Predictors of Gestational Weight Gain in Mexican American Women in Los Angeles

Ruth Mielke and Nicholas Gorman

California State University, Fullerton School of Nursing

Abstract

Background and Significance: Extremes of gestational weight gain (GWG) are associated with newborn and pregnancy complications, postpartum obesity and chronic illnesses. In the United States, Mexican American women are the largest subgroup of Hispanics but have been studied least often. The purpose of the study was to determine the prevalence, characteristics, and predictors of GWG in Mexican American women. **Methods:** A retrospective, correlational design used data from charts (n=684) in a federally qualified health center in Los Angeles. Prevalence of GWG was inadequate, 22%; adequate, 33%; and excessive, 45%. Risk factors for excessive GWG were hypertension (p = .04), overweight (p = .00), or obese pre-pregnancy BMI (p = .01). Conversely, women who had gestational diabetes (p = .02), ate more snacks (p = .01), were multiparous (p = .03), and less acculturated (p = .03) experienced less excessive gain. **Conclusions:** Efforts to prevent excessive GWG in Mexican Americans should be targeted to women having their first baby and those with high pre-pregnancy BMI. One strategy may be recommending diet/exercise similar to that used in women with gestational diabetes. For women who are less acculturated and/or who are multiparous, strategies that will minimize inadequate GWG may improve newborn outcomes.

Keywords: gestational weight gain, gestational diabetes, Mexican American, pregnancy, obesity, women

Introduction

Achieving adequate weight gain during pregnancy is critical to optimize infant and maternal outcomes (Institute of Medicine [IOM], 2009). However, only one third of women gain an appropriate amount of weight during pregnancy (Brawarsky et al., 2005; Schieve, Cogswell, & Scanlon, 1998). Inadequate gestational weight gain (GWG) is mainly associated with poorer infant outcomes; preterm birth (Han et al., 2011) and suboptimal infant birth weight (Drehmer, Duncan, Kac, & Schmidt, 2013; Han et al., 2011; Siega-Riz et al., 2009). Excessive GWG is also associated with negative infant outcomes such as perinatal mortality and excessive infant birth weights (March of Dimes, 2007; Siega-Riz, et al., 2009). In the mother, excessive GWG increases the likelihood of delivery complications (DeVader, Neeley, Myles, & Leet, 2007; Rhodes, Schoendorf, & Parker, 2003; Stotland, Hopkins, & Caughey, 2004), postpartum weight retention (Gore, Brown, & West, 2003; Siega-Riz, et al., 2009), and subsequent obesity (Gunderson, Abrams, & Selvin, 2000; Rooney & Schauberger, 2002; Schmitt, Nicholson, & Schmitt, 2007).

In the longer term, inadequate and excessive GWG appear to alter the fetal intrauterine environment, resulting in obesity in childhood (Salsberry & Reagan, 2005), adolescence (Salsberry & Reagan, 2007), and in Type 2 diabetes and atherogenic profiles in adulthood (Lau, Rogers, Desai, & Ross, 2011; Rasmussen & Yaktine, 2009). Therefore, optimizing GWG improves not only maternal health but that of the next generation.

Ethnicity and Gestational Weight Gain

Multiethnic studies have reported biologic, behavioral, psychological, and provider related factors associated with GWG (Althuizen, van Poppel, Seidell, & van Mechelen, 2009; Brawarsky, et al., 2005; Chasan-Taber et al.,

2008; Dipietro, Millet, Costigan, Gurewitsch, & Caulfield, 2003; Herring et al., 2012; Wells, Schwalberg, Noonan, & Gabor, 2006). Among ethnic minority women, sociocultural factors must also be considered, for example, more obesogenic built environments (Booth, Pinkson, Walker, & Poston, 2005; Lederman, Alfasi, & Deckelbaum, 2002); culturally influenced dietary preferences such as home-prepared versus fast food (Carrera, Gao, & Tucker, 2007; Gutierrez, 1999); beliefs about the amount of weight that should be gained, and which foods are either avoided or preferred during pregnancy (Tovar, Chasan-Taber, Bermudez, Hyatt, & Must, 2010; Webb, Siega-Riz, & Dole, 2009) - all of which may increase vulnerability to inadequate and excessive GWG.

Sociocultural Characteristics

Acculturation. In Hispanics, acculturation into U.S. culture has been associated with negative prenatal behaviors such as alcohol use and smoking (Zambrana, Scrimshaw, Collins, & Dunkel-Schetter, 1997) while preservation of the Mexican culture is evidenced by positive behaviors - healthy diets and avoidance of substances (Dixon, Sundquist, & Winkleby, 2000). Subsequently, fewer perinatal complications and low birth weight infants are observed in less U.S.-acculturated women (Callister & Birkhead, 2002). However, their wider age-range of childbearing results in more offspring, and greater exposure to the weight changes of pregnancy (Bowie et al., 2007).

