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Excess Maternal Body Weight and Preeclampsia/Eclampsia Risk among Women in San Bernardino County, 2007-2008.

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Abstract

Objective: An association between maternal adiposity and preeclampsia has been found in several large U.S. studies. The objective of our study was to examine the association between maternal body weight (recommended weight gain categories, pre-pregnancy BMI categories) and preeclampsia/eclampsia in the analysis of all births occurring in San Bernardino County during 2007 and 2008.

Methods: A retrospective cohort study was conducted using information from the San Bernardino County birth cohort files of live births occurring between 2007-2008 (N=65 228). We conducted logistic regression analyses to examine the relationship between pre-pregnancy body mass index (BMI), Institute of Medicine qualitative weight gain (IOM-QWG), and preeclampsia/eclampsia outcomes, controlling for socio-demographic factors and surrogate measures of socioeconomic status that included participation in the Women, Infants, Children (WIC) Supplemental Nutrition Program, and maternal education.

Results: Using BMI 18.5-24.9 as the reference category, we found that pre-pregnancy BMI was associated with preeclampsia/eclampsia in 2007 (OR [95% CI] = 0.52 [0.31, 0.86] for BMI < 18.5; 1.40 [1.14, 1.71] for BMI 25.0 to 29.9 and 2.36 [1.97, 2.84] for BMI >30) and 2008 (0.90 [0.58, 1.40], BMI <18.5; 1.83 [1.48, 2.25], BMI 25.0-29.9; 2.69 [2.21, 3.27], BMI >30.0). Gaining "too much" weight according to IOM-QWG guidelines was associated with the increased odds of preeclampsia/eclampsia in 2007 (OR=1.60 [1.32, 1.92]) and 2008 (OR=1.84 [1.50-2.25]) using "just right" as the reference category.

Conclusion: Our findings indicated that overweight or obese pre-pregnancy BMI as well as gaining too much weight during pregnancy was associated with higher odds for preeclampsia/eclampsia.

Keywords: San Bernardino County; Preeclampsia; Eclampsia; Pre-pregnancy BMI, Institute of Medicine (IOM) Qualitative Weight Gain

Introduction

Preeclampsia is a hypertensive condition of pregnancy diagnosed when a woman with no history of hypertension develops hypertension and proteinuria after 20 weeks of gestation [1]. Preeclampsia affects multiple maternal organs including the liver, brain, and kidneys [2, 3]. Consequences of preeclampsia to the fetus include impaired fetal growth, premature birth, and death (4). Eclampsia is the onset of seizures related only to a preeclampsia diagnosis [1].

Maternal pre-pregnancy body mass index (BMI) classified as overweight and obese are associated modifiable risk factors for preeclampsia [5, 6]. Obese pregnant women (BMI >30kg/m^2) experience a nearly three-fold increase in developing preeclampsia compared to women of normal weight (BMI 18.5-<25.0 kg/m2) [7]. This problem is further compounded by the increasing prevalence of obesity among women who become pregnant in the United States which was estimated in 2009 to be 26% [7].

Current clinical approaches to ameliorating the

effects of preeclampsia are mostly secondary prevention measures that include early detection and screening, medication management, and preterm delivery [3]. By contrast, primary prevention efforts are less clinically utilized and include interventions at pre-conception or prenatal care visits that include weight management, nutritional counseling, and behavioral counseling or therapy [8]. The Select Panel on Preconception Care indicated that the purpose of preconception care should be to identify and modify maternal risk factors (biomedical, behavioral, and social) which may otherwise adversely affect pregnancy outcomes [9]. Weight screening is recommended during preconception visits through postpartum visits [10].

The overall objective of our study was to better understand the relationship between preeclampsia/eclampsia and maternal adiposity. Our specific aims were to explore the association between maternal pre-pregnancy BMI and preeclampsia/eclampsia risk, and to explore the association between IOM-QWG weight gain recommendations and preeclampsia/eclampsia risk.

Patients and Methods

Study Population

A total of 65 228 birth cohort records were used in the analysis from women who gave birth in the county of San Bernardino during 2007 and 2008. Records were included in the analysis if (a) mother's place of residence was in San Bernardino County at the time of delivery; (b) the mother only gave birth to a singleton baby (e.g., not twins, triplets), and (c) the length of gestation was greater than or equal to 20 weeks. Records with missing information were used but those with missing characteristics of interest were treated as missing, no imputation was used. The records contain data for all live births occurring in a calendar year, death information for those infants who were born in that year but subsequently died within 12 months of birth, and all fetal deaths that also occurred during that calendar year as well as detailed demographic information related to the child, mother, and father [11]. The files were obtained without personal identifiers. As a result the women who gave birth in both 2007 and 2008 could not be identified. Therefore, analyses for 2007 and 2008 were conducted separately.

