797**	0.678	0.938	0.775**	0.657	0.915
3 - 5 events	0.614***	0.514	0.734	0.572***	0.477	0.686
6 or more events	0.628**	0.485	0.813	0.555***	0.425	0.724
Previous Live Birth						
No	ref					
Yes	0.91	0.782	1.059	0.872	0.748	1.017
Insurance Before Pregnancy						
None	ref					
Medicaid	1.069	0.873	1.31	1.125	0.916	1.381
Private/Other	1.312**	1.082	1.592	1.416**	1.161	1.728
Prenatal Care Paid By						
None	ref					
Medicaid	1.417*	1.086	1.85	1.302	0.992	1.71
Private/Other	1.641**	1.226	2.197	1.544**	1.146	2.08
Kotelchuck Index						
Inadequate	ref					
Intermediate	1.449**	1.132	1.854	1.461**	1.137	1.877

Adequate	1.38**	1.12	1.7	1.389**	1.125	1.716
Adequate Plus	1.32*	1.066	1.635	1.293*	1.041	1.606
Year of Survey						
2004	ref					
2005	1.025	0.836	1.255	1.057	0.859	1.3
2006	1.011	0.809	1.263	1.014	0.807	1.274
2007	1.03	0.837	1.268	1.046	0.845	1.294
2008	0.983	0.779	1.241	1.003	0.788	1.276
2009	1.551**	1.166	2.063	1.664**	1.243	2.228
State						
Colorado	ref					
Hawaii	0.828	0.561	1.221	0.816	0.545	1.222
Maine	1.054	0.895	1.241	1.042	0.882	1.231
Missouri	0.813	0.633	1.044	0.789	0.611	1.018
New York	1.646***	1.389	1.951	1.602***	1.348	1.905
South Carolina	1.149	0.94	1.403	1.137	0.929	1.393

* P < 0.05 ** P < 0.01 *** P <0.0001

Analysis 4: Modeling Outcomes without Dental Problems

The previous analyses showed the dental problem variable driving some of the significance as to whether WIC participants received dental care. This set of analysis restricts the dataset to just those women who do not report a dental problem during their pregnancy. Seen below in Table 7, none of the models show a significant increase in the odds that women participating in WIC will go to the dentist (p=0.780), receive dental education (p=0.440) or receive preventative dental care (p=0.655) compared to the women who did not participate. Some of the trends in other variables do persist in these models for women without a dental problem, indicating that they have an impact on accessing dental care for any woman eligible for WIC, not just those with a reported problem.

Table 7: Logistic Regression Models of Going to Dentist, Receiving Dental Education and Preventative Care for Women Not Reporting a Dental Problem during Pregnancy

	Model 7: Went to Dentist			**Model 8: Dental Education**			**Model 9: Cleaning During Pregnancy**		
	OR	95% CI		OR	95% CI		OR	95% CI	
WIC Participation									
No	ref								
Yes	1.021	0.884	1.179	1.054	0.922	1.206	1.04	0.875	1.237
Mother's Age									
17 or younger	ref								
18 - 19	0.775	0.52	1.157	0.727	0.516	1.026	0.77	0.485	1.224
20 - 24	0.548**	0.375	0.8	0.651**	0.472	0.899	0.547**	0.357	0.839
25 - 29	0.482**	0.324	0.717	0.561**	0.398	0.791	0.552*	0.351	0.87
30 - 34	0.508**	0.337	0.765	0.583**	0.407	0.835	0.606*	0.379	0.97
35 - 39	0.573*	0.371	0.885	0.511**	0.347	0.751	0.611	0.37	1.009