Paternal education. As a proxy indicator of socioeconomic status, parental education may be associated with GWG (Williams and Collins, 2005). Lower education and poverty are associated with high body mass index (BMI), a key factor in excessive GWG (Drewnowski & Specter, 2004; Herring et al., 2012; Molarius, Seidell, Sans, Tuomilehto, & Kuulasmaa, 2000). In one study, parents with 12+ years of education were more likely to have first-born infants who survived the first year of life. Stillbirth was 1.7 times more likely in families with a paternal education of less than 10 years, and 1.2 times more likely than when maternal education was less than 10 years (Arntzen, Magnus, & Bakketeig, 1993). Hence, lower education, particularly paternal education, is associated with poorer living conditions, including reduced access to food and health care resources.

Biologic Characteristics

Maternal age. Adolescents and younger women (Deputy, Sharma, Kim, & Hinkle, 2015; Howie, Parker, & Schoendorf, 2003; Koleilat & Whaley, 2013; Schieve et al., 1998) are more likely to gain excessively. Though related to concurrent maturation, it is of concern because of the risk of postpartum weight retention and the potential for young women to move to a high BMI category by the next pregnancy (Gould Rothberg et al., 2011). There is less consistency in older women. Deputy et al. (2015) reported that inadequate GWG was more likely in multiethnic women 35 and older while Puerto Rican women over 30 years of age were at 2.5 times greater risk for excessive GWG than younger women (Chasan-Taber et al., 2008).

Pre-pregnancy body mass index. Pre-pregnancy BMI is a key predictor of GWG (IOM, 1990, 2009). High pre-pregnancy BMI is a recurring key determinant of excessive gain among non-Hispanic White (NHW) (Cogswell, Scanlon, Fein, & Schieve, 1999; Harris, Ellison, & Holliday, 1997; Olson & Strawderman, 2003; Strychar et al., 2000); non-Hispanic Black (NHB) (Lederman et al., 2002), Hispanic (Chasan-Taber et al., 2008; Koleilat & Whaley, 2013; Walker, Hoke, & Brown, 2009) and multi-ethnic women (Brawarsky et al., 2005; Walker & Kim, 2002; Wells et al., 2006). Specifically, overweight BMI has been the most commonly reported determinant of excessive GWG in all ethnicities (Brawarsky et al., 2005; Deputy et al., 2015; Nielsen et al., 2006; Olafsdottir, Skuladottir, Thorsdottir, Hauksson, & Steingrimsdottir, 2006; Schieve et al., 1998). Conversely, underweight BMI has been implicated in increased risk of inadequate gain (Deputy et al., 2015), but with less frequency.

Parity. Large multiethnic studies of women of all ages have reported primiparity versus subsequent births as a covariate for excessive GWG (Abrams & Parker, 1990; Brawarsky et al., 2005; Wells et al., 2006). Adolescent

primiparas gained 5.28 pounds more than multiparas (Scholl et al., 1988); had twice the likelihood of excessive GWG than multiparas (Howie, et al., 2003) and Harris et al. (1997) reported primiparity as an independent predictor of excessive GWG followed by infant birth weight, and maternal BMI.

Hypertension. A relationship between hypertension in pregnancy and excessive GWG has been observed in women of diverse ethnicities (Caulfield, Witter, & Stoltzfus, 1996; Johnson et al., 2013; Scholl et al., 1988; Wells et al., 2006). Compared to NHW women, NHB women consistently have more pregnancy-related hypertension independent of other factors (Chappell et al., 2008; Knuist, Bonsel, Zondervan, & Treffers, 1998; Liu et al., 2014). In Hispanics, findings are less consistent: from lower risk (Yeo, Wells, Kieffer, & Nolan, 2007) to differential risk - higher risk for certain types of hypertension (e.g., preeclampsia but not gestational hypertension) (Wolf et al., 2004). In all ethnicities, pregnancy-related hypertension is more common in primiparas (Johnson et al., 2013) and in women with a family history of hypertension (Ness, Markovic, Bass, Harger, & Roberts, 2003).

Excessive GWG and high pre-pregnancy BMI are modifiable factors that have independent as well as synergistic influences on hypertension in pregnancy. Hispanic women with excessive GWG had a three-fold risk of hypertension and four-fold risk of preeclampsia compared to women who gained appropriately. Those with obese pre-pregnancy BMI were 2.7 times greater risk of having pregnancy related hypertension than women in lower BMI categories (Fortner, Pekow, Solomon, Markenson, & Chasan-Taber, 2009). In NHB women with obese BMI the risk of hypertension was 1.5 fold greater but when compounded by excessive GWG, increased to 2.6 fold (Chandrasekaran, Levine, Durnwald, Elovitz, & Srinivas, 2014).

Gestational diabetes mellitus. Increased risk for gestational diabetes mellitus (GDM) is associated with excessive GWG in early pregnancy (Carreno et al., 2012; Hedderson, Gunderson, & Ferrara, 2010). However, once diagnosed with GDM, Hispanic women may be more likely to gain inadequately (Walker et al., 2009) or adequately (Chasan-Taber et al., 2008) overall due to dietary and exercise modifications.

