Impact of pre-pregnancy body mass index on birth defects: Michigan WIC and Michigan Birth Defects Registry data linkage, 2003-2007

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Introduction

- Obesity is not only a risk factor for several chronic diseases, but pre-pregnancy obesity can also cause adverse birth outcomes such as birth defects, large-for-gestational age infants, and even fetal and neonatal death.[1]
- In 2007, 26.1% of women had a pre-pregnancy body mass index (BMI) classified as obese (BMI >29.0) in Michigan.[2] This compares to about 32.0% of women enrolled in the Special Supplemental Nutrition Program for Women, Infant and Children (WIC) who had an obese pre-pregnancy BMI.[3]
- We explored the association of pre-pregnancy BMI on the risk for birth defects in the population of women enrolled in WIC through the linkage with the Michigan Birth Defects Registry (MBDR).

Study Questions

- Is there an association between pre-pregnancy BMI and having an infant with a birth defect among those enrolled in WIC?
- Which WIC agencies have the highest percentage of women who have a child with a birth defect and had an obese pre-pregnancy BMI?

Methods

- **Source of Data and Study Design**: This is a retrospective case-control study linking Michigan Birth Defects Registry (MBDR) data to the Pregnancy Nutritional Surveillance System (PNSS) data for birth years 2003 to 2007. In Michigan, PNSS data is collected solely from women, infants and children currently enrolled in WIC. Both WIC and MBDR data sources are routinely linked to live birth records through probabilistic linkages. The birth certificate number served as the unique identifier so that MBDR and WIC records could be deterministically linked. WIC data was a valuable and unique source of data as BMI, weight gain during pregnancy and other risk factors are routinely collected.
- **Study Population and Variables**: Cases were resident infants born in Michigan from 2003 to 2007 who were reported to have a birth defect by one year of age and whose mothers were enrolled in WIC. Controls were infants born in Michigan from 2003 to 2007 who were not reported to have a birth defect and whose mothers were enrolled in WIC. Controls were randomly selected for a 1:4 case-control ratio.

BMI was classified according to Institute of Medicine 1990 definitions (BMI <19.8: underweight; BMI = 19.8-26.0: normal; BMI = >26.0-29.0: overweight; BMI >29.0: obese).[4]

Variables used in the analysis included: maternal race, maternal age, gestational age at delivery, weight gain during pregnancy, smoking and drinking during pregnancy, and parity.

- **Statistical Analysis**: Odds ratios for having any birth defect as well as for each major category of birth defects in mothers with underweight, overweight, or obese pre-pregnancy BMI compared to those with normal BMI were determined. SAS v9.1 was used for statistical analysis. Maps were created with ArcGIS 10.0 using Jenks Natural Breaks Classification method.

Results

- A total of 23,800 (39.3%) infants reported to MBDR with birth defects were linked to mothers enrolled in WIC. Pre-pregnancy BMI of these mothers were as follows: 2,238 (9.4%) underweight; 8,926 (37.5%) normal; 3,174 (13.3%) overweight; 7,511 (31.6%) obese; and 1,951 (8.2%) unknown.
- A total of 95,200 controls were selected from the population of WIC enrollees who had a live birth from 2003 to 2007. Pre-pregnancy BMI of these controls were as follows: 9,758 (10.3%) underweight; 38,186 (40.1%) normal; 12,642 (13.3%) overweight; 27,032 (28.4%) obese; and 7,582 (8.0%) unknown.
- Characteristics of controls were similar to those of the total WIC population and characteristics of cases were similar to those of controls.
- Smoking and drinking during pregnancy were included in preliminary logistic models, but were not significant and were not included in final analyses.