40 or older	0.449**	0.252	0.802	0.525*	0.311	0.884	0.508	0.257	1.006
Education									
Less than 12 Years	ref								
Completed HS	1.093	0.875	1.365	0.843	0.702	1.011	1.014	0.778	1.32
Some College	1.396**	1.1	1.772	0.784*	0.639	0.961	1.181	0.894	1.561
Completed College	2.118***	1.621	2.767	1.137	0.897	1.44	1.69**	1.226	2.33
Race									
NH White	ref								
NH Black	0.805	0.624	1.038	1.367**	1.093	1.709	0.744*	0.555	0.997
Hispanic	0.835	0.678	1.028	1.129	0.941	1.355	0.822	0.642	1.051
Asian	0.602**	0.427	0.849	0.786	0.6	1.03	0.514	0.258	1.024
Hawaiian/PI	0.496***	0.404	0.609	0.924	0.743	1.15	0.526*	0.311	0.89
Other/Mixed	0.951	0.574	1.575	1.564	0.958	2.552	0.961	0.515	1.796
Smoked During Preg									
No	ref								
Yes	0.794*	0.633	0.995	0.794*	0.653	0.966	0.604**	0.46	0.792
Vitamin Use									
Did Not Take	ref								
1 - 3 per week	1.397**	1.109	1.76	1.289*	1.045	1.588	1.507**	1.148	1.977
4 - 6 per week	1.683**	1.285	2.206	1.397*	1.069	1.825	1.731**	1.26	2.377
Everyday	1.464***	1.253	1.709	1.404***	1.215	1.623	1.556***	1.293	1.873
Stressors (Grouped)									
None	ref								
1 - 2 events	0.844*	0.72	0.99	0.877	0.755	1.018	0.837	0.689	1.018
3 - 5 events	0.667***	0.555	0.802	0.793**	0.669	0.94	0.569***	0.455	0.711
6 or more events	0.638**	0.462	0.881	0.556***	0.419	0.738	0.601**	0.415	0.871
Previous Live Birth									
No	ref								
Yes	0.954	0.815	1.117	0.944	0.818	1.089	0.842	0.697	1.019
Insurance Before Pregnancy									
None	ref								
Medicaid	1.36*	1.068	1.734	1.21	0.988	1.481	1.171	0.889	1.542
Private/Other	1.671***	1.354	2.062	1.179	0.981	1.417	1.725***	1.352	2.201
Prenatal Care Paid By									
None	ref								
Medicaid	1.261	0.928	1.712	1.108	0.872	1.408	1.222	0.875	1.707
Private/Other	1.629**	1.184	2.243	1.416**	1.087	1.845	1.359	0.953	1.939
Kotelchuck Index									
Inadequate	ref								
Intermediate	1.349*	1.038	1.753	0.955	0.763	1.195	1.478*	1.075	2.034
Adequate	1.331*	1.065	1.664	1.026	0.847	1.242	1.383*	1.055	1.814
Adequate Plus	1.408**	1.115	1.777	1.169	0.957	1.427	1.352*	1.019	1.792
Year of Survey									
2004	ref								
2005	0.926	0.743	1.153	1	0.82	1.22	0.927	0.722	1.19
2006	1.008	0.797	1.274	0.949	0.763	1.18	0.975	0.739	1.287
2007	1.031	0.827	1.285	0.935	0.765	1.141	0.985	0.76	1.275
2008	1.121	0.88	1.427	1.087	0.872	1.355	0.97	0.728	1.291
2009	1.283*	1.028	1.6	1.147	0.933	1.41	1.543*	1.088	2.189
State									
Colorado	ref								
Hawaii	1.278**	1.071	1.526	1.36**	1.148	1.611	0.85	0.525	1.377
Maine	1.166	0.985	1.381	1.072	0.914	1.258	1.287*	1.051	1.577
Missouri	0.802	0.63	1.021	0.725**	0.579	0.909	0.716*	0.52	0.986
New York	1.459***	1.2	1.773	0.972	0.81	1.167	1.756***	1.418	2.175
South Carolina	1.257*	1.005	1.572	1.024	0.832	1.259	1.295*	1.006	1.666

