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Weight Gain in Early Pregnancy and Risk of Gestational Diabetes Mellitus among Latinas

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Abstract

Aim—To evaluate the association between gestational weight gain (GWG) in early pregnancy and incidence of abnormal glucose tolerance (AGT) and gestational diabetes mellitus (GDM) among Latinas.

Methods—We conducted a retrospective cohort study of 2,039 Latinas using pooled data from two medical centres in Massachusetts. Gestational weights were abstracted from medical records and GWG was categorized as low, appropriate, and excessive according to 2009 Institute of Medicine Guidelines. Diagnosis of AGT and GDM were confirmed by study obstetricians.

Results—A total of 143 women (7.0%) were diagnosed with GDM and 354 (17.4%) with AGT. After adjusting for age and study site, women with low GWG up to the time of GDM screen had a lower odd of GDM (OR 0.51, 95% CI 0.29–0.92). Among overweight women, women with excessive first-trimester GWG had a 2-fold higher odds of AGT (OR 1.96, 95% CI 1.17–3.30) and GDM (OR 2.07, 95% CI 1.04–4.12) compared to those with appropriate GWG; however, these findings were not significant among normal weight or obese women.

Conclusion—Among Latinas, low GWG up to the time of GDM screen was associated with lower odds of AGT and GDM, while excessive GWG among overweight women was associated

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with higher odds. Findings highlight need for interventions in early pregnancy to help women meet GWG guidelines and to moderate GWG among overweight Latinas.

Keywords

Gestational diabetes; Latina; Pregnancy; Weight gain

Introduction

Gestational diabetes mellitus (GDM), defined as glucose intolerance with onset or first recognition during pregnancy, complicates 6–7% of pregnancies [1] and is associated with immediate and long-term maternal-offspring cardio-metabolic risks [2–4]. Latinas are the largest female minority group in the U.S. and are at significantly increased risk of GDM [5]. As many as 50% of Latinas with a history of GDM will progress to type 2 diabetes within 5 years of a GDM pregnancy [6].

Excessive gestational weight gain (GWG) has been associated with adverse pregnancy outcomes [7, 8]. However, research examining the association between GWG and the risk of GDM has been conflicting and often relied upon study-specific cut points to determine excessive GWG. In contrast, recent Institute of Medicine (IOM) guidelines [9] for GWG are formulated as a target range of GWG within each category of pre-pregnancy BMI designed to optimize maternal and foetal outcomes. In addition, most studies were limited by the evaluation of total GWG over the entire pregnancy which includes weight gain after the diagnosis of GDM. This post-diagnosis weight gain may be influenced by the disease itself as well as by its management and treatment. Therefore, the temporality of the association between GWG and GDM cannot be assessed with a total GWG measure. Those studies which evaluated GWG up to the time of GDM screen [10] did not consistently adjust for confounding factors thereby limiting comparisons between studies and translation to public health recommendations.

Finally, prior studies have also been conducted among predominantly non-Latina white populations. Latinas are more likely to begin their pregnancies overweight or obese as compared to non-Latina white women with almost half entering pregnancy in these categories [7,9]. The number of Latinas with both elevated BMI and excessive GWG has been increasing over time [24].

Therefore, the aim of this study was to evaluate the association between adherence to IOM guidelines for GWG in the first trimester and up to the time of GDM screen and the risk of abnormal glucose tolerance (AGT) and GDM among Latinas. To our knowledge this is the first study to evaluate this association specifically among Latinas, an ethnic group at elevated risk for GDM.

Methods

We conducted a retrospective cohort study of Latinas using pooled data from two medical centres in Massachusetts: (1) Proyecto Buena Salud (PBS), a prospective cohort of pregnant Latinas based at Baystate Medical Centre in Western Massachusetts [11] and (2) a clinical care dataset based at the University of Massachusetts Memorial Health Care (UMMHC) in central Massachusetts. The Institutional Review Boards of Baystate Medical Centre, the University of Massachusetts Amherst, and the University of Massachusetts Medical School approved this study.

