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PREPREGNANT BODY MASS INDEX, WEIGHT GAIN AND THE RISK OF DELIVERING LARGE BABIES AMONG NON-DIABETIC MOTHERS

Conrad Kabali[1,2] and **Martha M. Werler**[3]

1*Boston University School of Public Health, Boston, Massachusetts*

2 *National Institute of Medical Research, Dar es Salaam,Tanzania*

3*Slone Epidemiology Center, Boston University School of Public Health, Boston, Massachusetts*

Abstract

Objective—Pre-pregnancy over-weight and excess weight gain during pregnancy have each been associated with an increased risk of delivering large babies. However, previous studies have focused on the separate effects of these two indices of weight in diabetic women.

Method—This study analyzed both separate and combined effects of pre-pregnant body mass index and weight gain in relation to macrosomia (≥ 4000g) in offspring among 815 non-diabetic women, using data collected from a retrospective study.

Result—Compared to mothers with normal pre-pregnancy BMI and pregnancy weight gain, risk of macrosomia in offspring was significantly elevated only in over-weight women with excess weight gain (adjusted OR =2.6, 95%CI [1.2,5.4]) but not among normal weight mothers with excess gain (adjusted OR=1.1, 95%CI [0.5,2.4]) or overweight mothers with normal or low gain (adjusted OR=1.1, 95%CI [0.4,3.1]).

Conclusion—Given the complications that are associated with delivering large babies, overweight women may benefit from not gaining excess weight gain in pregnancy.

Synopsis—Mothers who are overweight when entering pregnancy and also gain excess weight during pregnancy have a 2.5-fold increased risk of delivering a macrosomic baby.

Keywords

pre-pregnancy weight; body mass index; pregnancy weight gain; independent effects; macrosomia.

Background

High levels of pre-pregnancy weight and pregnancy weight gain have each been associated with an increased risk of delivering large babies (1,2). Women with large fetuses are at a higher risk of complications of delivery such as hemorrhage, infection, cesarean section, pre-eclampsia and perinatal mortality (1,3). Although much work has been done to study the effects of high maternal weight and weight gain on birth weight (4–12), less attention has been paid

Corresponding author and reprint requests. : Dr. Martha M. Werler, Slone Epidemiology Center, 1010 Commonwealth Avenue, Boston, MA 02215, Fax: 617-738-5119 email: mwerler@slone.bu.edu

to the effects among non-diabetic women (2,4). The focus on diabetic mothers is well understood given that diabetes is associated with both overweight and macrosomia (9). However, the restriction of studies to diabetic women makes it difficult to apply these findings to non-diabetic mothers. Some studies have analyzed the effects of maternal weight and weight gain while ignoring diabetes (8) and others have adjusted for diabetes as a potential confounder (5,7,9,10), leaving open the question as to whether heavier non-diabetic mothers also face similar risks of macrosomia in offspring.

Moreover, many studies have restricted their analysis to either pre-pregnancy weight (1,9) or weight gain during pregnancy (6,11,12). In the two studies that have analyzed combined effects, findings were limited to a low income population (8), or were presented as correlations between maternal weight parameters and mean birth weight, without estimates of the relative risk of macrosomia (2). Although previous studies provide some insight on the relationship between macrosomia and maternal weight gain and overweight, the combined effect of both weight measures in non-diabetic women on risk of large birth weight babies has not been studied.

This study, therefore, sought to establish whether excessive pre-pregnancy weight as measured by body mass index, excessive pregnancy weight gain, or their combined effects are risk factors for delivering large babies. The analysis was restricted to non-diabetic women and took into account potential confounding factors such as sociodemographic and reproductive factors.

Methods

Study Population

The analysis used controls from a multicenter case control study of hemifacial microsomia (a craniofacial malformation) conducted from 1996 to 2002. The controls were identified from pediatric clinics in 26 cities across Canada and United States (US). Specifically, controls were selected by the pediatric practice (or one of similar size and location) of each case by identifying the next four children seen in the practice whose ages were within two months of the case's age. Further details about this study can be found elsewhere (13). Mothers of the control children were interviewed about demographic and reproductive factors and pregnancy exposures and behaviors. Specifically, mothers were asked about her pre-pregnancy weight and height, pregnancy weight gain and her child's birth weight. Likewise, information was reported on maternal age, marital status, race/ethnicity, income, years of education, cigarette smoking in pregnancy, alcohol intake in pregnancy, child's sex, number of previous births, date of birth and date of last menstrual period The study was approved by the Boston University Institutional Review Board.

