PRENATAL WIC PARTICIPATION AND THE EFFECT ON GESTATIONAL WEIGHT GAIN AND LOW BIRTH WEIGHT AMONG FLORIDA'S MEDICAID POPULATION

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Abstract

BACKGROUND: Recent WIC studies have published conflicting benefits of WIC participation on birth outcomes. The WIC program provides prenatal counseling with the goal of achieving recommended gestational weight gain and improving birth outcomes. Emphasis is placed on foods of high nutritional quality, and for underweight women, inclusion of some calorically dense foods is encouraged. Pregnant women on Medicaid are automatically eligible for WIC prenatal services; 3 in 4 of women on Medicaid in Florida apply and participate.

STUDY AIMS: Among women on Medicaid study 1) the relationship between WIC participation and recommended gestational weight gain, 2) the relationship between WIC participation and low birth weight and 3) the relationship of gestational weight gain as a mechanism by which WIC may prevent low birth weight.

METHODS: A cross-sectional study was conducted using data from the Florida Pregnancy Risk Assessment Monitoring Survey (PRAMS) merged with the birth certificates, 2000-2005. The study population was limited to Medicaid participants who experienced a singleton live birth. Weighted multinomial logistic regression was used to estimate adjusted odds ratios for WIC participation and adequacy of weight gain. Adequacy of gestational weight gain was based on the 1990 IOM guidelines. Odds ratios were adjusted for race, ethnicity, age, education, marital status, prenatal care, smoking, plurality, and body mass index.

RESULT: Fifty percent of surveyed women were on Medicaid at delivery. Seventy-two percent of Medicaid women participated in WIC prenatally. Medicaid women in WIC had similar odds of inadequate (AOR: 1.2, 0.9-1.7) and excessive (AOR 1.1, 0.8-1.4) gestational weight gain using the 1990 IOM recommendations as Medicaid women not receiving WIC. Medicaid women receiving WIC had significantly (<0.05) lower odds of experiencing a low birth weight delivery (AOR 0.8, 0.6-0.9). The association between WIC participation and low birth weight appears to be independent of gestational weight gain.

CONCLUSIONS: Medicaid women not participating in WIC prenatally had similar risk of gestational weight gain as Medicaid women participating in WIC. However, Medicaid women not participating in WIC continue to experience an increased risk of a low birth weight delivery.

PUBLIC HEALTH IMPLICATIONS*:* WIC continues to appear to improve birth outcomes. Further research is needed to better understand the relationship between gestational weight gain, birth outcomes, and the WIC program.

Introduction

The Special Supplemental Nutrition Program for women, infant, and children (WIC) was established in 1972. The purpose of the WIC program is to prevent poor birth outcomes, such as infant mortality and low birthweight, by improving the nutrition and health of participants.

WIC is administered at the Federal level by the Food and Nutrition Service of the U.S. Department of Agriculture. Most state WIC programs provide vouchers that participants use at authorized food stores. A wide variety of state and local organizations cooperate in providing the food and health care benefits, and 46,000 merchants nationwide accept WIC vouchers. During 2007, in Florida, 753,558 clients received at least one WIC service.

Pregnant or breastfeeding women, infants, and children under age 5 who live in a household with income less than 185% of the Federal Poverty Level are eligible to participate in WIC. The application is voluntary. To apply in Florida, women have to bring proof of where they live, identification for them and each child, a recent height and weight measurement, a hemoglobin or hematocrit blood test result, immunization records, and a medical referral form. While there is not automatic enrollment in the Medicaid program or vice versa, all women enrolled in Medicaid are automatically eligible for WIC.

A 1990 study showed that women who participated in WIC during their pregnancies had lower Medicaid costs for themselves and their babies than did women who did not participate (Devaney, Bilheimer, & Schore, 1990). The study concluded that for every dollar spent on the prenatal WIC program, the associated savings in Medicaid costs during the 60 days after birth ranged from $1.77 to $3.13 for newborns and mothers and from $2.84 to $3.90 for newborns only. The same study concluded that WIC participation was also linked with longer gestations (3.5% decrease in preterm birth) and higher birthweight (3.3% decrease in low birth weight). The South Carolina Bureau of Maternal Health confirmed that white and black women not participating in WIC were 23% and 27% respectively more likely to experience a LBW outcome; and 111% and 84% respectively more likely to have experienced a VLBW outcome than women participating in WIC (Jones & Hale, 2007). Enrollment in WIC is associated with changes in maternal behavior and health. The National WIC evaluation (Rush et al., 1988) found that pregnant women participating in WIC had greater intake of all 11 measured micronutrients with the exception of vitamin A, when compared with a control group not in WIC.

