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Relating Maternal Weight to the Occurrence of Birth Defects in Colorado

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Introduction

A healthy weight is important for overall health. In the previous 20 years, there has been a dramatic increase in obesity in the United States and rates continue to increase. This creates an important public health concern as obesity is associated with many adverse health outcomes, including coronary heart disease, hypertension, stroke, type 2 diabetes, selected cancers, respiratory ailments, and certain gynecological problems (namely abnormal menses and infertility).[1] In 2010 the national prevalence rates of adult obesity ranged from a high of 32.2 percent to a low of 21.0 percent (Colorado's rate). However, Colorado's 2010 rate of 21.0 percent is up from 19.4 percent in 2008.[2]

In addition to the increased prevalence of obesity in the general public, there have been troubling increases in obesity among women of reproductive age. Nationally, it has been documented that women are having babies at substantially heavier weights than any other time in our country's history.[3] Maternal obesity during pregnancy creates challenges for both mother and baby: It is associated with complications such as cesarean delivery, gestational hypertension, preeclampsia, and gestational diabetes. Increased use of health care and longer hospital stays are also associated with obesity during pregnancy.[1] Other severe negative outcomes have been associated with maternal obesity, such as fetal and neonatal death.[4] In 2003, Watkins et al. found evidence linking neural tube defects (NTD) and obesity, while associations with other birth defects are currently being explored and reported.[5]

In 2007, Colorado implemented the National Center for Health Statistics 2003 revision of the U.S. standard certificate of live birth. This revision includes recommendations for collecting maternal height along with prepregnancy weight and weight at delivery, which allows for the calculation of maternal prepregnancy body mass index (BMI) and a related measure, appropriate weight gain during pregnancy. BMI is a measure calculated using a person's weight and height, and provides a reliable indicator of appropriate or inappropriate weight for most people.

The availability of data concerning prepregnancy BMI and weight gain during pregnancy on the birth certificate, along with the ability to link this information to data from Colorado's

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population-based birth defects registry, provide a unique opportunity to explore the relationship between maternal weight, weight gain, and the occurrence of birth defects in Colorado.

Methods

Colorado Responds to Children with Special Needs (CRCSN) is the Colorado Department of Public Health and Environment's (CDPHE) population-based surveillance system established to monitor the occurrence of birth defects throughout the state. Data from the CRCSN registry were used to identify children who were diagnosed with a condition falling into one or more of the following birth defect/anomaly categories: any major birth defect, major cardiovascular anomalies, major musculoskeletal anomalies, central nervous system anomalies, or spina bifida. Specific classifications were chosen due to maternal weight-related findings noted in other studies throughout the country.

Statistics regarding maternal prepregnancy BMI and weight gain during pregnancy were based on data from Colorado's birth certificate registry which is maintained by the Health Statistics Section at CDPHE. Children born in Colorado between the years 2007-2009 were included; however, births were excluded if the mother was not a Colorado resident at time of the child's birth, or if the birth certificate noted that the mother had pre-existing diabetes.

In 2009, the Institute of Medicine (IOM) released updated guidelines for categorizing body mass index (BMI) values for women as well as appropriate weight gain during pregnancy. Prior to 2009, the IOM had not issued guidelines since 1990. During the time from the issuance of the 1990 guidelines, more research had been conducted on the effects of weight gain in pregnancy on the health of both mother and baby, and more appropriate recommendations were developed.[6]

Categories used for classifying maternal prepregnancy BMI and appropriate weight gain were based on Institute of Medicine recommendations, as presented in their 2009 report, "Weight Gain During Pregnancy: Re-examining the Guidelines".[7] The specific BMI cutoffs used and weight gain ranges applied are presented in Table 1. An online BMI calculator can be found at http://www.nhlbisupport.com/bmi/.

Table 1. IOM Classifications for prepregnancy BMI and recommended weight gain during pregnancy.