Behavioral Characteristics

Exercise. Physical activity varies by age, socioeconomic status, and acculturation. Hispanics are the most physically inactive ethnic group in the United States (Evenson & Wen, 2010) and in pregnancy, expend 30% less energy than NHW women (Schmidt, Pekow, Freedson, Markenson, & Chasan-Taber, 2006). First generation Hispanic women who immigrated to the U.S. before 25 years of age and with greater English proficiency reported more physical activity than older women with less English (Evenson, Sarmiento, & Ayala, 2004). Puerto Rican women most likely to engage in modest to more intense exercise were U.S. born, college-educated, had higher income, and fewer children compared to those more likely to engage in domestic activity who preferred Spanish and had more children (Chasan-Taber et al., 2007).

Maternal food intake. Although believed that more U.S.-acculturated Hispanic women take on the energy dense, high-fat diet common in young women in the U.S., this assumption is not well documented. In Mexican American adolescents, increasing GWG was positively associated with acculturation, but during pregnancy, they were more likely to eat traditional “more healthy” foods prepared by their mothers (Gutierrez, 1999). A review of acculturation and Hispanic food practices found no positive correlation between acculturation and dietary fat intake despite evidence that fat-related behaviors differed based on acculturation. Less acculturated women consumed more whole milk and used fat in food preparation; whereas the more acculturated consumed more fast food, snacks, and added fats. More acculturated individuals consumed more fruit, rice, and beans and less acculturated individuals consumed less sugar and sugar-sweetened beverages than more acculturated individuals (Ayala, Baquero, & Klinger, 2008). Therefore, it may be that the overall dietary

pattern and lifestyle of women with less acculturation (e.g., consuming foods with natural fat rather than added fats and a diet higher in fiber, Bacardi-Gascon, Dueñas-Mena, & Jimenez-Cruz, 2007), in addition to physical work involved in food preparation, promotes adequate GWG.

The Present Study

In the United States, the Hispanic population is the fastest growing ethnic minority with the largest sub-groups being Mexican Americans (66%) and Puerto Ricans (9%) (Ennis, Ríos-Vargas, & Albert, 2011). However, perinatal differences exist among Hispanic sub-groups. Birth rates are highest in Mexican Americans (117 per 1,000) compared to Puerto Ricans (75.7) and Cubans (55.1, Bowie, Juon, Cho, & Rodriquez, 2007), while preterm birth is highest in Puerto Ricans (14.0%) and lowest in Central/South Americans (11.7%) (March of Dimes, 2007).

Factors associated with GWG have been reported in other Hispanic sub-groups (Chasan-Taber et al., 2008; Tovar et al., 2010; Tovar, Chasan-Taber, Bermudez, Hyatt, & Must, 2012) but few studies have disaggregated Mexican women for study. It was hypothesized that a model of non-modifiable factors (age, parity, acculturation, paternal education), modifiable factors (pre-pregnancy BMI, exercise, maternal food intake), and covariates (hypertension, gestational diabetes) for GWG would identify Mexican women at risk for extremes of GWG who would benefit from strategies to promote healthy pregnancy gain.

Methods

Design and Sample

The study was a retrospective, correlational design. Data were obtained from patient records from a federally qualified health center in Los Angeles. The center has a busy women's health clinic where prenatal care is provided by nurse-midwives and physicians. The majority of patients are low-income and Hispanic (84%) (HRSA, 2014).

A purposive sample of Mexican/Mexican American women (n=684) was achieved by screening 1,257 charts of women with Hispanic surnames who delivered infants between 2007 and 2009. Inclusion criteria were: term gestation (last prenatal visit 36+ weeks), singleton, maternal age 12+ years old, ethnicity documented as Hispanic with place of birth in Mexico or the United States. If the chart indicated birthplace in U.S., the woman was contacted to determine self-identification as Mexican American. The chart had to include a pre-pregnancy weight or weight documented at $\leq$ 14 weeks gestation. Charts were excluded if a pre-existing condition known to impair metabolism (e.g. thyroid disease and diabetes) was noted.

Charts analyzed must have indicated enrollment in the Comprehensive Perinatal Services Program (CPSP), a Medicaid case management program for pregnant women in California. Women enrolled in CPSP have provider prenatal visits and separate risk assessments inclusive of nutrition, health education, and psychosocial components.

Procedures and Measures

Data was manually extracted from medical records by the researcher and two registered nurses and entered onto a code sheet developed for the study. Data was extracted from: (a) the American College of Obstetrics and Gynecology (ACOG) Antepartum Record (ACOG, 2008), (b) CPSP Prenatal Combined Assessment/Reassessment Tool (CPSP, 1998), and (c) PFFQ (CPSP, 2004). The study protocol was approved by the Institutional Review Board of the investigators' affiliation as well as the health center.

Variables

The outcome variable, GWG, was measured by subtracting the self-reported pre-pregnancy weight from the last recorded maternal weight during the pregnancy. If pre-pregnancy weight was unknown, the first recorded weight during the first trimester was used. The latter was considered to be a reasonable approach as first trimester weight gain is minimal (Hytten, 1991; Picciano, 2007).