Recently disagreements about the efficacy of the WIC program have been published. One set of researchers concluded that prenatal participation in WIC has a minimal effect on adverse birth outcomes (Joyce, Gibson, & Colman, 2005) while another set of researchers (Bitler and Currie, 2004) concluded that, although WIC's mothers have observable characteristics predictive of poorer health outcomes, the WIC program helps these women to have healthier infants.

The study, "Length of Prenatal Participation in WIC and Risk of Delivering a Small for Gestational Age Infant: Florida, 1996-2004," by Gueorguieva, Morse, and Roth, found an association between the length of exposure to WIC and full term, late preterm, and very preterm small for gestational age (SGA) birth outcomes. A ten percent increase in the percent of time on the Florida WIC program was associated with a decrease of 2.5% the risk of SGA for full term, 2.0% in late term, and 3.7 in the very preterm outcomes (Gueorguieva et all, 2009).

Gestational weight gain has been associated with preterm delivery, neonatal intensive care unit admission, small or large for gestational age, assisted ventilation, seizure, hypoglycemia, policythemia, and meconium aspiration syndrome (Stotland, Cheng, Hopkins, & Caughey, 2006). Dietz, Calaghan, Cogswell, Morrow, Ferre and Schieve (2006) found a strong association between very low weight gain and very preterm delivery. Underweight (OR 10.3, 7.8-13.7), normal (OR 6.2, 5.1-7.5) and obese (OR 2.3, 1.8-3.1) pregnant women who gain inadequate weight during pregnancy, were more likely to have a very preterm delivery, than healthy weight women with the appropriate weight gain (Dietz et al., 2006).

The objective of this study was to determine recent Florida evidence on the effectiveness of prenatal WIC participation including 1) the association between WIC participation and recommended gestational weight gain among pregnant women on Medicaid, 2) the association between WIC participation and low birth weight and 3) the association between WIC participation and weight gain as a mechanism by which WIC reduces the odds of low birthweight delivery.

Method

This cross-sectional study used data from the Florida Pregnancy Risk Assessment Monitoring System (PRAMS) merged with birth certificate data, 2000-2005. PRAMS is a joint surveillance project between the Florida Department of Health (FDOH) and the U.S. Centers for Disease Control and Prevention designed to monitor the physical, mental,

economic, and social health of Florida's mothers and newborns. PRAMS is a mail survey with telephone follow up. The Florida PRAMS response rate for this period was 76%.

The study population was limited to singleton gestations, whose delivery was paid for by Medicaid. Singleton gestations were selected because the epidemiology of multiple births for gestational weight gain and low birth weight outcome are different. The Medicaid population was selected because all of these low-income women are eligible for WIC. However, some Medicaid women chose not to participate in WIC prenatally. Comparing those who participated in WIC to those who did not among the Medicaid population limits the study to potentially WIC eligible women with similar health care payment source and income levels.

The prevalence of study outcomes: gestational weight gain and low birth weight (<2,500 g), and the variable of interest: prenatal WIC participation was assessed using Wald-chi-square analysis. The association between gestational weight gain and WIC participation was adjusted for both birth certificate and PRAMS variables. The birth certificate variables included race/ethnicity, maternal age, maternal education, marital status, adequacy of prenatal care, and body mass index. PRAMS variables included prenatal care, smoking, and parity. The association between low birth weight and WIC participation was adjusted for all the same variables included in the previous model. Other potential variables were initially included and then later dropped because they had p values greater than 0.30.