* P < 0.05 ** P < 0.01 *** P <0.0001

Analysis 5: State-Level Preventative Care

These models set out to answer the second research question by looking at patterns within each of the six states used in this analysis for whether a woman received a dental cleaning during her pregnancy. The models (found in Tables 8 and 9) also used the observations which did not report having a dental problem. None of the states had a significant increase in preventative care among the women who participated in WIC. The directionality of the effect of the program had a positive impact in Colorado, Hawaii and South Carolina while WIC participation decreased the odds of receiving a dental cleaning during pregnancy in Maine, Missouri and New York. Very few of the other variables included in the regressions had a significant effect on preventative care in either direction for all of the states examined, including those variables which had a consistent effect when the data from all of the states was pooled together. Notably, participation in New York decreased the odds of receiving preventative dental care in the state-specific regression while New York had a significant positive impact on getting preventative care when the states were pooled (see Table 7).

Table 8: Logistic Regression Model of Receiving Preventative Care in Colorado, Hawaii and Maine

	Colorado			Hawaii			Maine		
	OR	95% CI		OR	95% CI		OR	95% CI	
WIC Participation									
No	ref								
Yes	1.184	0.899	1.56	1.424	0.851	2.385	0.95	0.732	1.232
Mother's Age									
17 or younger	ref								
18 - 19	0.881	0.443	1.75	0.381	0.08	1.813	2.509	0.951	6.623
20 - 24	0.582	0.312	1.085	0.292	0.062	1.376	1.14	0.441	2.949
25 - 29	0.639	0.321	1.273	0.256	0.054	1.21	1.171	0.44	3.12
30 - 34	0.705	0.345	1.441	0.407	0.079	2.108	1.78	0.648	4.891
35 - 39	0.678	0.31	1.484	0.229	0.04	1.321	2.273	0.801	6.449
40 or older	0.379	0.137	1.046	0.111*	0.015	0.833	1.863	0.562	6.179
Education									
Less than 12 Years	ref								
Completed HS	1.039	0.715	1.509	1.56	0.606	4.018	0.976	0.612	1.556
Some College	1.509*	1.016	2.241	0.749	0.251	2.236	1.221	0.744	2.003
Completed College	2.19**	1.398	3.431	1.354	0.449	4.079	1.406	0.819	2.414

Race									
NH White	ref								
NH Black	0.452*	0.209	0.975	2.025	0.518	7.927	0.632	0.198	2.018
Hispanic	1.022	0.761	1.373	0.79	0.349	1.788	0.627	0.19	2.067
Asian	0.539	0.175	1.657	0.425	0.174	1.041	1.643	0.571	4.728
Hawaiian/PI	0.658	0.111	3.888	0.397	0.205	0.768	not available		
Other/Mixed	2.229	0.948	5.242	1.27	0.131	12.36	2.872*	1.049	7.864
Smoked During Pregnancy									
No	ref								
Yes	0.631	0.388	1.024	0.895	0.308	2.602	0.734	0.523	1.031
Vitamin Use									
Did Not Take	ref								
1 - 3 per week	1.004	0.661	1.525	1.209	0.47	3.113	2.257**	1.479	3.445
4 - 6 per week	1.581	0.969	2.579	1.148	0.37	3.559	1.34	0.833	2.154
Everyday	1.377*	1.046	1.812	1.134	0.608	2.115	1.548**	1.192	2.011
Stressors (Grouped)									
None	ref								
1 - 2 events	1.055	0.777	1.433	1.591	0.88	2.875	0.916	0.682	1.231
3 - 5 events	0.779	0.544	1.116	1.397	0.683	2.858	0.684*	0.492	0.951
6 or more events	0.784	0.436	1.412	0.275	0.036	2.067	0.826	0.501	1.364
Previous Live Birth									
No	ref								
Yes	0.83	0.606	1.137	1.411	0.799	2.489	0.892	0.676	1.178
Insurance Before Pregnancy									
None	ref								
Medicaid	1.647	0.978	2.772	0.472	0.159	1.403	1.603*	1.075	2.391
Private/Other	2.583***	1.782	3.746	1.684	0.559	5.073	2.434***	1.661	3.567
Prenatal Care Paid By									
None	ref								
Medicaid	1.25	0.817	1.912	3.292	0.818	13.25	0.46**	0.258	0.822
Private/Other	1.447	0.922	2.27	2.264	0.534	9.597	0.923	0.524	1.625
Kotelchuck Index									
Inadequate	ref								
Intermediate	1.525	0.974	2.388	0.449	0.171	1.176	0.756	0.36	1.589
Adequate	1.349	0.912	1.996	1.289	0.581	2.861	1.397	0.767	2.546
Adequate Plus	1.232	0.795	1.908	1.172	0.512	2.683	1.406	0.769	2.572
Year of Survey									
2004	ref			not available			ref		
2005	1.354	0.934	1.961				1.356	0.922	1.994
2006	1.587*	1.082	2.327				1.11	0.744	1.654
2007	1.126	0.774	1.636				1.116	0.759	1.641
2008	1.249	0.854	1.828				1.103	0.747	1.63
2009	not available						1.684**	1.155	2.454