Prepregnancy BMI classification	BMI range	Recommended weight gain during pregnancy (in pounds)
Underweight	<18.5	28-40
Normal weight	18.5-24.9	25-35
Overweight	25.0-29.9	15-25
Obese	>=30.0	11-20

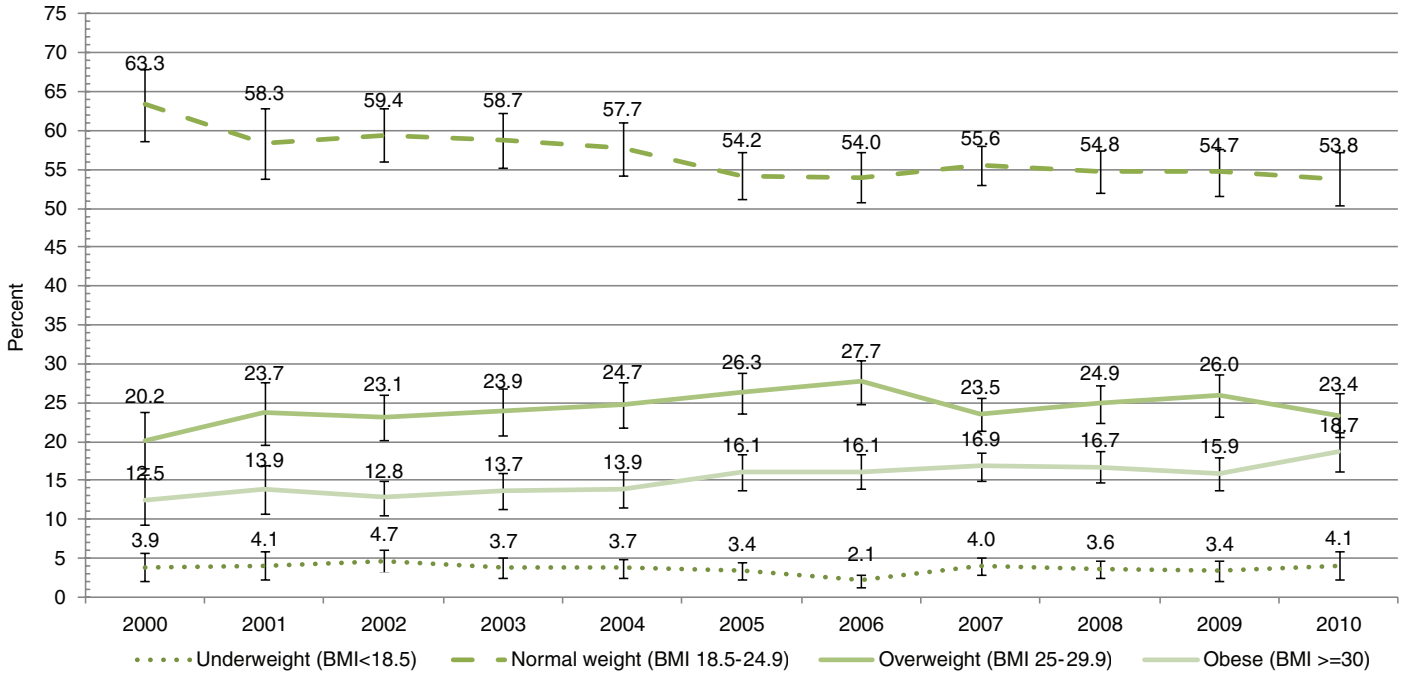
Source: Weight Gain During Pregnancy: Re-examining the Guidelines, Institute of Medicine, May 2009.

Data were compiled and analyzed using the SAS version 9.2 software (SAS Institute, Cary, North Carolina). Unless stated otherwise, differences noted in this report are statistically significant, as determined by either testing at the alpha=0.5 level, or by nonoverlapping 95 percent confidence intervals.