Study Variables

Our outcomes of interest were preeclampsia and eclampsia. The birth certificate includes a variable on complications of pregnancy in which the facility records if the mother had preeclampsia, eclampsia or both, and is included among any other complications that may have arisen during pregnancy. Our exposure variables were maternal pre-pregnancy BMI and the IOM-QWG index in which weight gain during pregnancy is recorded as being either "too low," "just right," or "too much." Confounders of interest included the following: maternal age, race/ethnicity, and years of education; the modified adequacy of prenatal care utilization index (APNCU-2M) proposed by VanderWeele et al. [12]; and the primary payer for prenatal care. Maternal height and pre-pregnancy weight were self-reported on the birth certificate in inches and pounds, respectively. The pre-pregnancy BMI variable was calculated by dividing pre-pregnancy weight in pounds divided by the reported height inches squared multiplied by 703. BMI was then stratified according to the Centers for Disease Control BMI classification: (a) underweight (< 18.5kgm/m^2), (b) normal (18.5kg/m^2-24.9kg/m^2), (c) overweight (25.0-29.9kg/m^2), and (d) obese (> 30.0kg/m^2) [13]. The recommendations for weight gain during pregnancy from the Industry of Medicine (IOM) based on pre-pregnancy BMI are as follows: 28-40lbs for underweight women (BMI <19.8kg/m^2), 25-35lbs for normal weight women (BMI: 19.8-26 kg/m^2), 15-25 lbs for overweight women (BMI: 26.1-29kg/m^2) and at least 15 lbs for obese women (BMI>29kg/m^2) [13]. Gestational weight gain was calculated using self-reported pre-pregnancy weight and weight gain during pregnancy.

Logistic regression analyses were conducted to assess maternal associated preeclampsia or eclampsia risk. Three models were explored: 1) a crude model with preeclampsia alone, or preeclampsia or eclampsia combined, as the outcome with each exposure or confounder; 2) the crude model plus age; and 3) a multivariable model that included either pre-pregnancy BMI or IOM-QWG as the exposure, and maternal age, race/ethnicity, and years of education; APNCU-2M index; and the primary payer for prenatal care as potential confounders. All analyses were conducted using SAS version 9.3 (SAS Institute, North Carolina).

Results

Table 1 presents a comparison of sociodemographic characteristics of women in our study population diagnosed with preeclampsia or eclampsia versus those without those diagnoses.

Odds ratios for the associations between maternal pre-pregnancy BMI and IOM weight gain recommendations and preeclampsia/eclampsia are illustrated in tables 2 and 3, respectively. Pre-pregnancy BMI classified as 'underweight' was associated with statistically significant reductions in odds for preeclampsia/eclampsia in 2007. Excess weight increased the likelihood of the occurrence of preeclampsia/eclampsia.

Similarly, in 2007 the "too little" IOM-QWG category was observed to be associated with statistically significant reduction in odds for preeclampsia/eclampsia. Increased odds for preeclampsia/eclampsia were noted for mothers in the 'too much' category after multivariate adjustment.