* P < 0.05 ** P < 0.01 *** P <0.0001

Table 9: Logistic Regression Model of Receiving Preventative Care in Missouri, New York and South Carolina

	Missouri			New York			South Carolina		
	OR	95% CI		OR	95% CI		OR	95% CI	
WIC Participation									
No	ref								
Yes	0.858	0.53	1.391	0.938	0.652	1.351	1.285	0.79	2.089
Mother's Age									
17 or younger	ref								
18 - 19	1.277	0.337	4.841	0.374	0.122	1.149	1.021	0.418	2.494

20 - 24	0.904	0.256	3.194	0.397	0.149	1.059	0.417	0.165	1.052
25 - 29	0.588	0.142	2.444	0.44	0.156	1.24	0.331*	0.126	0.871
30 - 34	0.967	0.227	4.12	0.362	0.125	1.051	0.486	0.17	1.388
35 - 39	0.71	0.153	3.292	0.411	0.135	1.256	0.486	0.157	1.504
40 or older	1.51	0.246	9.268	0.343	0.079	1.492	0.378	0.082	1.735
Education									
Less than 12 Years	ref								
Completed HS	1.06	0.482	2.329	1.097	0.621	1.937	0.689	0.366	1.298
Some College	1.327	0.572	3.077	1.049	0.596	1.845	1.042	0.539	2.017
Completed College	1.494	0.589	3.786	1.481	0.719	3.053	1.771	0.803	3.907
Race									
NH White	ref								
NH Black	1.471	0.748	2.891	0.544	0.286	1.037	0.748	0.487	1.147
Hispanic	0.38	0.128	1.13	0.663	0.405	1.085	0.449	0.161	1.25
Asian	0.979	0.181	5.301	0.47	0.103	2.142	0.541	0.046	6.39
Hawaiian/PI	not available			0.293	0.023	3.75	not available		
Other/Mixed	not available			0.782	0.316	1.932	0.379	0.1	1.438
Smoked During Pregnancy									
No	ref								
Yes	0.904	0.475	1.719	0.544*	0.327	0.904	0.453*	0.215	0.955
Vitamin Use									
Did Not Take	ref								
1 - 3 per week	1.597	0.801	3.182	2.573**	1.398	4.733	0.801	0.383	1.673
4 - 6 per week	1.314	0.612	2.819	3.069**	1.494	6.304	0.866	0.349	2.152
Everyday	1.651*	1.009	2.702	2.083**	1.412	3.073	0.994	0.612	1.613
Stressors (Grouped)									
None	ref								
1 - 2 events	0.835	0.519	1.342	0.716	0.47	1.092	0.616	0.377	1.009
3 - 5 events	0.654	0.38	1.126	0.388***	0.239	0.63	0.473*	0.267	0.839
6 or more events	0.544	0.234	1.266	0.452	0.202	1.011	0.537	0.222	1.298
Previous Live Birth									
No	ref								
Yes	0.993	0.605	1.631	0.678	0.454	1.012	1.146	0.712	1.847
Insurance Before Pregnancy									
None	ref								
Medicaid	0.632	0.294	1.357	0.991	0.558	1.761	1.22	0.646	2.302
Private/Other	1.343	0.825	2.186	1.21	0.705	2.079	1.815	0.934	3.526
Prenatal Care Paid By									
None	ref								
Medicaid	0.727	0.196	2.704	1.392	0.579	3.349	0.999	0.399	2.505
Private/Other	1.118	0.306	4.086	1.149	0.449	2.943	1.618	0.585	4.474
Kotelchuck Index									
Inadequate	ref								
Intermediate	0.815	0.294	2.258	2.171*	1.116	4.225	1.09	0.517	2.3
Adequate	1.472	0.597	3.627	1.636	0.971	2.756	1.04	0.545	1.982
Adequate Plus	1.324	0.514	3.411	1.544	0.881	2.707	1.289	0.714	2.325
Year of Survey									
2004	not available			ref			ref		
2005	not available			0.781	0.483	1.263	0.804	0.49	1.319
2006	not available			0.65	0.355	1.19	0.677	0.375	1.221
2007	ref			1.091	0.66	1.803	0.69	0.414	1.151
2008	not available			0.903	0.555	1.467	not available		
2009	1.86**	1.25	2.768	not available			not available		