Results

The proportion of women of child-bearing age in Colorado—an estimate of the population risk of becoming pregnant—who are either overweight or obese has been increasing in the past decade, along with a corresponding and notable decrease in "normal" BMI, i.e. healthy weight (Figure 1). In 2010, only 53.8 percent of women ages 18-44 were classified as being of normal or healthy weight, while 23.4 percent were overweight; 18.7 percent were obese; and 4.1 percent were underweight.

Figure 1. Weight status of women of child-bearing age (18-44 Years): Colorado BRFSS, 2000-2010.



Error bars represent the 95% confidence interval of the proportion.
Source: Colorado Behavior Risk Factor Surveillance System (BRFSS), Health Statistics Section, Colorado Department of Public Health and Environment.

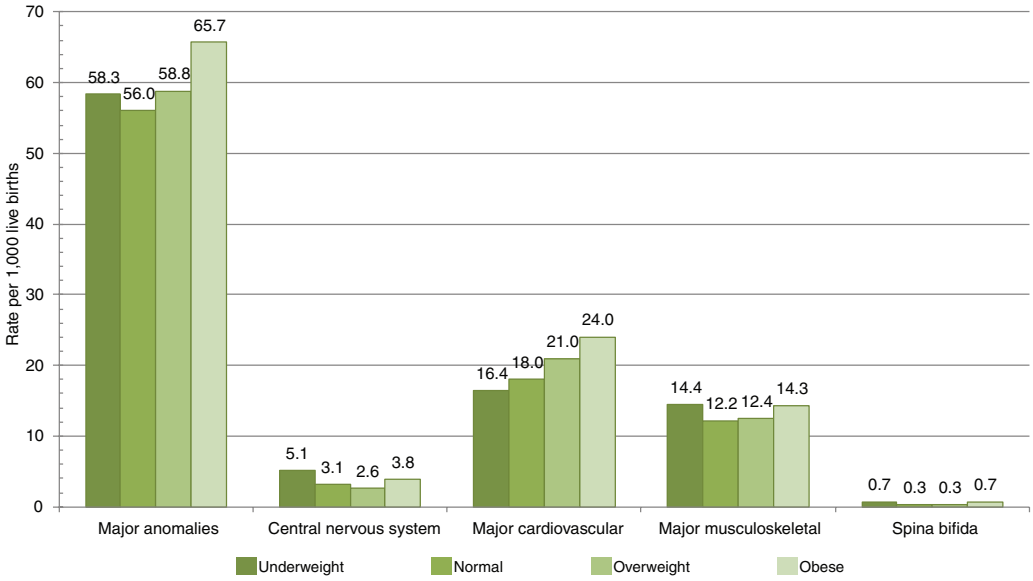
Live birth prevalence rates for selected birth defect classifications and maternal BMI are presented in Table 2. The prevalence of birth defects varied across both BMI and maternal weight gain categories. Mothers categorized as obese prior to pregnancy had higher rates of deliveries of infants with major cardiovascular (24.0 per 1,000 live births vs. 18.0), major musculoskeletal (14.3 vs. 12.2), spina bifida (0.7 vs. 0.3), and overall major congenital anomalies (65.7 vs. 56.0), compared to normal-weight mothers. Overweight mothers were at higher risk of delivering infants with cardiovascular defects (21.0 vs. 18.0), while underweight mothers were at higher risk of delivering infants with central nervous system defects (5.1 vs. 3.1) than their normal-weight counterparts (Figure 2).

Table 2. Birth defect counts, rates, and 95% confidence intervals, by birth defect category and maternal prepregnancy BMI: Colorado residents, 2007-2009.