Eligible women were restricted to those women who self-identified as Latinas, were ages 16 to 40 years, without heart disease, chronic kidney disease, pre-gestational diabetes and/or chronic hypertension, and who delivered singleton gestations between 2006 and 2011. This resulted in a sample size of 1,611 women for PBS and 1,009 women for UMMHC.

For the purposes of the pooled analysis, we then excluded women missing pre-pregnancy height (n=108 for PBS and n=10 for UMMHC) or who were not screened for GDM due to having a spontaneous or therapeutic abortion prior to GDM screen or no longer receiving prenatal care at the study hospitals (n=346 for PBS and n=117 for UMMHC). This resulted in a sample size of 1,157 women from PBS and 882 women from UMMHC for a final pooled analysis dataset of 2,039 women.

Assessment of Gestational Weight Gain

Pre-pregnancy weight and measured weight at each prenatal visit were abstracted from medical records. We calculated pre-pregnancy body mass index (BMI) as pre-pregnancy weight in kilograms divided by height in meters squared. GWG in the first trimester was calculated as the difference between weight measured at the prenatal visit closest to 13-week gestation and pre-pregnancy weight. This variable was considered continuously, and also categorized according to adherence to IOM guidelines of 0.5–2.0 kg by the end of the first trimester regardless of pre-pregnancy BMI [9]. Categories were defined as: low (gaining less than the recommended minimum), appropriate (gaining within the recommended range), and excessive (gaining more than the recommended maximum).

GWG up to the time of GDM screen was calculated as the difference between weight measured within two weeks of the GDM screen and pre-pregnancy weight. This variable was considered continuously, and categorized according to adherence to IOM guidelines for GWG in the first trimester (up to week 13) plus trajectory of gain throughout second and third trimester. Specifically, women with a BMI < 18.5 kg/m^2 are advised to gain 0.45–0.59 kg/week, women with a BMI of 18.5–24.9 kg/m^2 are advised to gain 0.36–0.45 kg/week, women with a BMI of 25.0–29.9 kg/m^2 are advised to gain 0.23–0.32 kg/week, and women with a BMI ≥ 30.0 kg/m^2 are advised to gain 0.18–0.27 kg/week [9]. Categories were defined as: low, appropriate, and excessive. We also created dichotomous variables of excessive vs. not excessive GWG to facilitate comparison with prior literature [10].

Outcome Assessment – Gestational Diabetes Mellitus and Abnormal Glucose Tolerance

Both study sites practice universal screening for GDM at 24–28-week gestation. The screening test consists of a non-fasting oral glucose challenge test in which venous blood is sampled 1 hour after a 50-g oral glucose load (1h-OGTT). If the plasma glucose concentration is >135 mg/dl (PBS) or ≥ 140 mg/dl (UMMHC), a 3 hour 100-g diagnostic glucose tolerance test is performed (3h-OGTT). Diagnosis of GDM was defined according to the American Diabetes Association criteria as 2 or more elevated values at fasting (≥ 95 mg/dL), and 1 hour (≥ 180 mg/dL), 2 hour (≥ 155 mg/dL), or 3 hours (≥ 140 mg/dL) post-glucose load [12]. All suspected cases of GDM were reviewed by an obstetrician for confirmation of diagnosis. In addition to examining GDM, we also considered abnormal glucose tolerance (AGT) defined as an abnormal value on the 1h-OGTT (yes or no).

Covariate Assessment

Sociodemographic and clinical characteristics of the index pregnancy were abstracted from medical records. Sociodemographic characteristics included age, education, language preference (English, Spanish, and other). Clinical characteristics included gravidity, number of prenatal care visits, pre-pregnancy smoking (none, 1–10 cigarettes, and > 10 cigarettes per day), family history of diabetes, and history of GDM.