Crude Analysis (Table 1):

- Women who were **overweight** were more likely than those with a normal pre-pregnancy BMI to have an infant with:
  - a neural tube defect (NTD) (OR=1.8, 95% CI: 1.2, 2.8),
  - a heart defect (OR=1.2, 95% CI: 1.1, 1.3),
  - or an integument defect (OR=1.3, 95% CI: 1.1, 1.5).
- Women who were **obese** were more likely to have an infant with several different types of birth defects (central nervous system [CNS], heart, respiratory, integument, or chromosomal) compared to those with a normal pre-pregnancy BMI.

Table 1: Estimated crude effect (odds ratio [OR] and 95% confidence interval [CI]) of pre-pregnancy BMI on having a specific birth defect: MBDR-WIC Data, 2003-2007.

Birth Defect	Underweight		Normal	Overweight		Obese	
	OR	95% CI	OR	OR	95% CI	OR	95% CI
Any Defect	1.0	(0.9, 1.0)	1	1.1	(1.0, 1.1)	**1.2**	**(1.1, 1.2)**
CNS	0.9	(0.8, 1.2)	1	1.0	(0.9, 1.3)	**1.3**	**(1.1, 1.5)**
NTD	0.6	(0.3, 1.2)	1	**1.8**	**(1.2, 2.8)**	1.3	(0.9, 1.9)
Eye	0.9	(0.7, 1.1)	1	0.9	(0.7, 1.1)	1.2	(1.0, 1.5)
Heart	1.0	(0.9, 1.1)	1	**1.2**	**(1.1, 1.3)**	**1.3**	**(1.3, 1.4)**
Respiratory	1.0	(0.8, 1.2)	1	1.1	(0.9, 1.3)	**1.5**	**(1.3, 1.7)**
Digestive	1.1	(0.9, 1.3)	1	0.9	(0.7, 1.0)	1.2	(1.0, 1.3)
Genitourinary	0.9	(0.8, 1.0)	1	1.0	(0.9, 1.2)	1.1	(1.0, 1.2)
Musculoskeletal	0.9	(0.8, 1.0)	1	1.0	(1.0, 1.1)	1.1	(1.0, 1.2)
Integument	1.1	(0.9, 1.3)	1	**1.3**	**(1.1, 1.5)**	**1.4**	**(1.2, 1.5)**
Chromosomal	0.9	(0.7, 1.3)	1	1.3	(1.0, 1.7)	**1.4**	**(1.1, 1.8)**

Table 2: Estimated adjusted effect (odds ratio [OR] and 95% confidence interval [CI]) of pre-pregnancy BMI on having a specific birth defect: MBDR-WIC Data, 2003-2007.

Birth Defect	Underweight		Normal	Overweight		Obese	
	OR	95% CI	OR	OR	95% CI	OR	95% CI
Any Defect	1.0	(0.9, 1.0)	1	1.0	(1.0, 1.1)	**1.1**	**(1.1, 1.2)**
CNS	0.9	(0.7, 1.1)	1	1.0	(0.8, 1.2)	**1.2**	**(1.1, 1.4)**
NTD	0.6	(0.3, 1.2)	1	**1.7**	**(1.1, 2.7)**	1.2	(0.8, 1.8)
Eye	0.9	(0.7, 1.2)	1	0.9	(0.7, 1.1)	1.2	(1.0, 1.4)
Heart	1.0	(0.9, 1.1)	1	1.1	(1.0, 1.2)	**1.3**	**(1.2, 1.4)**
Respiratory	1.0	(0.8, 1.2)	1	1.1	(0.9, 1.3)	**1.4**	**(1.2, 1.6)**
Digestive	1.1	(0.9, 1.3)	1	0.9	(0.7, 1.0)	1.2	(1.0, 1.3)
Genitourinary	0.9	(0.8, 1.0)	1	1.0	(0.9, 1.2)	1.0	(0.9, 1.1)
Musculoskeletal	0.9	(0.8, 1.0)	1	1.0	(0.9, 1.1)	1.1	(0.9, 1.1)
Integument	1.1	(0.9, 1.3)	1	1.2	(1.0, 1.3)	1.2	(1.0, 1.3)
Chromosomal	1.0	(0.7, 1.4)	1	1.2	(0.9, 1.6)	1.20	(1.0, 1.5)

