The effect of maternal prenatal body mass index (BMI)* on child overweight, obesity and morbid obesity among Michigan WIC participants

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Background

•As for adults, obesity in children has become an epidemic in the United States and other industrialized countries.
•Although somewhat controversial, the concept that events in utero can increase the risk of childhood and adult obesity has been proposed.[1,2]
•Maternal obesity in early pregnancy has been found to increase the risk of childhood obesity.[3]

Study Question:
•Is there an association between maternal prenatal BMI and child overweight, obesity and morbid obesity (BMI > 97th percentile) among children ages 2 to 5 years?

Methods

Data Source & Study Design:
Data from the Michigan Pediatric Surveillance System (PedNSS) 2000-2007 linked with the Michigan Pregnancy Surveillance System (PNSS) 2003-2007 were used for this cross-sectional study.

Study population:
•Children ages 2 to 5 years of age;
•Records with missing outcome or primary predictor variable were excluded.

Dependent variables:
•Child's BMI† Categorized as: overweight, obese or morbid obesity.

Primary predictor variable:
Maternal pre-natal BMI§
Covariates:
•Maternal Characteristics (e.g. gestational weight gain, education, smoking during pregnancy)
•Child Characteristics (e.g. race/ethnicity, birthweight and breastfeeding)

Statistical analysis:
•Logistic regression was used to estimate the effects of maternal pre-pregnancy BMI on child BMI
SAS 9.2 (SAS Institute Inc., Cary, NC) was used for statistical analyses.

Results

Distribution of Selected Characteristics

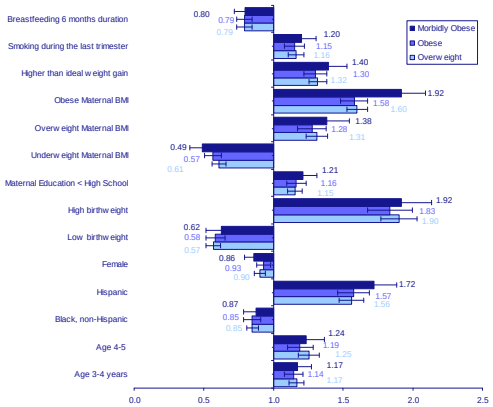
Table 1. Distribution of characteristics and prevalence of BMI* among children 2-5 years of age, MI PedNSS 2000-2007/ MI PNSS 2003-2007

Characteristics	Total Population N	%	Overweight N	%	Child's BMI Obese N	%	Morbidly Obese N	%
Child's age								
2 to < 3 years	38,411	39.3	10,815	28.2	4,794	12.5	3,837	9.8
3 to < 4 years	32,284	33.0	9,931	30.8	4,551	14.1	3,737	11.3
4 to < 5 years	27,151	27.8	8,745	32.2	4,122	15.2	3,358	12.1
Gender								
Male	49,269	50.4	15,349	31.2	7,151	14.5	5,938	11.8
Female	48,577	49.7	14,142	29.1	6,316	13.0	4,994	10.1
Race/Ethnicity								
White, non-Hispanic	51,627	52.8	15,234	29.5	6,661	12.9	5,238	10.0
Black, non-Hispanic	25,007	25.6	6,435	25.7	2,887	11.5	2,371	9.3
Hispanic	14,784	15.1	5,850	39.6	2,993	20.2	2,560	16.9
Asian/Pacific Islander	1,587	1.6	415	26.2	177	11.2	150	9.3
American Indian/Alaska Native	357	0.4	121	33.9	59	16.5	40	11.1
Multi-racial, non-Hispanic	4,484	4.6	1,436	32.0	690	15.4	573	12.4
Infant Birthweight								
Low < 2,500 grams	3,724	7.3	739	19.8	322	8.7	266	7.0
Normal	43,212	84.2	12,999	30.1	5,875	13.6	4,747	10.8
High > 4,000 grams	4,405	8.6	1,989	45.2	1,030	23.4	842	18.5
Breastfeeding duration to 6 months								
Yes	9,708	18.1	2,645	27.3	1,125	11.6	924	9.4
No	44,002	81.9	13,673	31.1	6,354	14.4	5,159	11.5
Maternal Pre-natal BMI§								
Underweight	5,705	10.3	1,051	18.4	386	6.8	298	5.2
Normal weight	22,852	41.3	6,224	27.2	2,615	11.4	1,989	8.6
Overweight	8,165	14.8	2,696	33.0	1,257	15.4	1,004	12.1
Obese	18,638	33.7	6,992	37.5	3,505	18.8	2,982	15.6
Maternal pregnancy weight gain§								
Less than recommended	15,209	29.8	4283	28.2	1,940	12.76	1,576	10.2
Recommended	13,811	27.1	3912	28.3	1,691	12.24	1,352	9.6
More than recommended	21,968	43.1	7470	34.0	3,536	16.1	2,853	12.7
Maternal Education								
Less than High School	24,013	40.6	7862	32.7	3,752	15.62	3,098	12.6
High School Diploma or GED	24,193	40.9	7154	29.6	3,222	13.3	2,605	10.6
More than High School	10,887	18.4	3024	27.8	1,298	11.9	1,001	9.0
Smoking during pregnancy								
Yes	10,269	20.9	3432	33.4	1,630	15.9	1,341	12.8
No	38,966	79.1	11,678	30.0	5,286	13.6	4,260	10.7
All	97,846		29,491	30.1	13,467	13.8	10,932	10.9