Data Analyses

Analyses were performed using Stata/MP 13.1 (StataCorp 2013. Stata Statistical Software: Release 13 College Station, TX). Summary statistics for demographic and clinical characteristics were presented as either mean (standard deviation [SD]) for continuous variables or as frequency for categorical variables. We compared the characteristics of women at each study site using chi-squared or Fischer's exact test for categorical variables and Student's T-test or Wilcoxon Rank Sum test for continuous variables.

We estimated the association between GWG and incident AGT and GDM using logistic regression models. Because continuous GWG did not meet the regression model criterion for a linear relationship with the study outcomes (i.e., AGT or GDM), GWG was modelled categorically in regression models.

We decided *a priori* to include age in multivariable logistic regression models due to their strong associations with GDM in the prior literature. We also included study site in adjusted models. Confounding by additional covariates was assessed by evaluating changes in the odds ratios for GWG when each covariate was included in the regression model with a change of 10% or greater indicating meaningful confounding. Using this criterion, history of GDM and the other covariates did not qualify as meaningful confounders.

To evaluate whether the association between GWG and GDM differed according to pre-pregnancy BMI, we repeated the above analysis stratifying by pre-pregnancy BMI. Due to the small numbers of underweight women, they were excluded from this stratified analysis.

Finally, we performed several sensitivity analyses. First, we repeated our analyses of GWG and risk of GDM excluding women whose GDM screen was performed between < 24 weeks or ≥ 34-week gestations. We also repeated analyses excluding women who screened positive for GDM, but were not subsequently diagnosed with GDM.

Results

Overall, women were young (mean 24.1 years of age), and the majority were overweight/obese (49%) with a mean pre-pregnancy BMI of 26.4 kg/m^2, and multigravida (71%) with a mean gravidity of 2.7 (Table 1).

On average, women were 27.5-week gestation at the time of their GDM screen. Most women preferred English (75%), were non-smokers (85%), without a family history of diabetes (60%) nor personal GDM history (98%). As compared to women in the PBS dataset, women in the UMMHC dataset differed in terms of age, pre-pregnancy BMI, gravidity, smoking status, and medical history, and therefore study site was included in all statistical models (Table I).

The mean first-trimester GWG was 2.0 kg (SD=4.4) with over one-third of women having low GWG (39.4%), one quarter (24.4%) meeting guidelines, and 36.2% having excessive GWG (Table 2). The mean GWG up to the time of GDM screen was 9.2 kg (SD=6.2) with approximately half of women (50.1%) exceeding IOM guidelines. A total of 143 (7.0%) women were diagnosed with GDM and 354 women (17.4%) with AGT (Table II).

We then evaluated the association between GWG and odds of AGT (Table III). After adjusting for age and study site, women with low GWG in the first trimester had a suggestion of a lower odds of developing AGT compared to women with appropriate GWG (OR 0.72, 95% CI 0.51–1.02), but this was not statistically significant. Women with excessive GWG did not have a significantly increased risk of AGT (OR = 1.05, 95% CI 0.75–1.47). In terms of GWG up to the time of GDM screen, in multivariable models neither low (OR 1.04, 95% CI 0.74–1.46) nor excessive (OR 1.04, 95% CI 0.79–1.38) GWG was significantly associated with AGT (Table III).

We then evaluated the association between GWG and odds of GDM (Table III). After adjusting for age and study site, women with low GWG in the first trimester had the suggestion of a lower odds of GDM (OR 0.59, 95% CI 0.35–1.01) as compared to women with appropriate GWG, but this was not statistically significant. There was no association between excessive GWG in the first trimester and GDM (OR 1.08, 95% CI 0.67–1.76) (Table III). In terms of GWG up to the time of GDM screen, in multivariable models, women with low GWG up to the time of GDM screen had lower odds of GDM compared to those with appropriate GWG (OR 0.51, 95% CI 0.29, 0.92) while excessive GWG was not associated with GDM (OR=0.99, 95% CI 0.66–1.47) (Table III).