Birth Defect Category	Maternal prepregnancy BMI	Number of infants with birth defects	Total live births	Rate (per 1,000 live births)	95% confidence interval of rate
Major anomalies					
	Underweight	513	8,794	58.3	(53.4-63.2)
	Normal	5,836	104,195	56.0	(54.6-57.4)
	Overweight	2,805	47,676	58.8	(56.7-61.0)
	Obese	2,246	34,187	65.7*	(63.1-68.3)
	Unknown	925	13,426	-	-
Major cardiovascular					
	Underweight	144	8,794	16.4	(13.7-19.0)
	Normal	1,873	104,195	18.0	(17.2-18.8)
	Overweight	1,001	47,676	21.0*	(19.7-22.3)
	Obese	822	34,187	24.0*	(22.7-28.0)
	Unknown	340	13,426	-	-
Major musculoskeletal					
	Underweight	127	8,794	14.4	(12.0-16.9)
	Normal	1,270	104,195	12.2	(11.5-12.9)
	Overweight	592	47,676	12.4	(11.4-13.4)
	Obese	490	34,187	14.3*	(13.1-15.6)
	Unknown	201	13,426	-	-
Central nervous system					
	Underweight	45	8,794	5.1*	(3.6-6.6)
	Normal	323	104,195	3.1	(2.8-3.4)
	Overweight	122	47,676	2.6	(2.1-3.0)
	Obese	130	34,187	3.8	(3.2-4.5)
	Unknown	65	13,426	-	-
Spina bifida					
	Underweight	6	8,794	0.7	(0.3-1.3)
	Normal	30	104,195	0.3	(0.2-0.4)
	Overweight	12	47,676	0.3	(0.1-0.4)
	Obese	23	34,187	0.7*	(0.4-1.0)
	Unknown	5	13,426	-	-

***** Indicates rate statistically higher than rate for normal-weight mothers at the 95% confidence level.
'Total live births' excludes births to mothers with pre-existing diabetes.
Source: Colorado Responds to Children With Special Needs, Colorado Department of Public Health and Environment.

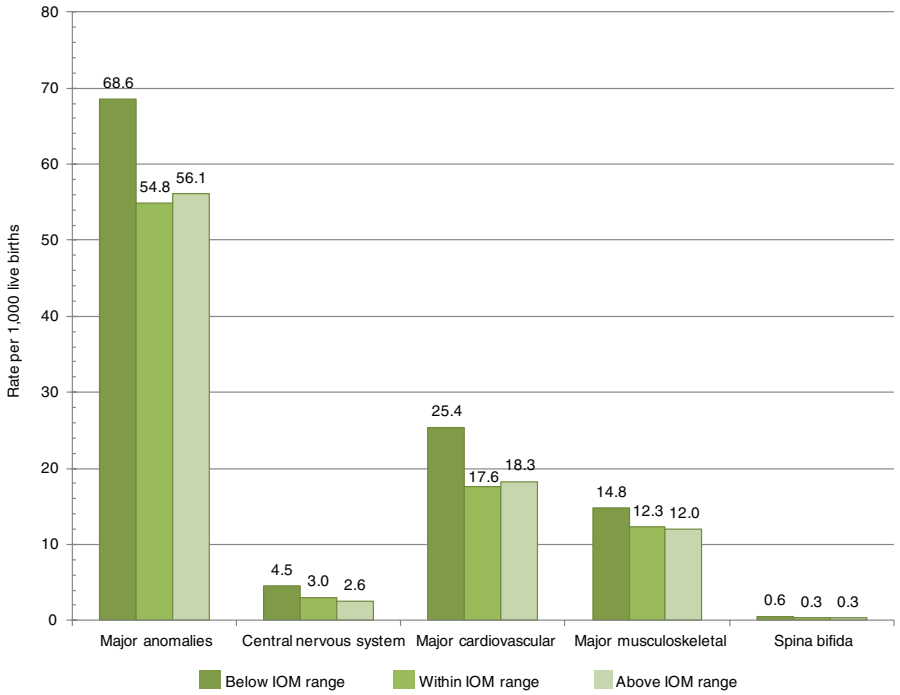
Figure 2. Birth defect rates by birth defect and maternal prepregnancy BMI: Colorado residents, 2007-2009.



Source: Colorado Responds to Children With Special Needs, Colorado Department of Public Health and Environment.