Multinomial Logistic regression was used to determine the association between WIC participation and the outcomes of adequacy of gestational weight gain. Weight gain was assessed using the Institute of Medicine (IOM) guidelines (Committee on Nutritional Status, (1990) for four categories and their respective weight gain recommendations (RWG): underweight (BMI <19.8, RWG 28-40 lbs), normal (BMI19.8-26, RWG 25-35 lbs), overweight (BMI>26-29, RWG 15-25 lbs), and obese (BMI >29, RWG 15 lbs). Gestational weight gain was grouped in three categories according to IOM recommendations: inadequate, adequate, and excessive weight gain.

Multinomial logistic regression allows direct comparison of covariables across multiple outcomes. Logistic regression was used to measure the association between WIC participation and the outcome of low birth weight (less than 2,500 grams). All possible interactions among the independent variables were included in both models. If gestational weight gain is in the pathway between WIC participation and low birth weight, the expectation is 1) that there is an association between gestational weight gain and WIC

participation, and 2) the association between WIC participation and low birthweight will be diminished when adjusted for adequacy of gestational weight gain. To assess the first assumption, we used a multinomial logistic regression model for gestational weight gain as the outcome variable and WIC prenatal participation as the study variable of interest. The second assumption was assessed using prenatal WIC participation as the study variable, LBW as the outcome variable and gestational weight gain as a covariate. The analysis was done using STATA 9.2 (STATA, StataCorp, College Station, TX.), to account for complex sampling. All statistical tests assumed significance at $p<0.05$ and marginally significance at $p<0.10$.

Results

During the period 2000-2005, 13,761 women were surveyed by Florida PRAMS. Ninety-four percent of these women had singleton births (n= 12,930). Approximately half (n=6,403) of surveyed women were in Medicaid at the time of delivery. Of Medicaid women, 72 percent (n=4,604) were in WIC during their pregnancy (Table1).

Table 1. Study population: Florida PRAMS 2000-2005

Total	Unweighted (n)	Weighted (N)
No of Surveys	13,761	1,244,761
Singletons	12,930	1,223,164
In Medicaid at Delivery	6,403 (100%)	542,111 (100%)
In Medicaid & in WIC	4,604 (71.9%)	415,180 (76.6%)
In Medicaid not in WIC	1,449 (22.6%)	124,795 (23.0%)
Unknown	350 (5.5%)	2,136 (0.4%)

Table 2 presents the socio-demographic and health characteristics of Medicaid women participating and not participating in WIC. Women in WIC were significantly younger (6.7% vs. 4.9%), less educated (lower percentage of women with more than high school education 19.7% vs. 26.0%), more obese (24% vs. 16.5%), and black (31.4% vs. 25.6%).

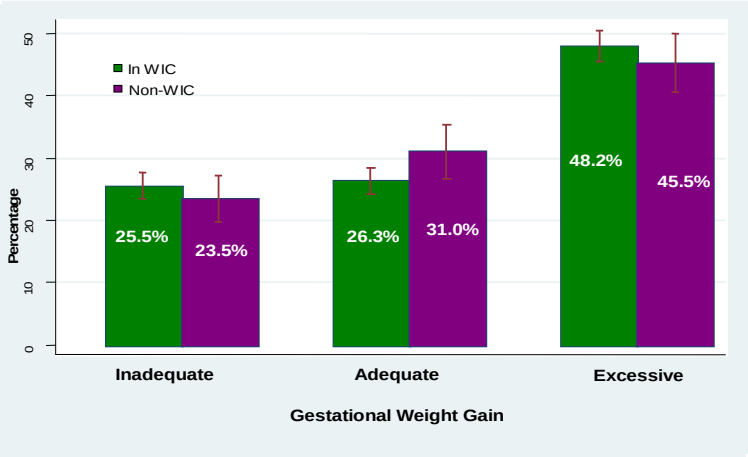
Table 2. Distribution of Medicaid Population by Socio-Demographic and Health Characteristics