GWG was categorized as inadequate, adequate, or excessive based on 2009 IOM guidelines which use pre-pregnancy BMI categories to determine adequate gain: underweight (BMI < 18.5 kg/m^2), 28 to 40 pounds; normal weight (BMI 18.5 – 24.99 kg/m^2), 25 to 35 pounds; overweight (BMI 25-29.9 kg/m^2), 15 to 25 pounds, and obese (BMI $\geq$ 30 kg/m^2), 11 to 20 pounds. Inadequate GWG was less than the recommendation in each BMI category, adequate GWG was within the recommendation, and excessive GWG was above the recommendation. Predictor variables: acculturation, paternal education, maternal age, pre-pregnancy BMI, parity, hypertension, gestational diabetes mellitus, exercise, and maternal food intake, were selected based on the review of the literature and their availability on the chart forms (Table 1).

Table 1.

Definitions of Predictor Variables

Variable	Definition
Sociocultural	
Acculturation	Preferred language at home (Cabassa, 2003) • Least (mother and father preferred Spanish) • Intermediate (mother and/or father preferred Spanish or English) • Most acculturated (mother and father preferred English).
Paternal education	Number of years of school completed by father of woman's baby
Biologic	
Maternal age	Chronologic age at beginning of pregnancy
Pre-pregnancy body mass index [a]	BMI prior to pregnancy = (weight in Pounds /(height in inches) x (height in inches) x 703
Parity	Number of term and preterm births achieving at least 20 weeks gestation • Primiparous – no prior infant of at least 20 weeks gestation (first baby) • Multiparous - one or more prior births of at least 20 weeks gestation
Hypertension	Blood pressure $\geq$ 140 mm Hg (systolic) and/or $\geq$ to 90 mm Hg (diastolic) prior to or during pregnancy "Yes" –any chronic hypertension and/or gestational hypertension.
Gestational diabetes mellitus	Impaired glucose tolerance that occurs during pregnancy (ACOG, 2013b) • A1 – diet/exercise controlled • A2 – use of oral agent (glyburide) • A2 – use of insulin "Yes"- any of the above categories
Behavioral	
Exercise	Reported number of minutes a day x reported number of days a week
Maternal food intake[d]	Sum of the number of servings in food categories, *protein*, *milk*, *grains*, *fruits and vegetables* and *fats and sweets*, and *snacks*

Note: [a] If pre-pregnancy weight was unknown, first recorded prenatal weight during first trimester was used. [b] In pregnancy hypertension can be a preexisting condition or conditions, preeclampsia or gestational hypertension, that develop during pregnancy (ACOG, 2013b). [c] Excluded pre-existing diabetes. [d] Categories were determined with recommendation by expert registered dietician with a specialty in pregnancy nutrition and with comparison to the MyPyramid for Moms, the USDA macronutrient recommendations for pregnancy (U. S. Department of Agriculture, 2008). Each food intake variable was measured as servings per week except for snacks, snacks per day. [e] Content validity of questions selected for measurement of acculturation was based on Short Acculturation Scale for Hispanics (SASH), a 12-item scale widely used with Hispanics (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). SASH constructs are preferred language and language spoken with others (home and friends).

Data Analysis

Descriptive statistics were calculated on all variables of interest. A series of one-way ANOVAs and chi-square tests of independence were conducted to examine whether there were systematic sociocultural, biologic, or behavioral differences among Mexican American women

who experience inadequate, adequate, or excessive GWG (Tables 1- 4).

In order to determine whether any of the characteristics identified in Tables 2-4 predicted Mexican American women's GWG, a multinomial logistic regression model was examined. Given the theoretical plausibility of each characteristic as predictors of GWG, it was decided a priori to include all statistically significant predictors from Tables 2-4 in the regression model. A *p* value of less than or equal to .05 was considered statistically significant. SPSS version 20 was used for the analysis.

Results

In this group of Mexican American women, 22% gained less than recommended, 33% gained adequately, and 45% gained excessively. The mean age was 26.38 (SD = 6.48), average number of prenatal visits was 12.73 (SD = 3.00), and mean BMI was 27.09 (SD = 5.40). Most women (81%) were born in Mexico ($p \leq .05$) and had less than 12 years of education (64.4%). More of the Mexican born women (34.2%) had adequate GWG than U.S. born (27.1%). U.S. born women had more excessive GWG (55%) than women born in Mexico (42.4%). In contrast, more Mexican born women had inadequate gain (23.4%) than U.S. born (17.8%, $p \leq .05$).

Sociocultural Characteristics

Both sociocultural characteristics were significantly different in the three GWG categories (Table 2). Of Spanish only speaking women (least acculturated), 40.8% gained excessively compared to 55.8% who spoke Spanish or English (moderately acculturated), and 53.6% who spoke English only (most acculturated). More Spanish speaking women gained adequately (35.6%) than Spanish or English (28.8%) or English only (23.2%). Mean paternal education was significantly different ($p \leq .001$) in that women with excessive GWG had partners with higher educational level (9.83 $\pm$ 2.64) compared to those with adequate (9.05 $\pm$ 3.06) or inadequate (8.84 $\pm$ 2.91) GWG.

Table 2.