X^2 tests for difference in sociodemographic characteristics and health behaviors by Child BMI were statistically significant ($p < 0.001$)

Effects of characteristics on Child BMI

Figure 1. Crude effects of characteristics on Child BMI, MI PedNSS 2000-2007/PNSS 2003-2007



Effect of maternal and infant characteristics on Child BMI

Table 2. Adjusted odds ratios of characteristics on child BMI ages 2-5 years, MI PedNSS 2000-2007/PNSS 2003-2007

	Effect	Overweight AOR	95% CI		Obese AOR	95% CI		Morbidly Obese AOR	95% CI	
Child Characteristics	Age 3-4 years vs. 2-3 years	1.149	1.078	1.224	1.166	1.072	1.267	1.161	1.059	1.273
	Age 4-5 years vs 2-3 years	1.206	1.111	1.31	1.251	1.123	1.392	1.24	1.103	1.394
	Black, non-Hispanic vs. White, non-Hispanic	0.863	0.8	0.932	0.872	0.786	0.968	0.875	0.78	0.982
	Hispanic vs. White, non-Hispanic	1.619	1.489	1.76	1.638	1.474	1.821	1.701	1.518	1.906
	Female vs. Male		eliminated			eliminated		0.892	0.821	0.97
	Low birthweight vs. Normal Birthweight	0.629	0.552	0.716	0.619	0.513	0.746	0.672	0.549	0.823
	High birthweight vs. Normal Birthweight	1.682	1.528	1.852	1.672	1.489	1.878	1.692	1.495	1.915
	Breastfeeding 6 months duration	0.789	0.73	0.851	0.746	0.671	0.829	0.834	0.744	0.934
Maternal Characteristics	Maternal Education < High School vs. High School	1.124	1.051	1.201	1.18	1.082	1.288	1.202	1.093	1.322
	Underweight Maternal BMI vs. Normal weight	0.594	0.529	0.667	0.515	0.43	0.617	0.516	0.421	0.634
	Overweight Maternal BMI vs. Normal weight	1.213	1.113	1.323	1.311	1.169	1.47	1.282	1.128	1.457
	Obese Maternal BMI vs. Normal weight	1.596	1.493	1.705	1.786	1.637	1.948	1.909	1.735	2.1
	Higher than ideal pregnancy weight gain vs. Ideal	1.187	1.107	1.274	1.293	1.176	1.421	1.303	1.174	1.446
	Smoking during the last trimester	1.252	1.164	1.347	1.318	1.199	1.449	1.323	1.193	1.467

MI PedNSS 2000-2007/PNSS 2003-2007

[a] Model includes: child's age and race/ethnicity, infant birthweight, maternal education, maternal prenatal BMI, maternal pregnancy weight gain, smoking during the last trimester and breastfeeding to 6 months. Child's gender was significant was retained in in the morbidly obese model.

Summary

• More than two-fifths of children ages 2 to 5 years of age were overweight or obese (Table1).
• Nearly half of the mothers were overweight or obese (Table1).
After adjusting for maternal and child characteristics:
•Effects positively associated with child overweight, obesity, and morbid obesity (Table2):
– High birthweight
– Maternal prenatal BMI either overweight or obese
– Higher than ideal maternal pregnancy weight gain
– Smoking during the last trimester
•Breastfeeding to 6 months duration was found to be inversely associated with child overweight, obesity and morbid obesity.

Conclusion

•Children whose mothers were obese had an increased odds of being overweight, obese or morbidly obese.

•The odds of the association between maternal obesity and the outcome increased as child's BMI increased.

•Maternal prenatal weight, pregnancy weight gain, smoking during pregnancy are modifiable characteristics that should be addressed by public health programs targeted to decreasing the prevalence of child obesity.

Limitations
•Limited to a single state WIC program
•The WIC population differs from the general population
•Unmeasured confounders are possible

References

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Notes

* BMI = weight in kg/(height in meters)^2
† Based on 2000 CDC growth chart percentiles for BMI-for-age for children ≥ 2 yrs. Overweight (BMI >85th percentile to 95th percentile, Obese (BMI ≥ 95th percentile) & Morbid Obesity (BMI ≥ 97th percentile.

§Based on: Institute of Medicine. Nutrition During Pregnancy. Washington DC: National Academies Press; 1990. Underweight (BMI <19.8), Overweight (BMI = 26.1- 29.0) & Obese BMI (≥ 29.1)

Acknowledgement
The authors gratefully acknowledge and thank the local WIC agency coordinators, health professionals and clerical staff for collecting participants data which makes the MI PNSS possible.