n (%)	2007 Total N = 33 193	No Preeclampsia or Eclampsia n = 32 466	Combined Preeclampsia or Eclampsia n = 727	2008 Total N = 32 035	No Preeclampsia or Eclampsia n = 31 363	Combined Preeclampsia or Eclampsia n = 672
Mother's Pre-pregnancy BMI						
Underweight (<18.50)	1 789	1 773 (6.33)	16 (2.47)	1 781	1 759 (6.35)	22 (3.70)
Normal (18.50-24.99)	14 966	14 708 (52.52)	258 (39.75)	14 496	14 294 (51.62)	202 (33.95)
Overweight (25.00-29.99)	6 381	6 226 (22.23)	155 (23.88)	6 360	6 198 (22.38)	162 (27.23)
Obese (≥30.00)	5 516	5 296 (18.91)	220 (33.90)	5 649	5 440 (19.65)	209 (35.13)
IOM Qualitative Weight Gain						
Too Little	14 863	14 611 (45.00)	252 (34.66)	14 202	13 940 (44.45)	262 (38.99)
Just Right	9 950	9 748 (30.03)	202 (27.79)	10 038	9 869 (31.47)	169 (25.15)
Too Much	8 380	8 107 (24.97)	273 (37.55)	7 795	7 554 (24.09)	241 (35.86)
Maternal Age (years)						
< 18 years	1 422	1 390 (4.28)	32 (4.40)	1 317	1 293 (4.12)	24 (3.57)
18-<35 years	27 918	27 357 (84.27)	561 (77.17)	26 886	26 360 (84.05)	526 (78.27)
35 years or older	3 851	3 717 (11.45)	134 (18.43)	3 832	3 710 (11.83)	122 (18.15)
Maternal Race/Ethnicity						
Non-Hispanic white	20 059	19 655 (59.21)	404 (55.57)	19 213	18 830 (60.04)	383 (56.99)
Non-Hispanic black	8 218	8 022 (24.71)	196 (26.96)	8 013	7 836 (24.98)	177 (26.34)
Hispanic	2 800	2 706 (8.33)	94 (12.93)	2 756	2 682 (8.35)	74 (11.01)
Asian/Pacific Islander	1 925	1 897 (5.84)	28 (3.85)	1 824	1 794 (5.72)	30 (4.46)
Other/Multi/Unknown	191	186 (0.57)	5 (0.69)	229	221 (.70)	8 (1.19)
Mother's Years of Education						
0-8 years	2 360	2 309 (7.17)	51 (7.04)	2045	2 009 (6.46)	36 (5.41)
9-11 years	7 831	7 699 ((23.90)	132 (18.23)	7 504	7 352 (23.65)	152 (22.86)
12 years	11 145	10 877 (33.77)	268 (37.02)	10 399	10 169 (32.71)	230 (34.59)
13-15 years	7 445	7 251 (22.51)	194 (26.60)	7 699	7 529 (24.22)	170 (25.56)
16 years or more	4 153	4 074 (12.65)	79 (10.91)	4 104	4 025 (12.95)	77 (11.58)
Adequacy of Prenatal Care Utilization Index						
Not Adequate	901	878 (43.10)	23 (33.33)	791	777 (39.66)	14 (26.42)
Adequate	1,189	1,147 (56.31)	42 (60.87)	1,201	1,162 (59.32)	39 (73.58)
Adequate Plus	16	12 (0.59)	4 (5.80)	20	20 (1.02)	0 (0.00)
Primary Payer for Prenatal Care						
Uninsured	1 084	1 060 (3.26)	24 (3.30)	888	871 (2.78)	17 (2.53)
Private Insurance	13 920	13 676 (42.12)	244 (33.56)	13 295	13 705 (41.69)	220 (32.74)
Medi-Cal	16 236	15 851 (48.82)	385 (52.96)	15 844	15 473 (49.34)	371 (55.21)
Other	1 953	1 879 (5.79)	74 (10.18)	2 008	1 944 (6.20)	64 (9.52)

Table 1: Socio-demographic characteristics of mothers with combined preeclampsia or eclampsia in San Bernardino County in 2007 and 2008.

Discussion

The present study provides further evidence regarding preeclampsia/eclampsia risk and maternal weight status. We demonstrated a strong relationship between preeclampsia/eclampsia occurrence and excess maternal body weight prior to pregnancy and weight gain during pregnancy with odds 1.4-2.8 and 1.6-1.8 respectively. Similar studies examining the relationship between maternal weight status and preeclampsia risk also used birth cohort or hospital records [14-17].

Pre-pregnancy BMI and gestational weight gain are well-studied risk factors for adverse birth and pregnancy complications, including preeclampsia [18]. Yet obesity screening, diagnosis and weight counseling among women of reproductive age in primary care settings are low, highlighting the need for increased obesity prevention and weight loss efforts in other healthcare settings [19].

Table 2: Crude, age-adjusted, and multivariable odds ratios with 95% confidence interval limits for preeclampsia outcome alone among mothers in San Bernardino County in 2007 and 2008.

	2007 (n=705)			2008 (n=656)		
	Crude	Age-Adjusted[1]	Multivariable[2]	Crude	Age-Adjusted[1]	Multivariable[2]
Maternal Pre-pregnancy Body Mass Index (kg/m2)						
Underweight	0.49	0.5	0.5	0.92	0.94	0.92
	(0.29, 0.83)	(0.30, 0.84)	(0.30, 0.84)	(0.59, 1.44)	(0.60, 1.46)	(0.59, 1.43)
Normal Weight	1 (Reference)			1 (Reference)		
Overweight	1.41 (1.15, .72)	1.39 (1.13, 1.70)	1.42	1.88	1.86	1.88
			(1.15, 1.75)	(1.52, 2.32)	(1.50, 2.30)	(1.51, 2.34)
Obese	2.32	2.32	2.26	2.81	2.78	2.77
	(1.93, 2.80)	(1.92, 2.79)	(1.87, 2.74)	(2.30, 3.42)	(2.28, 3.39)	(2.26, 3.40)
IOM Qualitative Weight Gain						
Too Little	0.83	0.8	0.82	1	1.08	1.11
	(0.68, 1.00)	(0.67, 0.97)	(0.68, 1.00)	(0.90, 1.34)	(0.89, 1.31)	(0.91, 1.36)
Just Right	1			1		
	(Reference)			(Reference)		
Too Much	1.63	1.64	1.61	1.86	1.89	1.84
	(1.35, 1.97)	(1.36, 1.98)	(1.33, 1.95)	(1.52, 2.28)	(1.54, 2.31)	(1.49, 2.25)

[1] - Age-adjusted model is crude model + maternal age a confounder.