Sociocultural Characteristics by Gestational Weight Gain

Sociocultural Determinants	Inadequate GWG n=153	Adequate GWG *n* = 225	Excessive GWG *n* = 306	*F* or χ^2
	n (%) or M ± SD	n (%) or M ± SD	n (%) or M ± SD	
Acculturation				
Spanish	106 (70.2)	160 (73.4)	184 (61.1)	9.92*
Spanish or English	32 (21.2)	45 (20.6)	87 (28.9)	
English	13 (8.6)	13 (6.0)	30 (10.0)	
Paternal Education	8.84 ± 2.91	9.05 ± 3.06	9.83 ± 2.64	6.82***
<12 years	86 (70.5)	126 (67.4)	162 (62.3)	2.81
≥ 12 years	36 (29.5)	61 (32.6)	98 (37.7)	

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$

Biologic Characteristics

The three GWG categories were significantly different for biologic characteristics of pre-pregnancy BMI, parity, hypertension, and GDM (Table 3). Adequate GWG occurred most often (41.6%) in women who were underweight or of normal weight prior to pregnancy. Excessive gain occurred most frequently in women who were overweight (63.5%) or obese (42.2%) at pregnancy onset. Very few women (*n* = 10) were underweight at the onset of pregnancy. Women with normal pre-pregnancy BMI more commonly had adequate GWG (41.3%) than those with overweight (25.3%) or obese BMI (30.1%). Of the study's 199 primiparous women, 109 (54%) gained too much and by parity, comprised the majority (58.3%) in the excessive gain group. Hypertension was also most common in women with excessive GWG. Inadequate gain was more common in women with GDM, in particular those managed with diet or oral medication. Of the 74 women with

Table 3.

Biologic Characteristics by Gestational Weight Gain

Biologic Determinants	Inadequate GWG n =153	Adequate GWG n = 225	Excessive GWG n = 306	*F* or χ^2
	n (%) or M ± SD	n (%) or M ± SD	n (%) or M ± SD	
Age (years)	27.32 ± 6.37	26.30 ± 6.23	25.98 ± 6.68	2.20
< 20	18 (11.8)	37 (16.4)	62 (20.3)	6.36
20-35	115 (75.2)	167 (74.2)	211 (69.2)	
>35	20 (13.1)	21 (9.3)	32 (10.5)	
Pre-Pregnancy BMI	27.55 ± 6.66	26.29 ± 5.26	27.46 ± 4.70	3.80*
Underweight	4 (40.0)	5 (50.0)	1 (10.0)	69.01***
Normal	75 (29.0)	107 (41.3)	77 (29.7)	
Overweight	28 (11.2)	63 (25.3)	158 (63.5)	
Obese	46 (27.7)	50 (30.1)	70 (42.2)	
Parity				
Primiparous	30 (19.9)	60 (26.7)	109 (35.7)	13.36**
Multiparous	121 (80.1)	165 (73.3)	196 (64.3)	
Hypertension (dichotomous)				
No	141 (92.8)	211 (93.8)	268 (87.6)	6.87*
Yes	11 (7.2%)	14 (6.2)	38 (12.4)	
Gestational Diabetes				
No	119 (79.3)	199 (88.8)	287 (94.1)	26.25***
A1	14 (9.3)	7 (3.1)	5 (1.6)	
A2, glyburide	13 (8.7)	14 (6.3)	9 (3.0)	
A2, insulin	4 (2.7)	4 (1.8)	4 (1.3)	
Gestational Diabetes (dichotomous)				
No	119 (79.3)	199 (88.8)	287 (94.1)	22.60***
Yes	31 (20.7)	25 (11.2)	18 (5.9)	

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$

GDM, 40% gained inadequately, 33% gained adequately, and 24% gained excessively $p < .001$).

Behavioral Characteristics

The GWG categories were significantly different ($p \leq .001$) for one behavioral characteristic - snacks per day (Table 4). Women with inadequate GWG ate more snacks per day (2.13 ± 0.99) than women with adequate GWG (2.03 ± 0.92) or with excessive GWG (1.75 ± 1.04). Among the three categories, there were no significant differences in exercise, maternal food intake, or intake of specific food groups.

Determinants of Gestational Weight Gain

Multinomial logistic regression modeling revealed several statistically significant predictors of inadequate and excessive GWG ($\chi^2(18) = 126.04$, $p < .001$).

Table 5 shows that inadequate GWG was associated with multiparity (OR = 2.09) and was less likely in women with less acculturation (OR = 0.50).

Determinants of excessive weight gain were hypertension (OR = 2.16) and high pre-pregnancy BMI; overweight (OR = 4.65) or obese (OR = 2.17) as compared to normal pre-pregnancy BMI. Protective factors for excessive gain were GDM (OR = 0.41), multiparity (OR = 0.47), less acculturation (OR = 0.57) and eating more snacks per week (OR = 0.96).

Table 4.