We then evaluated these associations stratifying by pre-pregnancy BMI (Table IV). Among overweight women, women with excessive first-trimester GWG had 2-fold higher odds of both AGT (OR 1.96, 95% CI 1.17–3.30) and GDM (OR 2.07, 95% CI 1.04–4.12) compared to women without excessive GWG (Table IV). In contrast, there were no statistically significant associations between excessive first-trimester GWG and glucose outcomes among normal weight or obese women. We also did not observe significant differences in the association between GWG up to the time of GDM screen and glucose outcomes according to pre-pregnancy BMI (Table IV).

Finally, we performed sensitivity analyses. First, we excluded 199 women whose GDM screen was performed between < 24 weeks or ≥ 34-week gestation. Findings were virtually unchanged (data not shown). We also repeated analyses excluding 211 women who screened positive for GDM, but were not subsequently diagnosed with GDM. Again, findings were similar; women with low GWG in the first trimester had a 57% reduction in odds of GDM (OR 0.43, 95% CI 0.22, 0.83).

Discussion

In this retrospective cohort study of Latina women, we found that those with low GWG up to the GDM screen had a 50% lower odds of GDM compared to women who gained within recommended ranges according to IOM guidelines. Among overweight women, excessive first-trimester GWG was associated with 2-fold higher odds of AGT and GDM. In contrast, there were no statistically significant associations between excessive GWG and risk of AGT or GDM among normal weight or obese women.

Our findings that excessive GWG in early pregnancy was associated with an increased risk of GDM are consistent with a recent meta-analysis of eight studies (13,748 women) which examined either first-trimester GWG or GWG up to the GDM screen. Odds ratios comparing excessive GWG with non-excessive GWG ranged from 1.09 to 2.46 with five studies not observing statistically significant associations [10]. Pooled analysis yielded a summary OR of 1.40 (95% CI 1.21, 1.61) with low between-study heterogeneity (I^2 = 16.7%). These results are like those observed in the current study for overweight women who experienced a two-fold odds of AGT and GDM for excessive GWG in the first trimester. However, in contrast to the current study, most studies did not adjust for confounding factors nor report how IOM criteria were used to classify excessive GWG; none were conducted among Latinas.

Our findings that low GWG up to the time of GDM screen was associated with a decreased risk of GDM are consistent with those of a recent hospital-based prospective cohort study in Korea. In this study, Park et al. found that low GWG up to the time of GDM screen based upon 2009 IOM guidelines was associated with an almost 50% reduction in GDM (OR=0.565, 95% CI 0.325–0.978) [25]. Similarly, we found an odds ratio of 0.51 (95% CI 0.29, 0.92) for GWG up to the time of GDM screen. These findings are consistent with observations of lower insulin resistance among those with low GWG as compared to those with normal and excessive GWG [25].

Prior studies have evaluated whether the associations between excessive GWG and the risk of GDM differ according to pre-pregnancy BMI. In the recent meta-analysis, the authors found no evidence for a difference in effect between normal weight and overweight/obese women [10]. In contrast, we found that women who were overweight prior to pregnancy were particularly susceptible to the impact of excessive GWG on risk of GDM, experiencing a 2-fold odds of both GDM and AGT. These findings are consistent with those conducted among other racial/ethnic populations. For example, in a prospective study among 952 black and white women in North Carolina, Saldana et al. found that that greater GWG was associated with increased risk of impaired glucose tolerance only among women who were overweight prior to pregnancy [26]. As in the current study, Saldana et al. did not observe this increased risk among women who were obese prior to pregnancy. The authors propose that this may be due, in part, to the fact that obese women may have pre-pregnancy insulin resistance levels close to an upper threshold. Therefore, the potential impact of additional insulin resistance caused by excessive GWG on risk is limited in this group [26]. Another proposed explanation is that the beta cell capacity of obese women may be closer to exhaustion, again limiting the potential influence of additional weight gain.

Higher GWG in early pregnancy may be due to greater accrual of fat mass [15,16] thereby reducing a woman's ability to compensate for the increased insulin resistance associated with pregnancy [9,17]. Omental adipocyte hypertrophy, and decreased omental and abdominal subcutaneous adipose tissue capillary density, are consistent with impaired adipose tissue expandability in pregnancy being associated with GDM [18].