Overall, women who gained more than the IOM-recommended amount of weight were not at a higher risk of delivering infants with these congenital anomalies; however, mothers who gained less than the IOM-recommended, i.e. inadequate amount of weight, were at higher risk of delivering babies with a major birth defect (68.6 per 1,000 live births vs. 54.8), as well as major defects of the central nervous (4.5 vs. 3.0), cardiovascular (25.4 vs. 17.6), and musculoskeletal systems (14.8 vs. 12.3) than normal-weight mothers. (Figure 3).

Figure 3. Birth defect rates by birth defect and maternal weight gain during pregnancy: Colorado residents, 2007-2009.

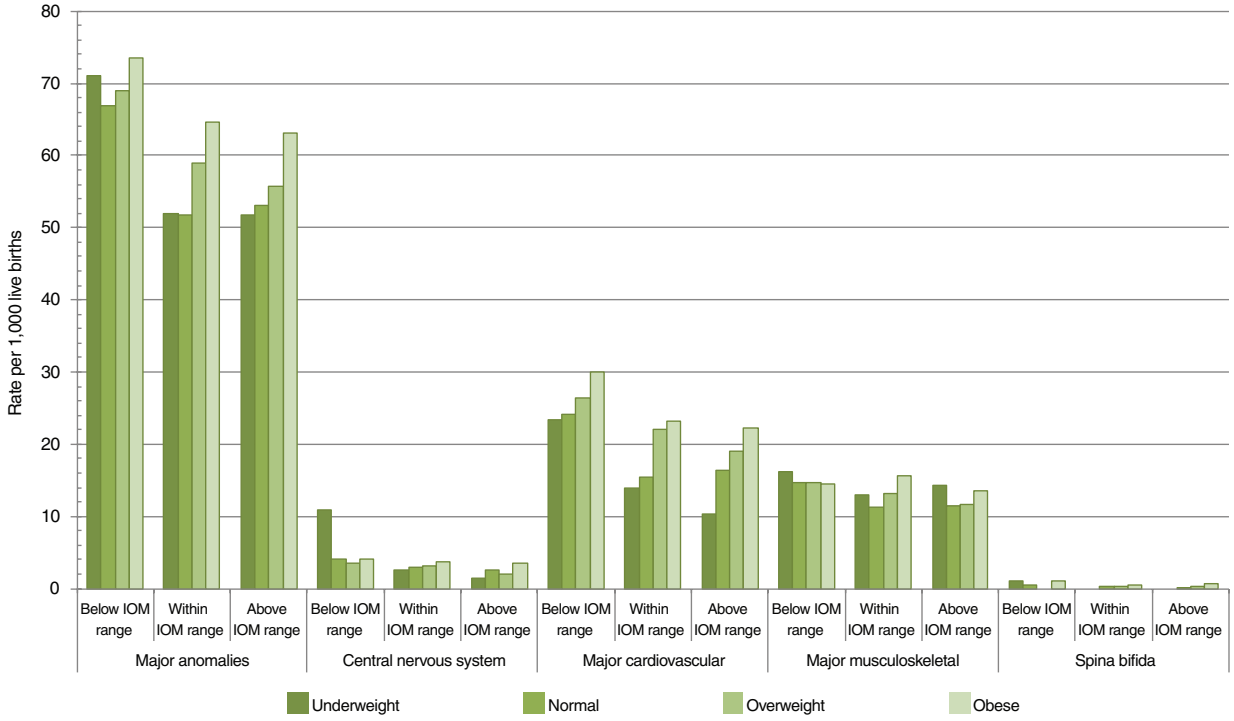


Source: Colorado Responds to Children With Special Needs, Colorado Department of Public Health and Environment.

When stratified by categories of maternal weight gain during pregnancy, obese mothers who gained excessive weight during pregnancy were at higher risk of delivering an infant with major defects than normal-weight mothers who gained excessive weight (63.2 per 1,000 live births vs. 53.0). The same holds true for defects of the cardiovascular system (22.2 vs. 16.3). Underweight mothers who gained an inadequate amount of weight were more likely to deliver an infant with defects of the central nervous system than corresponding normal-weight mothers (10.8 vs. 4.1) (Figure 4).