Behavioral Characteristics by Gestational Weight Gain

Behavioral Determinants	Inadequate GWG n =153	Adequate GWG n = 225	Excessive GWG n = 306	*F* or χ^2
	n (%) or M ± SD	n (%) or M ± SD	n (%) or M ± SD	
Exercise (minutes/wk)	119.51 ± 126.73	136.42 ± 182.45	117.36 ± 145.90	1.00
0-50	48 (34.0)	76 (36.2)	108 (37.5)	4.56
51-100	30 (21.3)	48 (22.9)	55 (19.1)	
101-150	27 (19.1)	30 (14.3)	59 (20.5)	
>150	36 (25.5)	56 (26.7)	66 (22.9)	
Maternal food intake (servings/wk)	138.54 ± 31.85	140.48 ± 33.17	136.86 ± 34.43	0.75
Protein	14.03 ± 6.60	15.14 ± 7.22	14.77 ± 6.24	1.27
< 16	100 (65.8)	140 (62.2)	182 (59.7)	3.63
16-28	50 (32.9)	78 (34.7)	118 (38.7)	
> 28	2 (1.3)	7 (3.1)	5 (1.6)	
Milk	16.37 ± 7.51	17.37 ± 8.78	16.79 ± 8.48	0.69
< 16	66 (43.4)	97 (43.1)	124 (40.7)	1.64
16-28	78 (51.3)	112 (49.8)	165 (54.1)	
> 28	8 (5.3)	16 (7.1)	16 (5.2)	
Grain	42.63 ± 16.61	44.34 ± 16.10	41.99 ± 18.15	1.24
< 38	54 (35.5)	76 (33.8)	106 (34.8)	0.67
38-65	85 (55.9)	129 (57.3)	177 (58.0)	
> 65	13 (8.6)	20 (8.9)	22 (7.2)	
Fruits & vegetables	38.91 ± 15.73	37.67 ± 15.98	38.36 ± 15.03	
< 21	10 (6.6)	13 (5.8)	20 (6.6)	0.30
21-49	115 (75.7)	178 (79.1)	240 (78.7)	0.94
> 49	27 (17.8)	34 (15.1)	45 (14.8)	
Fats & sweets	10.72 ± 9.23	11.83 ± 10.13	12.74 ± 10.51	2.05
< 3	21 (14.0)	22 (9.8)	19 (6.3)	8.87
3-12	70 (46.7)	121 (54.0)	156 (51.5)	
> 12	59 (39.3)	81 (36.2)	128 (42.2)	
Snacks per day	2.13 ± 0.99	2.03 ± 0.92	1.75 ± 1.04	8.97***
0	6 (4.3)	18 (8.1)	52 (17.2)	25.28***
1-2	88 (63.3)	149 (67.1)	195 (64.4)	
> 2	45 (32.4)	55 (24.8)	56 (18.5)	

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$

Discussion

This is the first known study to document prevalence of GWG in a homogeneous group of Mexican/Mexican American women. The finding that one third of the women in this study gained adequately is consistent with previous literature regarding women of all ethnicities (Barbara Abrams, Altman, & Pickett, 2000; Caulfield et al., 1996; Cogswell et al., 1999; Olson & Strawderman, 2003). It is also consistent with older studies of other Hispanic groups in the United States: 33% in Puerto Ricans (Chasan-Taber et al., 2008); 32% in Hispanics in the San Francisco area (Brawarsky et al., 2005) and 33.9% in Hispanic women in New Mexico (Walker et al., 2009).

During the study period, the IOM released new GWG guidelines that use World Health Organization BMI categories instead of the previous ones based on the Metropolitan Life insurance tables (IOM, 2009). These classify smaller proportions of women as underweight before pregnancy while a larger proportion are classified as overweight. The limitations of comparing this sample to older studies are that the 2009 IOM guidelines result in fewer women with inadequate GWG and more women with excessive GWG than if the 1990 IOM guidelines were applied.

Table 5.

Summary of Multinomial Regression Models for Determinants of Inadequate and Excessive Gestational Weight Gain (n = 553)

Determinants	β	SE β	Exp (β)	95% CI	
IGWG vs. AGWG				*LL*	*UL*
Snacks per Week	.01	.02	1.01	0.98	1.05
Paternal Education	-.02	.24	0.64	0.36	1.13
Gestational Diabetes	.53	.36	1.69	0.84	3.41
Hypertension	-.04	.49	0.96	0.37	2.50
Pre-pregnancy BMI[b]					
Underweight	-.46	.89	0.60	0.11	3.61
Overweight	-.42	.32	0.19	0.35	1.22
Obese	.17	.31	0.58	0.65	2.16
Acculturation	-.69	.31	0.50*	0.27	0.91
Parity[d]	.74	.34	2.09*	1.07	4.08
EGWG vs. AGWG				*LL*	*UL*
Snacks per Week	-.04	.01	0.96**	0.93	0.99
Paternal Education	-.02	.24	0.98	0.62	1.55
Gestational Diabetes	-.90	.38	0.41*	0.19	0.86
Hypertension	.77	.37	2.16*	1.04	4.48
Pre-pregnancy BMI[b]					
Underweight	-2.05	1.16	0.13	0.01	1.23
Overweight	1.54	.25	4.65***	2.82	7.66
Obese	.78	.28	2.17**	1.24	3.80
Acculturation	-.56	.25	0.57*	0.35	0.94
Parity[d]	-.75	.25	0.47***	0.29	0.78

*$p \leq .05$ **$p \leq .01$ *** $p \leq .001$

Note: $R^2 = .20$ (Cox and Snell), .23 (Nagelkerke). Model $\chi^2(18) = 126.04$, $p < .001$.