Maternal Characteristics	MEDICAID	
	IN WIC	NOT IN WIC
Race/Eth	**%**	**%**
White	34.7	42.7
Black	31.4*	25.6*
Hispanic	32.0	28.9
Other	1.9	2.9
Mother Age	**%**	**%**
< 18 Years	6.7*	4.9*
18-34	85.1	83.5
35 and +	8.1	11.6
Mother Ed	**%**	**%**
Less than HS	36.4	30.8
High School	44.0	43.2
More than HS	19.7*	26.0*
Marital Status	**%**	**%**
Married	35.0	36.9
No Married	65.0	63.1
Body Mass Index	**%**	**%**
Normal	48.2	52.4
Underweight	15.6	19.7
Overweight	12.3	11.4
Obese	24.0*	16.5*
Smoke	**%**	**%**
Never	75.0	71.1
Smoke before and quit	11.5	13.3
Smoke during pregnancy	13.5	15.6
Prenatal Care	**%**	**%**
Prenatal care first trimester	62.1	57.2
No PCFT or not PC	37.9	42.8
Parity	**%**	**%**
First child	41.9	40.0
Two or more	58.2	60.0

* $p < 0.05$ The statistical test included all the categories for each characteristic

Figure 1 shows the distribution of gestational weight gain categories among the WIC and non-WIC-Medicaid participants. No significant differences among Medicaid-WIC and not-WIC participants were found in gestational weight gain: inadequate (25.5% vs. 23.5%), adequate (26.3% vs. 31.0%), or excessive (48.2% vs. 45.5%).

Figure1. Distribution of Gestational Weight Gain Categories and (95%CI) Among FL's Medicaid Mothers with Singleton Live Births, by WIC Participation: 2000-2005



The crude (COR) and adjusted (AOR) for the associations between inadequate and excessive gestational weight gain among the Florida Medicaid mothers participating in WIC are presented in Table 3. The adjusted odds ratio (AOR) among women participating in WIC for inadequate and excessive gestational weight gain showed no significant differences: (AOR: 1.2, 95% CI: 0.9-1.7) and (AOR: 1.1, 95% CI: 0.8-1.4) respectively.

Being age 35 or more when compared with age 18-34 (AOR: 0.6, 95% CI: 0.4-0.9), quitting smoking during pregnancy (AOR: 0.5, 95% CI: 0.3-0.8), and being overweight (AOR: 0.5, 95% CI: 0.3-0.8) were associated with decreased odds of inadequate weight gain, while having experienced a previous birth (AOR: 1.4, 95% CI: 1.1-1.8) and being obese before pregnancy (AOR: 8.9, 95% CI: 5.0-16.3) were associated with increased odds of inadequate weight gain.

In the adjusted analysis with excessive weight gain as the outcome, quitting smoking during pregnancy (AOR: 1.8, 95% CI: 1.2-2.6), being overweight (AOR: 2.3, 95% CI: 1.7-3.3) or obese (AOR: 29.2, 95% CI: 16.6-51.3) were associated with increased odds of excessive weight gain. In contrast, being age 35 or more when compared with age 18-34 (AOR: 0.5, 95% CI: 0.3-0.9) having a previous birth (AOR: 0.6, 95% CI: 0.5-0.8) and being underweight (AOR: 0.5, 95% CI: 0.4-0.7) were associated with decreased odds of excessive weight gain.

No statistically significant risk factor interactions were identified among the independent variables in the multivariate model and WIC participation. In other words, WIC participation did not have significant impact on women with specific risk factors in the model.

Table3. Adjusted odd ratio (AOR) for inadequate and excessive gestational weight gain among Florida's Medicaid mothers with a singleton live birth, 2000-05