**Adjusted for maternal race and age, gestational age, maternal weight gain, and parity.*

Adjusted Analysis (Table 2):

- Women who were **overweight** were more likely to have an infant with an NTD (OR=1.7, 95% CI: 1.1, 2.7) compared to those with a normal pre-pregnancy BMI.
- Women who were **obese** were more likely than those with a normal pre-pregnancy BMI to have an infant with:
  - any type of defect (OR=1.1, 95% CI: 1.1, 1.2),
  - a CNS defect (OR=1.2, 95% CI: 1.1, 1.4),
  - a heart defect (OR=1.3, 95% CI: 1.2, 1.4),
  - or a respiratory defect (OR=1.4, 95% CI: 1.2, 1.6).

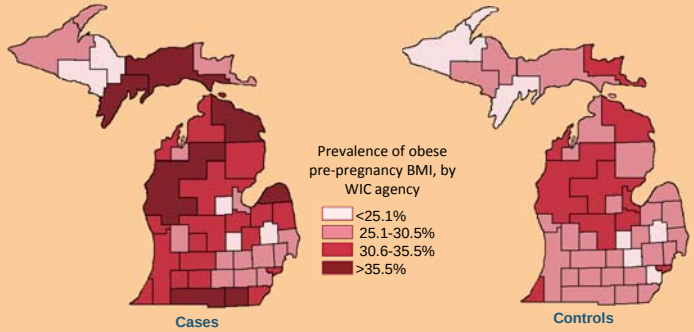

Figure 1: Prevalence of obese pre-pregnancy BMI among cases and controls, by WIC agency: MBDR-WIC, 2003-2007.

- Prevalence of obese pre-pregnancy BMI among cases and controls were assessed by WIC agencies in Michigan in order to identify regions for targeted intervention (Figure 1).
- Prevalence of obese pre-pregnancy BMI was higher among cases than in controls.
  - Percent obese pre-pregnancy BMI among cases: 31.6% (31.0, 32.2)
  - Percent obese pre-pregnancy BMI among controls: 28.4% (28.1, 28.7)
- The highest prevalence of obese pre-pregnancy BMI among cases was found in several areas across Michigan, highlighting the importance of education and behavioral supports for WIC enrollees.

Discussion

- Mothers who were overweight or obese before becoming pregnant had increased odds of having an infant with a birth defect compared to those with a normal BMI.
- WIC agencies in Michigan with the highest percentage of obese pre-pregnancy BMI were identified and could be targeted for additional intervention within the WIC population.
- Based on these results, the Birth Defects Program plans further collaboration with the WIC Program to support the integration of interconception health care messages regarding: 1) the importance of maintaining a healthy weight prior to pregnancy and 2) the risk of having an infant with a birth defect associated with obese pre-pregnancy BMI.

Study Limitations:

- The study population was limited to women enrolled in WIC. WIC serves low-moderate income pregnant and postpartum women, infants, and children up to age 5; results may not apply to those not enrolled in WIC.
- Some factors associated with obesity and an increased risk for birth defects, such as diabetes mellitus, could not be controlled for in this study.
- Birth defects diagnoses reporting is per the MBDR and the severity of each case is not known.
- The categories of diagnoses are not exclusive – children with more than one defect may be in more than one category.

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Resources

[1]Cedergren MI. Maternal morbid obesity and the risk of adverse pregnancy outcome. *Obstetrics & Gynecology*. 2004; 103 (2): 219-224.

[2]Michigan Pregnancy Risk Assessment Monitory System (PRAMS) Data, 2007.

[3]Michigan Special Supplemental Nutrition Program for Women, Infant and Children (WIC) Data, 2007.

[4]Institute of Medicine. Nutrition during pregnancy: Part I: Weight gain. Washington DC: National Academies Press. 1990.

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