[a] Reference category: Less than 12 years education

[b] Reference category: Normal

[c] Reference category: Least acculturated

[d] Reference category: Primiparity

Our study had a larger proportion of Mexican American women who gained adequately and a smaller proportion who gained excessively compared to recent large multi-ethnic studies (Hunt, Alanis, Johnson, Mayorga, & Korte, 2013; Chihara et al., 2014). Compared to a study of Hispanics in Texas, our sample had fewer women with inadequate gain, more women with adequate gain, and similar prevalence of excessive gain (Sangi-Haghpeykar, Lam, & Raine, 2014). The positive differences may be due to the large proportion of less acculturated women in our sample who were less likely to gain excessively and more likely to have adequate weight gain than more acculturated. System factors- easily accessed prenatal care, case management, and the provision of multi-layered care by providers, health educators, and support staff at the center could also be influential in these differences.

Models of Gestational Weight Gain

Models of GWG using sociocultural, biologic, behavioral, and variables have been proposed. In NHW women, Olson and Strawderman (2003) described a "biopsychosocial model" that explained 27% of the variance in overall GWG.

Factors associated with greater GWG were decreased physical activity, consuming more food, overweight pre-pregnancy BMI, and low income while factors associated with inadequate GWG were low BMI, consuming less food, and smoking. Models of GWG in Hispanic women have been reported in Puerto Ricans in Massachusetts (Chasan-Taber et al., 2008); Hispanics in New Mexico (Walker et al., 2009) and in Houston, Texas (Sangi-Haghpeykar, Lam, & Raine, 2014). In the Latina GDM Study, Chasan-Taber et al. (2008) found that older maternal age, more prenatal visits, overweight, parity and acculturation were associated with both inadequate and excessive GWG among Puerto Rican women. In our study, predictor variables accounted for 20% of the variance in the model of GWG in Mexican American women and are described in the next section.

Acculturation. Less acculturation to the U.S. was protective of both extremes of GWG. This finding is partially consistent among Puerto Ricans, in which U.S.-born women were more likely to gain excessively (Chasan-Taber et al., 2008), and women with less than 10 years of U.S. residence were less likely to gain excessively (Tovar et al., 2012). Similarly, more acculturated (U.S. born) Hispanic women in Houston, Texas were more than 3 times likely to gain excessively (Sangi-Haghpeykar et al., 2014) than non-U.S. born, and Spanish speaking Hispanic women in Southern California were about half as likely to have excessive GWG. Our study found that Mexican women with less acculturation were also less likely to have inadequate GWG – a finding not previously reported.

Hypertension. Recent national attention to identification and treatment of hypertensive disorders during pregnancy compels health workers to be aware of its associated factors. In our study, Mexican American women with hypertension were twice as likely to have excessive GWG. This is an important finding in that excessive GWG is modifiable and can be influenced by correct advice and information (Cogswell et al., 1999; Stotland et al., 2005). Therefore, preconception interventions for women with high BMI as well as strategies to promote adequate gain in pregnancy may be a double-pronged approach to decreasing the incidence of hypertension in pregnancy.

Parity. In our study, women in their first pregnancy were more likely to gain excessively. This is consistent with studies which have suggested that the first/ index pregnancy has higher GWG than subsequent pregnancies in multiethnic women (Brawarsky et al., 2005; Wells et al., 2006) and in Puerto Ricans (Chasan-Taber et al., 2008).

Recent studies of NHW primiparas reported excessive gains of 74.3% and 74% (Chung et al., 2013; Restall et al., 2014) – higher than reports from older studies which may in part reflect the application of the 2009 GWG guidelines. In comparison, in our study, 54.7% of primiparous women gained excessively, which is still of great concern because women of minority groups are more likely to retain excess postpartum weight than NHW women (Gould Rothberg, et al., 2011; Walker, Freeland-Graves, Milani, George, et al., 2004).

Snack consumption. Snack consumption was the only behavioral variable related to GWG. Mexican women consuming more snacks per week were less likely to have excessive gain during pregnancy. In contrast, studies of NHW women and adolescents have not reported this association (Olson & Strawderman, 2003; Stevens-Simon & McAnarney, 1992). Our finding is consistent with a recent study in which pregnant women with high pre-pregnancy BMI were randomized to a treatment group of which part was to consume three meals and three snacks each day (Petrella et al., 2014). Women in the treatment group had lower GWG than those in the control group. The hypothetical basis for our finding is suggested in the next section.

Gestational diabetes mellitus. In our study, women with GDM were 60% less likely to have excessive GWG. Our findings were unlike Walker et al. (2009), who found that Hispanic women with GDM were more likely to have inadequate gain. However, Chasan-Taber et al. (2008) reported that more Puerto Rican women

achieved adequate GWG when they had GDM than those without GDM.