[2] - Multivariable model adjusts for maternal age, race/ethnicity, years of education, Adequate of Prenatal Care Utilization index, and primary payer for prenatal care.

Table 3: Crude, age-adjusted, and multivariable odds ratios with 95% confidence interval limits for preeclampsia and eclampsia outcomes combined among mothers in San Bernardino County in 2007 and 2008.

	2007 (n=727)			2008 (n=626)		
	Crude	Age-Adjusted[1]	Multivariable[2]	Crude	Age-Adjusted[1]	Multivariable[2]
Maternal Pre-pregnancy Body Mass Index (kg/m2)						
Underweight	0.52	0.52	0.52	0.89	0.9	0.88
	(0.31, 0.86)	(0.31, 0.86)	(0.31, 0.86)	(0.57, 1.38)	(0.58, 1.40)	(0.56, 1.37)
Normal Weight	1 (Reference)			1 (Reference)		
Overweight	1.42	1.4	1.43	1.85	1.83	1.85
	(1.16, 1.74)	(1.14, 1.71)	(1.17, 1.76)	(1.50, 2.28)	(1.48. 2.25)	(1.49, 2.29)
Obese	2.37	2.36	2.31	2.72	2.69	2.68
	(1.97, 2.84)	(1.97, 2.84)	(1.91, 2.78)	(2.24, 3.31)	(2.21. 3.27)	(2.19, 3.28)
IOM Qualitative Weight Gain						
Too Little	0.82	0.81	0.82	1.1	1.08	1.1
	(0.69, 1.00)	(0.672,0.98)	(0.68, 1.00)	(0.90, 1.33)	(0.89, 1.31)	(0.90, 1.35)
Just Right	1			1		
	(Reference)			(Reference)		
Too Much	1.63	1.64	1.6	1.86	1.89	1.84
	(1.35, 1.95)	(1.36, 1.97)	(1.32, 1.92)	(1.53, 2.27)	(1.55, 2.31)	(1.50, 2.25)

[1] - Age-adjusted model is crude model + maternal age a confounder.

[2] - Multivariable model adjusts for maternal age, race/ethnicity, years of education, Adequate of Prenatal Care Utilization index, and primary payer for prenatal care.

From this and other studies it is interesting to note that women who are classified as overweight according to the CDC's BMI standards, not only the obese, experience increased odds for preeclampsia/eclampsia. Thus practitioners interacting with women of reproductive age should focus on providing assistance for all women to maintain a pre-pregnancy BMI below 25.0kg/m^2. Focused efforts to manage weight prior to pregnancy may help alleviate the increased odds of preeclampsia/eclampsia associated with excess gestational weight gain (GWG) which is based on pre-pregnancy BMI. Thus GWG in women who are overweight or obese prior to pregnancy is more of a concern than for those who are underweight or normal weight. In addition, excess GWG has been associated with difficulty losing weight after giving birth as well as overweight/obesity for 10 years or more following childbirth [23]. This may lead to further adverse pregnancy outcomes including preeclampsia/eclampsia in subsequent pregnancies.

Limitations

This study was subject to some limitations. Firstly, studies of birth certificates are observational and their data limited in type and quality. As a result additional confounders such as alcohol consumption, smoking, caffeine and illicit drug use were not included in our multivariable analysis. We did however exclude multiple births, those with implausible gestational age, and those with missing covariate data. Secondly, maternal recall, or misidentification, of the last menstrual period may have impacted the quality of gestational age data [24] and thereby affected their modified prenatal care utilization index classification which considers gestational age in its computation[12, 19]. A third limitation of our study was the use of surrogate measures of socioeconomic status such as maternal highest education, the modified APNCU index, and the primary payer for prenatal care.

Conclusions

Maternal adiposity remains an important factor in the development of preeclampsia/eclampsia. The association between "too much" weight gain during pregnancy and preeclampsia/eclampsia indicates the importance of monitoring GWG and providing pregnant women adequate assistance to slow their GWG. The odds of the occurrence of preeclampsia/eclampsia increased with increasing pre-pregnancy BMI. Interestingly, women who were overweight experienced increased preeclampsia/eclampsia odds, not just those who were obese. Indicating that weight management efforts in primary care settings are equally important for women of reproductive age who are overweight and obese. Considering the morbidity, mortality and increased use financial resources associated with preeclampsia/eclampsia focusing on maternal weight management prior to and during pregnancy appears to be worthwhile. Future studies should address frequency of weight screening and counseling among overweight versus obese women prior pregnancy and the impact on preeclampsia/eclampsia odds.

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Conflict of Interest

The authors have no conflicts of interest to declare.

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