* P < 0.05 ** P < 0.01
***P<0.0001

V. Discussion

Among the women eligible for WIC during their pregnancy, the women who participated in WIC did not use oral health care services at a significantly greater rate than those women who did not participate. Among all women eligible for WIC during their pregnancy, those women who participated in WIC did have increased odds of receiving dental education, though this increase was not sustained when women with a reported dental problem were removed from the study population.

Summary of Results

The results of this analysis did not find that WIC increases a woman's odds of going to the dentist or receiving a preventative dental cleaning during her pregnancy, thus failing to find support for the hypotheses for our research questions. Our hypothesis was supported by the outcome of receiving dental education among the total WIC eligible population, indicating that WIC does increase the likelihood that a woman who participates in the program during her pregnancy will receive information about how to care for her teeth and gums. The results for all three outcomes moved away from a significant level when women who reported a dental problem were removed from the analysis, suggeting that the benefit that WIC does provide to its clients in improving their access to dental care is to women who report an obvious dental issue. Also, none of the states stood out as having their WIC program increase the odds of a low-income pregnant woman receiving preventative care who does not present any dental problems. This outcome reveals that WIC is currently not a comprehensive way to improve the oral health status of low-income pregnant women.

Other Findings of Interest

Whereas WIC participation did not strongly predict prenatal care dental utilization, many individual level characteristics did across the different outcomes, confirming the extant

literature. For example, behaviors that suggest better health literacy and healthcare access, including more consistent vitamin use, greater number of prenatal care visits and insurance of any kind before or during pregnancy, improved the likelihood that an expectant mother would seek dental care or information. Variables that performed as predicted in a negative direction on dental care use included most race and ethnic groups when compared to non-Hispanic whites and major life stressors. However, non-Hispanic blacks saw the odds of receiving dental education increase by 13-30% for the regressions modeling dental education for the full eligible population and the population not reporting a problem; WIC may be contributing to this effect for non-Hispanic blacks as they participate in WIC at a higher rate than any other racial/ethnic group. Also unexpected is the lower odds for all three outcomes in all models as the woman ages. Convention holds that the older a woman is, the more experience and health education she gains, but we are not seeing that pattern here. Other variables that were included based on previous literature to have an effect on health behavior (smoking) or health knowledge (previous live births and mother's education) did not have a consistent effect on the dental care outcomes.