Definitions

The main exposures of interest were excessive maternal pre-pregnancy weight, measured by body mass index (BMI) and excessive pregnancy weight gain, as defined by the Institute of Medicine (IOM) guidelines (14). Pre-pregnancy BMI (kilograms/meters^2) was categorized as underweight (<19.8), normal (19.8 to 26), and overweight (>26). The categories for 'normal' pregnancy weight gain were 13 to 18 kilograms (kg) for low-weight women; 11 to 16 kg for normal-weight women; and 7 to 11 kg for overweight women. Excess gain was any amount over 'normal' gain and low gain was any amount under 'normal' gain. The outcome of interest was macrosomia, defined as a birth weight of at least 4000 grams (g), as in previous studies on this topic (3,10,15).

Statistical Analysis

First, a descriptive analysis was done to assess the distributions of all variables. Thereafter, logistic regression models were fitted to compare independent and combined effects of levels of maternal pre-pregnancy BMI and pregnancy weight gain on macrosomia. Estimates for odds ratios (OR) and 95% confidence intervals were obtained. Multivariate adjusted odds ratios included terms for maternal age (<24, 25–34, ≥35 years), marital status (married or living with child's father versus not living with child's father), race/ethnicity (Hispanic, black, white, other), family income in US dollars (<$15 000, $15 000–$24 999, $25 000–$34 999, $≥35 000, unknown/refused), years of education (<12, 12, 13–15, ≥16), cigarette smoking throughout pregnancy (yes, no) and alcohol intake throughout pregnancy (yes, no), child's sex (male, female), number of previous births or parity (primarous, multiparous), and gestational age (calculated as the number of days between the last menstrual period and birth date);.

Results

Subject Characteristics

There were 884 women in the total sample. Since the study was focused on non-diabetic women, all diabetic women were excluded (n=13). Also excluded were 13 mothers who had multiple gestations as they were more likely to gain excess weight and their babies' birth weights were likely to be lower than single gestations. An additional 34 women had either missing weight, height or weight gain data, and were excluded. Also excluded were mothers with outlying data: eight mothers had babies whose gestational age was less than 180 or more than 310 days and two mothers whose babies were reported to have birth weights less than 900g. Thus, the actual sample used in the analysis was 815 women.

Table 1shows distributions of maternal and infant characteristics among study women and the % of macrosomic babies within each characteristic. Most women were aged between 25 to 34 years (59%), married or living with the baby's father (88%), and white (68%); more had a higher annual family income (>$35 000) and at least a high school education (64%). Also, 8% of study women smoked cigarettes throughout pregnancy and 6% drank alcohol throughout pregnancy. The sex distribution for babies was 48% girls and 52% boys. Fifty-six % of women gave birth for the first time. The gestational age for 70% of babies was between 266 and 286 days (38–41 completed weeks).

Of the 815 study women, 9% delivered large babies. Women who drank alcohol, had the lowest level of income, or were black women the lowest proportion of macrosomia (4.4%, 4.6%, and 5.4%, respectively), while college-educated women had the highest proportion (11.3%).

Effects of Pre-Pregnancy Weight and Pregnancy Weight Gain

Pre-pregnancy overweight was prevalent among 27.6% of study women and 42.6% of gained excess weight during pregnancy. Table 2 shows the separate effects of pre-pregnant body mass index and weight gain, and the combined effect on risk of macrosomia. The proportion of macrosomia was 12.9% in the offspring of overweight women compared 7.5% in normal weight women. Likewise, 11.9% of the offspring of women with excess gain were macrosomic compared to 7.8% with normal gain. Crude and adjusted odds ratios were elevated for overweight women and those with excess weight gain, but were not statistically significant. Crude odds ratios were elevated for excess weight gain in combination with overweight and underweight, but only the former was statistically significant. For those weight and weight gain combinations with at least four macrosomia subjects, adjusted odds ratios were close to the null except for overweight combined with excess weight gain. Those women had a 2.6-fold increased risk of macrosomia that was statistically significant.