Women with GDM have more difficulty metabolizing carbohydrates than pregnant women in general. This results in high maternal levels of glucose which may result in larger infants with more body fat. To promote euglycemia, women with GDM engage in medical nutrition therapy and daily exercise (American Diabetes Association, 2012). In practice, three meals and two to three snacks daily are recommended to distribute glucose intake and to reduce postprandial glucose fluctuations. Daily exercise is recommended to improve glycemic control (ACOG, 2013a). The fact that women with GDM experience such dietary/activity treatment, and are more closely monitored than women without GDM, suggests the benefit of lifestyle modifications and increased vigilance with respect to pregnancy weight gain.

Pre-pregnancy body mass index. The key predictor of excessive gain in Mexican American women was high BMI – being overweight and obese at the beginning of pregnancy (4.65 and 2.17 times) compared to women with normal BMI. This is similar to, but more extreme than in Hispanic women in New Mexico (Walker et al., 2009). As women with normal pre-pregnancy BMI have reduced risk of preterm birth compared to those with lower or higher BMIs, this further reinforces the benefit of achieving optimal pre-pregnancy BMI (Kosa et al., 2011). Therefore, preconception health promotion should be directed to Mexican American women with overweight pre-pregnancy BMI, given their propensity to gain excessively, compounded with increased risk for postpartum retention (Walker, Freeland-Graves, Milani, Hanss-Nuss et al., 2004), which increases the likelihood of obese pre-pregnancy BMI (Gould Rothberg, et al., 2011) in subsequent pregnancies.

Study Strengths and Limitations

Study data was abstracted from the ACOG Antepartum Record and forms used for the California Comprehensive Perinatal Services Program which were designed to assess individual pregnant women's health, obstetrical, psychosocial and nutritional risk. No other studies to date were found in which these tools were used to study a minority population such as Mexican American women.

Study limitations were that the retrospective design limited the analysis to available data in clinic records. Although tools such as that used for food intake in this study have the advantages of suggesting dietary patterns over an extended period (a week in this study), disadvantages include uncertain validity, inadequate food lists (particularly culturally specific foods), and inconsistent estimate of portion sizes (Fowles, Sterling, & Walker, 2007). Further, as the study was conducted in a health clinic with a majority of low-income Hispanics, it does not represent the Mexican American population across socio-economic spectra.

Interaction effects were not examined due to the exploratory nature of this study. For instance with advancing age and subsequent pregnancies, pre-pregnancy BMI also increases (Bowie et al., 2007). As discussed, sociocultural factors such as acculturation and paternal education influence biologic and behavioral variables. Future research may build upon the initial predictors identified in this study, with thought given to inclusion of other known interaction effects.

Conclusion

Of all women, Mexican American women experience pregnancy most often and therefore are most vulnerable to the effects of GWG. The study reported a model of GWG to identify Mexican women at risk for extremes of GWG who could benefit from strategies to promote healthy pregnancy gain. Key factors associated with gaining excessively; high pre-pregnancy BMI and primiparity alert the clinician to provide early prenatal information on GWG and to seek additional support (dietician, group classes, pregnancy exercise/Zumba) for the woman with high BMI and/or is a first time mother. The relationship between hypertension and excess GWG encourages vigilance for hypertension when excess gain is developing as

well as supports efforts to prevent excess gain which may reduce hypertension.

Postpartum care should target women who have gained excessively and/or started in a high pre-pregnancy category by concerted support to exclusively breastfeed for at least six months; resume/initiate some form of cardiovascular exercise; and ensure that she has been given the option of a long acting reversible contraceptive.
Women with GDM were less likely to gain excessively - therefore a similar diet and exercise regimen may have the same result in women who are at greater risk for excessive gain who do not have GDM. Multiparous women were more likely to gain inadequately than primiparous so they should be provided with education that will encourage behaviors to achieve optimal gain. Low acculturation conferred protection against both extremes of GWG. This may be another aspect of the Hispanic paradox in which the adherence to traditional behaviors contributes to better health outcomes. Continued research is needed to identify strategies that resonate with Mexican/Mexican women, especially those at particular risk for extremes of weight gain; to promote health of the woman, her baby, and subsequent generations.

Acknowledgements
The project was supported by an Azusa Pacific University Doctoral Scholarship and California State Fullerton, New Faculty Scholarship. Acknowledgements are extended to Cheryl Westlake, PhD, RN, CNS for her assistance and support during my doctoral dissertation and to the administrators and staff at Eisner Pediatric & Family Medical Center who approved the research protocol. We also acknowledge the invaluable editing provided by Dana Rutledge, PhD,RN.

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Author Information
Ruth Mielke, PhD, CNM, FACNM, WHNP*
Assistant Professor
California State University, Fullerton - School of Nursing
Coordinator of the Women's Health Care Concentration
800 N. State College Road
Fullerton, CA 92831
ruthmielke@fullerton.edu
Office: 657-278-2670 Fax: 657-278-3338

Nicholas Gorman, EdD, MPH
Assistant Professor
California State University, Fullerton School of Nursing
* corresponding author