Policy Implications

Whereas WIC programs are generally intended to increase prenatal care access and behaviors, our research found that these programs do not appear to be significantly associated with improved prenatal dental care for women not reporting a dental problem. This may represent a significant missed opportunity for WIC programs due to the established clinical benefits of healthy mouth and gums for pregnancy outcomes[64, 65]. There are many women who did not report a problem in this study but could possibly be experiencing an oral health problem that needs to be addressed by a dental professional and are not being directed to appropriate care. Improving oral health among mothers and increasing their health

knowledge about the importance of maintaining a healthy mouth will also make an impact toward the desire for reduced gum disease and dental caries in children[66,67].

Most WIC programs do not have special interventions designed to increase prenatal dental care referrals, with the exceptions of addressing pressing dental problems in expectant mothers. Dental care access and good oral health status are things WIC says it supports[68] and states it provides screening and referrals. This may be the case for women who present obvious problems but data does not conclude that the WIC programs in the states examined make an impact on preventative care access. The screening checklist for new WIC participants is long so it is understandable that all but the most glaring dental problems get overlooked for other more obvious health issues. However, more emphasis on improving oral health during pregnancy could be made a priority. The positive association between Kotelchuck Index and all of the dental care outcomes, many at a significant level, indicates that better education of prenatal care providers may be another appropriate avenue to work to improve outcomes examined here.

Contributions to the Literature

As public health experts seek ways to increase prenatal dental care, it is important to explore options within existing programs/infrastructure and WIC reaches a very high-risk population in most states. This analysis indicates that WIC does provide some access to oral health education but does not currently improve access to other dental care services, especially if the woman does not present an obvious dental problem during her pregnancy. Perhaps WIC could be adapted to do so in the future.

Limitations

Data Constraints

Due to the unique administration partnership between the CDC and the states that participate, data is not available for all years in all states. This may have impacted our

estimates as each year of data in this study did not have the same number of observations and the individual state regressions relied on vastly different numbers of observations. The lack of data in certain years prevented accurate year-by-year comparisons.

PRAMS data is largely self-reported data, so there may be some recall bias that influences how women answer the questions. Missing data for the dental care questions may have had an impact on the results of the regression models in this study approaching significance. Missing income data may have had an impact on precisely predicting the WIC eligibility variable needed for this analysis, potentially biasing our results towards the null. The structure of the income question may also have impacted how this analysis classified WIC eligibility; the income categories in the questionnaire do not correspond to the income caps for WIC so a best approximation had to be made to classify the women in this analysis.

The construction of the "WIC Eligible" subpopulation was based on income categories that did not match precisely with the income eligibility cut-off points established by the federal poverty line, so the estimation of who was eligible for WIC was not as precise as desired. However, the small percentage of mislabeled women with income data indicates that the methodology was fairly robust. There are also subtle changes to the income levels each year based on the inflation rate, but these differences were too small to be reflected in the income categories available from PRAMS.

This analysis relied on a previously constructed dataset, so some information that may have been useful to this analysis was unavailable. Variables that were not available include: when the woman enrolled in the WIC program during her pregnancy, if she participated; where she received prenatal care during her pregnancy; and how often she interacted with the WIC office or WIC professionals[69]. This missing information may have

allowed the analysis to further refine the study population based on how women interacted with WIC during their pregnancy to see if those variables impacted the results.

General Application

Though the states chosen for this study were selected in order to include a diverse sample of the population, including racial and ethnic mix, economy, and political climate, these states were also a convenience sample, included because they asked the supplemental questions about oral health. There are states not included in this study who do ask the oral health questions, but the time and resource limitations of a Masters' thesis led to the decision that this analysis focus on six states that asked all of the oral health questions and were from different parts of the country rather than include all available states.

Many populous and diverse states such as Texas or Florida who represent large percentages of the national sample of WIC participants[70] were among the states that do not choose to ask some or all of the oral health questions so analysis from this study may not apply well to those or other states with different characteristics from the six states included here. WIC is a state-implemented program, so different state policies, the number of WIC agency sites within a state, and demographics will play a role in the impact the WIC program can have on its participants. However, the WIC program is organized and funded by the federal government, and the trend in the state-specific analysis indicates that there is a deficit in many of the states that could be addressed in federal policy.