Statistical comparisons notwithstanding, within categories of weight gain during pregnancy for most defect categories studied, a similar pattern emerged: As prepregnancy BMI increased beyond "normal", the risk of birth defects often appeared to increase, especially when moving from overweight to obese.

Figure 4. Birth defect rates by birth defect, pre-pregnancy BMI, and maternal weight gain during pregnancy: Colorado residents, 2007-2009.



Source: Colorado Responds to Children With Special Needs, Colorado Department of Public Health and Environment.

Discussion

Based on these Colorado data, there is a relationship between maternal weight, i.e. prepregnancy BMI, and the risk of having a child with a birth defect. Additionally, these data suggest that the risk of having a child with a birth defect varies across categories of maternal weight gain during pregnancy. When exploring both prepregnancy BMI and weight gain during pregnancy at the same time (i.e. prepregnancy weight stratified by weight gain), within many weight gain categories, the risk increases among mothers with a nonrecommended prepregnancy BMI.

Similar results were found in the state of Michigan study presented in the spring 2011 issue of The Michigan Monitor.[8] Carmichael et.al. also concluded that obesity increased the risk of multiple adverse health outcomes—including many during pregnancy that compromise both maternal and infant health. The study discusses potential underlying mechanisms of obesity and adverse birth outcomes and suggests further research is needed to improve our understanding of this unique association.[9]

Relating maternal weight and the occurrence of birth defects has been a topic of interest in other recent studies. When compared to average-weight women, increased risk has been noted for spina bifida, heart defects, omphalocele and multiple birth defects in children of obese women. Similarly, when compared to overweight women, increased risks have been noted for heart defects, multiple anomalies and the overall occurrence of birth defects. An increased risk for gastroschisis has been noted in children of mothers who are underweight before pregnancy. [5,10] These Colorado data add evidence that supports associations noted with prepregnancy maternal weight and an increased risk for selected birth defects.

Increasing awareness of the importance of maternal periconception health is a critical component of public health efforts to reduce the risk of disease and adverse outcomes in both mother and child. Being at the appropriate prepregnancy weight, and gaining the proper weight during pregnancy, are important factors for maternal and child health. Additionally, as approximately 36 percent of live births in Colorado in 2010 were the result of an unintended pregnancy,[11] the maintenance of a healthy weight is critical for women who are of child-bearing age. It is therefore important that a woman include discussions of healthy weight along with other health issues when visiting her doctor, both before and during pregnancy, to help achieve a healthy pregnancy and healthy outcome for her baby.

From the health care provider perspective, there are several recommended activities that may be incorporated into standard practice, particularly when addressing issues of women's health and periconception care:[12]

- Measure height and weight before conception or at the initial prenatal visit to allow for calculation of BMI.
- Discuss the Institute of Medicine's recommendations for weight gain during pregnancy.
- Inform all women about the complications and possible adverse outcomes associated with being overweight and obese before and during pregnancy.
- Promote eating a healthy diet which includes taking a multivitamin with folic acid every day.
- Screen for hypertension and diabetes mellitus in women at risk. Consider screening obese women for gestational diabetes during the first trimester.
- Encourage regular exercise that includes 30 minutes or more of moderate physical activity daily.
- Counsel postpartum women to return to a healthy weight.

Among the objectives outlined in Healthy People 2020, a series of health goals put forth for the nation, are the following: 1) Increase the proportion of women delivering a live birth who had a healthy weight prior to pregnancy; and 2) Increase the proportion of mothers who achieve a recommended weight gain during their pregnancies.[13] These two are found among the family of maternal and child health objectives in the preconception and pregnancy health sections, respectively. That these maternal characteristics are discussed alongside the Healthy People objectives concerning reductions in maternal and infant mortality, morbidity, and disability is most appropriate: It is through promotion of maternal health that public health and individual medical care can effect real reductions in infant morbidity and disability and improvements in both maternal and child health.

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