To our knowledge this is the first study to evaluate the association between GWG and GDM in Latinas, a previously understudied at-risk population. Additional strengths of our study include the use of the most recent IOM GWG guidelines, and the ability to adjust for confounding factors. However, as with the majority of prior studies, we relied upon self-reported pre-pregnancy weight, as recorded in the medical record.

Nevertheless, the validity of self-reported pre-pregnancy weight has been shown to be high, especially if collected early in pregnancy [19–21]. In addition, strong correlations ($r=0.95$, $p = 0.0001$) have been observed between self-reported pre-pregnancy weight and physician measured weight from the year before pregnancy and no significant ($P = 0.64$) differences between normal weight and overweight/obese subjects [22].

Conclusion

In summary, we found that among Latinas entering pregnancy overweight, excessive GWG in early pregnancy was associated with 2-fold higher odds of AGT and GDM. In contrast, Latina women with low GWG up to the time of GDM screen had significantly lower odds of GDM compared to women with appropriate GWG. However, it is important to note that weight gain below IOM recommendations cannot be recommended due to the increased risk of preterm birth and small-for-gestational-age deliveries associated with low weight gain [9]. Indeed, the published IOM guidelines were established to optimize maternal and foetal outcomes. Instead, our results highlight the need to emphasize the moderation of GWG early in pregnancy, especially among Latinas who are overweight before pregnancy. This is particularly critical as excessive GWG is common in overweight women and overweight women have an elevated risk for GDM.

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Table I

Sociodemographic and Clinical Characteristics Overall and by Study Site; Latinas, Massachusetts: 2006–2011.

	Total sample[a] (N=2,039)	PBS Dataset (n=1,157)	UMMHC Dataset (n=882)	*P*-value
Age (years)	24.1 ± 5.6	22.7 ± 5.0	25.9 ± 5.9	< 0.001
Prepregnancy BMI (kg/m^2)				< 0.001
Underweight (<18.5 kg/m^2)	115 (5.6)	70 (6.1)	45 (5.1)	
Normal weight (18.5 to <25.0 kg/m^2)	932 (45.7)	v	363 (41.2)	
Overweight (25.0 to <30.0 kg/m^2)	488 (23.9)	264 (22.8)	224 (25.4)	
Obese (30.0+ kg/m^2)	504 (24.7)	254 (22.0)	250 (28.3)	
Gravidity	2.7 ± 1.8	2.6 ± 1.8	2.9 ± 1.8	0.002
Language Preference				
English	1,480 (75.0)	820 (75.2)	660 (74.8)	0.228
Spanish	478 (24.2)	266 (24.4)	212 (24.0)	
Other	15 (0.8)	5 (0.5)	10 (1.1)	
Smoking During Pregnancy				
None	1,683 (85.3)	918 (84.1)	765 (86.7)	0.031
1–10 cigarettes/day	273 (13.8)	167 (15.3)	106 (12.0)	
>10 cigarettes/day	17 (0.9)	6 (0.5)	11 (1.2)	
Family History of Diabetes				< 0.001
No	1,223 (60.1)	727 (63.1)	496 (56.2)	
Yes	684 (33.6)	335 (29.1)	349 (39.6)	
Not Mentioned	128 (6.3)	91 (7.9)	37 (4.2)	
Personal History of GDM	48 (2.4)	10 (0.9)	38 (4.3)	< 0.001
Number of Prenatal Care Visits	11.0 ± 3.0	11.1 ± 3.7	11.0 ± 2.8	0.665
Gestational Age at GDM Screen (weeks)	27.5 ± 3.4	27.6 ± 3.7	27.4 ± 3.1	0.954

[a]Numbers may not add to total due to missing data

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Table II

Distribution of Gestational Weight Gain (GWG), Gestational Diabetes Mellitus (GDM), and Abnormal Glucose Tolerance (AGT) Among Latinas; Massachusetts: 2006–2011.