Future Research

The limitations presented in this analysis provide a starting point for future research into the effect of WIC on low-income pregnant women accessing dental care. Due to the limited amount of information on oral health care access in PRAMS indicates either another data source should be used, CDC should be encouraged to move the oral health questions to

the core questionnaire that all states use, or independent data collection could be crafted to gather the data missing for this analysis to create a more detailed picture of women's access and use of WIC as well as their access of dental care. Because this study only took a cross-sectional view of the data, a longitudinal study may also provide insight into the evolution of a woman's health knowledge about oral health care as she moves from nulligravida (never pregnant) to multiparous (multiple births) from various education sources, including WIC and pre- and post-conception care as well as other general healthcare. Additionally, this study should be replicated for the states not included in this analysis to see if there is a state with a WIC program making an impact on dental care use that other states could emulate.

Results generated in this study open the door to many other potential avenues of inquiry. Few studies in the literature include racial and ethnic groups beyond non-Hispanic whites, non-Hispanic blacks, and Hispanics when studying oral health[71]. Most of the models showed a pattern of lower use of dental care services for all racial and ethnic groups compared to non-Hispanic whites. Notable here is that Asians, Hawaiians and Pacific Islanders also have lower rates of dental care use, even in Hawaii where there are large numbers for these populations. These racial disparities merit further study, both to verify the findings in this study and to understand why these groups have also have a lower rate of dental care use. Another interesting study based on the results in this analysis would be to look at why the odds of dental care access decreases as a woman ages.

Looking past the non-significant numbers to the positive trend in increased odds of accessing care due to WIC and the greatly increased odds of access among women with clear dental issues, programs could be piloted to see if targeted interventions within WIC programs could make a difference in improving the rate at which women seek preventative dental care

during their pregnancy. Other programs could examine the improvement gained by increasing education for health professionals who work with pregnant women, specifically the Medicaid providers as the income cut off for pregnant women to participate is typically the same cut off point for WIC in most states. Targeted interventions could also be piloted within the Medicaid program specifically, such as the Right from the Start Program that targets pregnant women and newborns. Medicaid as a program was not specifically examined in this analysis, but the increased odds of accessing dental care when a woman has Medicaid before or during her pregnancy, in many models at a significant level, indicates that the Medicaid program could be another avenue for future research. Finally, further study should be made into how WIC is increasing access to education among its participants during pregnancy and how those strategies can be used to improve access to other dental care services.

VI. Conclusion

This study finds that WIC may be helping women with pronounced dental problems find treatment during their pregnancy and is providing general oral health education, but preventative care is not significantly improved for women enrolled in WIC currently. This study also finds that WIC is not providing increased access to care or additional education to women who do not have a reported dental problem.

Nonetheless, WIC still appears to be a possible policy option for improving dental care among low-income pregnant women. Because a large percentage of low-income women in the United States access services through WIC, the potential to reach large segments of this population is ideal. Additionally, increased health service utilization during the prenatal period, makes pregnancy an opportune time to work with women to improve their own health and educate them about the ways their health can impact their children. Future studies should continue to look for ways to improve the oral health status of low-income pregnant women and increase the amount of preventative care they receive.

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VIII. APPENDIX

Oral Health-Specific Supplemental Questions from PRAMS Questionnaire Used in Analysis

Y1. This question is about the care of your teeth during your most recent pregnancy.
a. I needed to see a dentist for a problem. No Yes
b. I went to a dentist or dental clinic. No Yes
c. A dental or other health care worker talked to me about how to care for my teeth and gums. No Yes

Y3. Did you have your teeth cleaned by a dentist or dental hygienist during the time periods listed below?
a. During my most recent pregnancy. No Yes

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