	Inadequate		Excessive	
	COR (95% CI)	**AOR (95% CI)**	**COR (95% CI)**	**AOR (95% CI)**
Medicaid WIC/No WIC (Not in WIC/Reference)				
In WIC	1.20 (0.92-1.56)	1.24 (0.92-1.66)	1.26(0.99-1.60)	1.06 (0.80-1.40)
Race/Ethnicity (White/Reference)				
Black	1.63 (1.38-1.92)***	1.02 (0.75-1.39)	1.12 (0.97-1.29)	0.83 (0.63-1.11)
Hispanic	0.99 (0.80-1.22)	0.82 (0.57-1.18)	0.91 (0.77-1.09)	0.91 (0.65-1.26)
Other	0.97 (0.66-1.44)	1.28 (0.55-2.96)	0.57 (0.40-0.81)**	1.52 (0.66-3.52)
Mother Age (18-34/Reference)				
Less than 18	0.95 (0.73-1.22)	0.90 (0.60-1.35)	0.72 (0.57-0.90)***	0.85 (0.59-1.24)
35 and +	0.85 (0.68-1.06)	0.58 (0.36-0.93)**	0.72 (0.59-0.87)***	0.54 (0.34-0.86)**
Mother Ed (More than HS/Reference)				
Less than HS	1.74 (1.42-2.12)***	0.99 (0.69-1.43)	1.18 (0.99-1.41)*	0.92 (0.65-1.33)
High school	1.41 (1.18-1.68)***	0.86 (0.62-1.19)	1.30 (1.12-1.51)***	0.98 (0.72-1.34)
Marital Status (Married/Reference)				
No married	1.29 (1.11-1.50)***	0.94 (0.71-1.24)	1.19 (1.04-1.36)**	1.15 (0.88-1.51)
Prenatal Care (Prenatal care first trimester/Reference)				
No PCFT or No PC	1.37 (1.15-1.62)***	1.08 (0.84-1.41)	1.00 (0.85-1.16)	0.92 (0.72-1.18)
Smoke (No smoke before or during pregnancy/Reference)				
Smoke before and quit	0.67 (0.49-0.92)**	0.48 (0.30-0.76)***	1.75 (1.39-2.21)***	1.77 (1.22-2.56)***
Smoke during pregnancy	1.14 (0.86-1.51)	0.81 (0.54-1.21)	1.46 (1.15-1.86)***	1.45 (0.99-2.11)*
Parity (First child/Reference)				
Two or more	1.31 (1.12-1.54)***	1.37 (1.05-1.80)**	0.92 (0.81-1.05)	0.64 (0.50-0.83)***
MOM_BMI (Normal/Reference)				
Underweight	1.18 (0.98-1.44)*	1.12 (0.83-1.51)	0.50 (0.41-0.61)***	0.54 (0.39-0.74)***
Overweight	0.84 (0.62-1.12)	0.54 (0.34-0.84)***	2.32 (1.88-2.86)***	2.32 (1.68-3.31)***
Obese	12.69 (8.77-18.36)***	8.93 (4.95-16.13)***	23.60 (16.62-33.5)***	29.22 (16.6-51.3)***
Kotelchuck (Adequate/Reference)				
Not adequate	1.48 (1.24-1.76)***	1.26 (0.97-1.64)*	1.00 (0.85-1.17)	1.00 (0.77-1.30)
Intendedness (Sooner of then/Reference)				
Later or did not	1.21 (1.04-1.42)**	0.94 (0.72-1.22)	1.10 (0.96-1.26)	1.03 (0.80-1.33)

*** <0.01

** >= 0.01 and <=0.05

* > 0.05 and <=0.10

Table 4 presents crude (COR) and adjusted (AOR) odds ratio for risk factors for low birth weight births among Florida's Medicaid mothers. The adjusted analysis was significant for the association between low birth weight and the WIC participation (AOR: 0.8, 95% CI: 0.6-0.9). Medicaid women in WIC had significantly lower odds of experiencing a low birth weight delivery compared to Medicaid women not in WIC.

Table 4. Adjusted odds ratio (AOR) for low birth weight in Florida's Medicaid mothers with singleton live birth, 2000-05