	Total Sample (N=2,039)	
	N	**%**
GWG up to end of 1st Trimester		
Low	636	39.4
Appropriate	395	24.4
Excessive	585	36.2
GWG up to GDM Screen		
Low	449	22.0
Appropriate	568	27.9
Excessive	1,022	50.1
GDM		
Yes	143	7.0
No	1896	93.0
AGT		
Yes	354	17.4
No	1685	82.6
	Mean	SD
GWG up to end of 1st Trimester		
Continous (kg; mean, SD)	2.0	4.4
GWG up to GDM Screen		
Continous (kg; mean, SD)	9.2	6.2

SD=standard deviation

Table III

Abnormal Glucose Tolerance (AGT) and Gestational Diabetes Mellitus (GDM) in Relation to Adherence to Gestational Weight Gain (GWG) Guidelines among Latinas, Massachusetts: 2006–2011

	AGT				GDM			
	Cases of AGT		Site- & Age Adjusted Model		Cases of GDM		Site & Age-Adjusted Model	
	N	**%**	**OR**	**95% CI**	**N**	**%**	**OR**	**95% CI**
GWG up to end of 1st Trimester								
Low	91	32.6	0.72	0.51, 1.02	31	27.4	0.59	0.35, 1.01
Appropriate	74	26.5	1.00	Referent	30	26.6	1.00	Referent
Excessive	114	40.9	1.05	0.75, 1.47	52	46.0	1.08	0.67, 1.76
GWG up to GDM Screen								
Low	75	21.2	1.04	0.74, 1.46	19	13.3	0.51	0.29, 0.92
Appropriate	97	27.4	1.00	Referent	44	30.8	1.00	Referent
Excessive	182	51.4	1.04	0.79, 1.38	80	55.9	0.99	0.66, 1.47

Table IV

Abnormal Glucose Tolerance (AGT) and Gestational Diabetes Mellitus (GDM) in Relation to Adherence to Gestational Weight Gain (GWG) Guidelines Stratified by Prepregnancy Body Mass Index (BMI).

	AGT				GDM			
	Cases		Site- & Age Adjusted Model		Cases		Site-Adjusted Model	
	N	%	OR	95% CI	N	%	OR	95% CI
GWG up to end of 1st Trimester								
Normal weight (BMI 18.5 to < 25.0 kg/m^2)								
Not Excessive	62	65.3	1.00	Referent	14	58.3	1.00	Referent
Excessive	33	34.7	0.93	0.58, 1.49	10	41.7	1.33	0.56, 3.15
Overweight (BMI 25.0 to < 30.0 kg/m^2)								
Not Excessive	43	51.8	1.00	Referent	21	50	1.00	Referent
Excessive	40	48.2	1.96	1.17, 3.30	21	50	2.07	1.04, 4.12
Obese (BMI 30.0+ kg/m^2)								
Not Excessive	56	55.4	1.00	Referent	26	55.3	1.00	Referent
Excessive	45	44.6	1.07	0.67, 1.70	21	44.7	1.07	0.57, 2.01
GWG up to GDM Screen								
Normal weight (BMI 18.5 to < 25.0 kg/m^2)								
Not Excessive	64	55.6	1.00	Referent	16	51.6	1.00	Referent
Excessive	51	44.4	0.93	0.62, 1.39	15	48.4	1.07	0.56, 2.23
Overweight (BMI 25.0 to < 30.0 kg/m^2)								
Not Excessive	38	36.2	1.00	Referent	18	34.0	1.00	Referent
Excessive	67	63.8	1.28	0.80. 2.03	35	66.0	1.39	0.74, 2.60
Obese (BMI 30.0+ kg/m^2)								
Not Excessive	63	48.8	1.00	Referent	25	44.6	1.00	Referent
Excessive	66	51.2	0.74	0.49, 1.12	31	55.4	0.94	0.53, 1.67