Conclusions

The prevalence of macrosomia has been increasing over the past decade (5,16,17). Because there are significant delivery complications associated with large birth weight babies, such as postpartum hemorrhage, perineal laceration, cesarean section, and shoulder dystocia, which can in turn result in longer hospital stays or even perinatal mortality (3,5,10,15,18), it is important to identify predictive factors.

Although the observed increased odds ratios for overweight and excess weight gain in relation to macrosomia were not statistically significant, they are consistent with the findings of previous studies of non-diabetic women (2,4,8). However, in the present study where both indices of weight were combined into one measure, the increased risk was confined to overweight women with excess gain. This group of women constituted approximately one sixth of the study population, but produced nearly one third of the 74 babies born with macrosomia. While the avoidance of excess weight before pregnancy is surely advisable, our findings suggest that women who become pregnant when they are already overweight may reduce the likelihood of delivering a large baby (and the concomitant complications) by not gaining excess weight during the course of pregnancy. Also observed was an increased risk for underweight women with excess weight gain, but this was based on only 3 macrosomia babies among 23 mothers. With such small numbers, it is difficult to judge whether the observed proportion of macrosomic babies in this category (13.0%) is due to chance or is a result of some biological mechanism that needs further investigation. Of note, increased risks of macrosomia for normal weight with excess gain or overweight women with low or normal gain were not observed.

Though a 2.6-fold increased risk between macrosomia and the combination of overweight and excess weight gain was identified, it is important to consider study limitations. The dataset used in this analysis was intended for a different purpose (13) and information was not collected on other important covariates such as paternal height and weight, and family history of obesity and birth weight. Therefore, it is not possible to estimate the extent to which these factors could have influenced the results. Further, information was not collected on weight gain within trimester, which might have identified a specific pattern of weight gain that affects fetal growth.

Also, information on weight, height, weight gain, and birth weight were collected through postpartum interviews, opening the opportunity for recall error. Other studies have shown that retrospective recall of pre-pregnant weight, weight gain in pregnancy, and birth weight are remarkably accurate (19-22), though overweight women are more likely to underestimate their pre-pregnant weights (20). Such reporting would result in a lower odds ratio than the true value. In other words, the true odds ratios for overweight women with excess gain may be even greater than 2.6 and the null odds ratios for other combinations of weight and weight gain may indeed be increased. Differential reporting or recall bias is another possibility. For example, if mothers of large babies were accurate reporters of their weight and weight gain, while mothers of normal weight babies deflated their own reported weights, the true odds ratios may be lower than observed. However, this pattern of differential recall has not been reported in the literature and seems unlikely. It is also worth noting that although BMI is considered an excellent measure of body composition, it is not perfect and it is possible that a small number of women could be misclassified.

Information on diabetes was also collected by retrospective maternal reports. The thirteen women who were excluded from the study reported have been diagnosed with diabetes at some time before the sixth month of gestation. Therefore, women who were diagnosed with gestational diabetes after the 5^{th} month were not excluded. These women, as well as those with hyperglycemia but who did meet diagnostic criteria for gestational diabetes, are likely to have larger BMIs and larger babies. Although this issue could not specifically be addressed in this

study, the observed findings are still relevant for clinicians who see overweight and obese women in early pregnancy.

Strengths of the study include its large sample from a wide geographical area. The study population was originally formed to serve as controls in a separate study, but the pre-pregnant body mass index and weight gain distributions are similar to those of U.S. women (8,23). In addition, the distribution of birth weights according to maternal age and race was similar to that of the US general population (24). Thus, the study population is a good representation of US pregnant women.

To conclude, non-diabetic women with a pre-pregnant BMI greater than 26 kg/m2 and a pregnancy gain of more than 11 kg have a greater than 2.6-fold risk of delivering a macrosomic baby . Given the significant complications that are associated with delivery of large babies, efforts to prevent excessive pregnancy weight gain among overweight women may help reduce this problem.