LBW	COR (95% CI)	AOR (95% CI)
Medicaid WIC/No WIC (Not in WIC/Reference)		
In WIC	0.77 (0.68-0.88)***	0.75 (0.64-0.88)***
Race/Eth (White/Reference)		
Black	2.19 (2.01-2.39)***	2.00 (1.68-2.39)***
Hispanic	0.96 (0.86-1.06)	0.99 (0.81-1.22)
Other	1.22 (0.98-1.52)*	1.02 (0.63-1.67)
Mother Age (18-34/Reference)		
Less 18	1.54 (1.34-1.78)***	0.95 (0.75-1.21)
35 and +	1.06 (0.94-1.19)	1.02 (0.78-1.33)
Mother Ed (More than HS/Reference)		
Less than high school	1.66 (1.50-1.84)***	1.16 (0.95-1.42)
High school	1.45 (1.32-1.59)**	1.05 (0.88-1.25)
Marital Status (Married/ Reference		
No married	1.79 (1.13-1.35)***	1.32 (1.12-1.54)***
Prenatal Care (Prenatal care first trimester/Reference)		
No PCFT or No PC	1.23 (1.13-1.33)***	0.88 (0.76-1.01)*
Smoke (Never smoke/Reference)		
Smoke before and quit during pregnancy	0.87 (0.76-1.01)*	1.12 (0.89-1.41)
Smoke during pregnancy	1.73 (1.51-1.98)***	2.03 (1.64-2.51)***
Parity (First child/Reference)		
Two or more	0.75 (0.69-0.82)***	0.69 (0.60-0.80)***
MOM_BMI (Normal/Reference)		
Underweight	1.49 (1.33-1.67)***	1.50 (1.25-1.80)***
Overweight	1.13 (0.99-1.29)*	1.28 (1.03-1.59)**
Obese	1.15 (1.03-1.28)**	1.30 (1.08-1.56)***
Pregnancy Weight Gain (Adequate/Reference)		
Less than adequate	2.20 (1.97-2.47)***	1.98 (1.66-2.35)***
More than adequate	0.64 (0.58-0.71)***	0.59 (0.50-0.70)***
Intendedness (Sooner of then/Reference)		
Later or did not	1.23 (1.13-1.33)***	0.91 (0.79-1.05)

*** <0.01

** >= 0.01 and <=0.05

* > 0.05 and <=0.10

The risk factors of black race (AOR: 2.0, 95% CI: 1.7-2.4), not married (AOR: 1.3, 95% CI: 1.1-1.5), smoking during pregnancy (AOR: 2.0, 95% CI: 1.6-2.5), being underweight (AOR: 1.5, 95% CI: 1.3-1.8), overweight (AOR: 1.3, 95% CI: 1.0-1.6), obese (AOR: 1.3, 95% CI: 1.1-1.6), and inadequate gestational weight gain (AOR: 2.0, 95% CI: 1.7-2.4) were associated with an increased risk of delivering a low birth weight baby. Having experienced a previous birth and excessive gestational weight gain were associated with decreased risk of delivering a low birth weight baby (AOR: 0.7, 95% CI: 0.6-0.8) and (AOR: 0.6, 95% CI: 0.5-0.7) respectively.

The association between WIC participation and low birth weight was not affected by the exclusion of the gestational weight gain variable from the model. The AOR for low birth weight went from 0.75 when including maternal weight gain to 0.78 (95% CI: 0.67-0.90) when excluding maternal weight gain from the model, a 4% increase. The interaction between WIC participation and gestational weigh gain was not statistically significant. In other words, no significant association was found between WIC and low birth weight as it relates to gestational weight gain.

Discussion

Consistent with the finding of other studies (Jones & Hale, 2007; Bitler & Currie, 2004), Medicaid women participating in WIC had lower odds of experiencing a low birth weight delivery than Medicaid women not participating in WIC. Black race, smoking during pregnancy, body mass index outside the healthy range, and inadequate gestational weight gain were associated with increased odds of a low birth weight delivery.

The association between the prevalence of inadequate weight gain in Florida's Medicaid mothers and their participation in WIC was not significant, even with the WIC program efforts to improve the dietary intake of pregnant women with inadequate gestational weight gain. The same situation occurred with excessive weight gain. No significant association was found when comparing the prevalence of excessive weight gain for women participating or not participating in WIC even though WIC's intention was to have a positive effect on the outcomes of disadvantaged American women (Besharov and Germanis, 2001). After taking into account potential confounders, Medicaid women participating in WIC had similar odds of inadequate or excessive gestational weight gain as their counterparts who were not participating in WIC. These results suggest that WIC

participation may not influence substantially gestational weight gain among the Medicaid population.

Previous study suggests that “it is not at all clear how much programs of maternal nutritional supplementation affect pregnancy weight gain or whether the effects of supplementation on birth weight are mediated by maternal weight gain (Rush et al. page 460).” The study by Bittler and Currie suggest that women in WIC are disadvantaged when compared to all women in Medicaid. They are less educated, less married, have unhealthy weight, and more poor. “Within the population of women whose deliveries were paid for the Medicaid program, WIC mothers appear to be negatively selected in terms of observables” (Bittler, pag 5). Although our study attempted to adjust for the disadvantaged nature of WIC participants, unadjusted risk from this selection bias may still remain. If this is true, similar weight gain results among women participating and not participating in WIC could be a positive finding as these disadvantages may lead to adverse gestational weight gain.

Quitting smoking during pregnancy was associated with lower odds of inadequate gestational weight gain and higher odds of excessive gestational weight gain. The relationship between smoking cessation and weight gain is well documented. Mongoven, Muller, Groff, Laurel and Keith (1996) in their study “Weight Gain Associated with Prenatal Smoking Cessation in White non-Hispanic Women demonstrated that quitters gained significantly more weight than smokers (36.59 vs. 28.89 pounds respectively), and a larger percentage of quitters (46%) gained excessive gestational weight than smokers (26%).

Prepregnancy overweight and obese women were more likely than prepregnancy healthy weight women to have excessive weight gain during pregnancy. This is a finding supported by other studies, where women that began pregnancy overweight or obese gained excessive weight during their pregnancy (Lederman, Alfasi, & Deckelbaum, 2002). Excessive weight gain during pregnancy can have far reaching implications for women. A Wisconsin study among pregnant women (1988-1990) with follow up in 2000, demonstrated that women who gained excessive weight during pregnancy failed to lose weight 15 years after pregnancy (Rooney & Mathiason 2005).

Although WIC showed an impact on LBW in FL, the impact is not related to gestational weight gain. Excluding the gestational weight gain from the model did not have an impact on the association between WIC participation and low birth weight. The interaction terms for WIC and gestational weight gain were not statistically significant.

These findings suggest that weight gain during pregnancy is not the mechanism by which WIC is associated with a lower odds of low birth weight.

Limitations

This analysis was subject to several limitations. PRAMS did not collect information on the date of entry into prenatal WIC. Our results could be biased by the women who entered into WIC at the end of their pregnancy, and as so, did not receive the full benefits of WIC participation. Our results could be biased in the other direction with women entering WIC, when their pregnancy is already term (more than 36 weeks), where the risk of LBW is substantially lower. During the period 2004-2007, 6.2% of all women in WIC, entered during their last trimester of prenatal care or did not have prenatal care (CHARTS, FDOH). To estimate the effect of this latter bias in our study, we limited the analysis to only the births delivered at term between 37-42 weeks. The WIC findings related to improvements in low birth weight did not change substantially.

Another limitation is that WIC prenatal participation may not be accurately measured because PRAMS asks mothers about their prenatal WIC participation after delivery. These women may be participating in infant WIC at the time and may report this as prenatal participation. Most data elements are self reported including height and weight (WIC vs PRAMS sensitivity was 92% and specificity was 90%) (WIC, FDOH). The PRAMS response rate was 76% making response bias less of an issue. Although we adjusted for maternal risk factors, selection bias may continue to be an issue in comparing the outcomes of women participating and not participating in WIC. The last limitation relates the statistical power finding no association. Although the adjusted odds ratio for WIC and excessive weight gain was not significant the 95% confidence interval is not narrow, (AOR: 1.1, 95% CI: 0.8-1.4). This means that a small impact in WIC lowering excessive weight gain may have gone undetected, somewhere between 0.8 and 1.0. However, the estimate odds ratio suggests that WIC may also be associated with an increase risk of excessive weight gain.

Implications

Although some researchers question the benefit of WIC on birth outcomes, this study continues to show WIC's impact on low birth weight. This investigation suggests that gestational weight gain is not a mechanism by which WIC impacts low birth weight.

Further research is needed to better understand the potential mechanisms by which WIC impacts low birth weight to provide further evidence that WIC participation decreases low birth weight. A secondary implication is that smoking cessation during pregnancy is associated with excessive gestational weight gain and suggests that Medicaid women who smoke, but quit during pregnancy, may benefit from extra nutritional counseling and support.

Lastly, excessive weight gain during pregnancy continues to be a major public health problem. Does WIC have a role in helping women have an appropriate weight gain during pregnancy? If so, is there a cost effective way for WIC to do so? WIC is the largest provider of nutritional information to pregnant women and these questions should be discussed given the current obesity epidemic.

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