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Table 1

Distribution of maternal and infant characteristics

Characteristics	Number and percentage among 815 study women		Number and percentage with macrosomic babies among women with characteristic	
	Number	(%)	Number	(%)
Socio-Demographic Characteristics				
Maternal Age				
<24 years	208	(25.5)	17	(8.2)
24–35 years	478	(58.7)	43	(9.0)
35–45 years	129	(15.8)	14	(10.9)
Marital Status				
Married/Living with Child's Father	716	(87.9)	68	(9.5)
Not Living with Child's Father	99	(12.1)	6	(6.1)
Race				
White	552	(67.7)	56	(10.1)
Hispanic	132	(16.2)	10	(7.6)
Black	92	(11.3)	5	(5.4)
Others	39	(4.8)	3	(7.7)
Annual Family Income (USD)				
<15,000	87	(10.7)	4	(4.6)
15,000–25,999	91	(11.2)	10	(11.0)
25,000–35,999	104	(12.8)	7	(6.7)
>35,000	473	(58.0)	49	(10.4)
Refused/Unknown	60	(7.4)	4	(6.7)
Education (Years)				
0–11	117	(14.4)	9	(7.7)
12	176	(21.6)	14	(8.0)
13–15	193	(23.8)	14	(7.2)
16+	328	(40.2)	37	(11.3)
Health Bahaviors				
Cigarette Smoking throughout Pregnancy				
Yes	67	(8.2)	68	(9.1)
No	748	(91.8)	6	(9.0)
Alcohol Drinking throughout Pregnancy				
Yes	45	(5.5)	2	(4.4)
No	770	(94.5)	72	(9.4)
Pregnancy Characteristics				
Baby Sex				
Female	392	(48.1)	30	(7.7)
Male	423	(51.9)	44	(10.4)
Parity				
Primiparae	458	(56.2)	43	(9.4)
Multiparae	357	(43.8)	31	(8.7)
Gestational Age (Days)				
202–266	150	(18.4)	2	(1.3)
266–286	570	(69.9)	56	(9.8)
286–310	95	(11.7)	16	(16.8)

Table 2

Odds ratios for maternal body mass index and weight gain in relation to risk of macrosomia

	Infant Birth Weight		
	Macrosomia	Crude OR	Adjusted OR
Variable	%	Estimate [95% CI]	Estimate [95% CI]
Body Mass Index*			
Overweight (n=225)	12.9	1.7 [1.0,2.8]	1.8 [1.0,312]
Normal (n=492)	7.5	reference	reference
Underweight (n=98)	8.2	1.2 [0.5,2.7]	1.2 [0.5,2.8]
Weight Gain			
Excess (n=347)	11.9	1.5 [0.9,2.7]	1.5 0.7,2.5
Normal (n=266)**	7.8	reference	reference
Low (n=202)	5.8	0.8 [0.4,1.7]	1.0 [0.4,1.9]
BMI and Weight Gain			
Overweight/Excess (n=131)	17.3	2.4 [1.2,4.8]	2.6 [1.2,5.4]
Overweight/Normal (n=51)	6.3	0.8 [0.2,2.7] }	1.1 [0.4–3.1]
Overweight/Low (n=43)	9.5	1.2 [0.4,3.8]	
Normal/Excess (n=193)	8.9	1.1 [0.5,2.3]	1.1 [0.5,2.4]
Normal/Normal (n=176)	8.2	reference	reference
Normal/Low (n=123)	5.6	0.7 [0.3,1.8]	0.9 [0,3,2.6]
Underweight/Excess (n=23)	13.0	1.7 [0.4,6.4]	&
Underweight/Normal (n=39)	7.9	1.0 [0.3,3.5] }	0.9 0.3-2.7
Underweight/Low (n=36)	6.1	0.7 [0.2,3.3]	

* Body mass index, >26 kg/m^2 for overweight; 19.8–26 kg/m^2 for normal weight; <19.8 kg/m^2 for underweight.

** Normal weight gain, 11–16 kgs for normal weight; 7–11 kgs for overweight; 13–18 kgs for underweight.

& Adjusted odds ratio not calculated because less than four macrosomia subjects.