

# **PREGNANCY AND DIABETES IN WEST VIRGINIA**



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## Executive Summary

Diabetes during pregnancy can lead to serious problems for both the mother and her baby if not controlled properly. Whether an expectant mother has Type 1, Type 2, or gestational diabetes, careful management of the disease is necessary to prevent complications during pregnancy, labor, delivery, and following the birth. Fetal risks when maternal diabetes is present include miscarriage and stillbirth, birth defects, macrosomia, growth restriction, neonatal hypoglycemia, respiratory distress syndrome, polycythemia, and hyperbilirubinemia. Maternal complications include chronic hypertension, preeclampsia, eclampsia, gestational hypertension, hydramnios, and ketoacidosis. Diabetes increases the probability of a Cesarean delivery, which carries a higher risk of complications than does a vaginal delivery. A woman who has gestational diabetes is more likely to develop Type 2 diabetes in later life, as are children born to diabetic mothers.

An examination of West Virginia birth certificate data showed that the percentage of resident births having maternal diabetes (unspecified as to gestational, Type 1, or Type 2) indicated on the certificate increased from 2.9% in 1996 to 4.1% in 2005. Aggregated data from 2001-2005 indicated that women reporting diabetes were more likely than other women to be over the age of 30, to have a premature birth, or to have a large-for-gestational-age infant. Hypertension was a much higher risk among women with diabetes, both chronic and gestational. Nearly half of the women with diabetes who gave birth from 2001-2005 had a Cesarean delivery, compared with 30% of women without diabetes. Diabetic women also had a 34% higher rate of complications during labor and/or delivery.

Data collected on maternal diabetes by the West Virginia Women, Infants and Children (WIC) Program indicated that 7.4% of the 13,986 postpartum women enrolled in the program in 2006 had gestational diabetes. Even higher percentages of maternal diabetes were reported by the Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS data showed an increase in diabetes during pregnancy from 8.5% in 2000 to 11.3% in 2004.

West Virginia hospitalization discharge data provide information on maternal diabetes by type of diabetes. Data on births in West Virginia hospitals collected from 2000-2005 showed an increase of 45% in the number of women with gestational diabetes and an increase of 153% in the number of women with Type 2 diabetes. The percentages of Cesarean deliveries among women with Type 1 diabetes (61%) and Type 2 diabetes (58%) were higher than the percentage among women with gestational diabetes (47%). Delivery complications were much higher among women with Type 1 (99%) and Type 2 (89%) diabetes than among those with gestational diabetes (28%). The costs of deliveries among women with diabetes are rising; hospitalization charges for births with maternal diabetes have increased from 4.9% of charges for all deliveries in 2000 to 7.1% in 2005.

The different data sources examined for this report yielded different prevalence rates for maternal diabetes among West Virginia women, indicating a need for a more focused analysis of the problem. The rates are increasing, however, regardless of source, a fact that should be of considerable concern to women and their health care providers. The overall increase in Type 2 diabetes in our state indicates the need for expanded screening among pregnant women who have diabetes risk factors, as the probability of a woman becoming pregnant and not knowing she has diabetes is also increasing. Conversely, a woman who is aware of her preexisting diabetes may not realize she is pregnant in the early weeks, pointing to the need for prepregnancy counseling to assure proper glucose control from the beginning of the pregnancy. The data presented in this document confirm the need for strict management of diabetes during pregnancy to curtail both economic costs and short- and long-term health problems for mother and child.

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## I. Pregnancy and Diabetes: An Introduction

Pregnancy can be an exciting time in a woman's life, but even for a woman in excellent health it can also be frightening, especially for the first-time mother. The changes her body will undergo during pregnancy in order to provide the nutrition and physical environment her growing baby needs to develop properly are tremendous. When diabetes is added to the situation, the potential complications can add another element of concern for her and her health care providers. Poor control of diabetes during pregnancy may lead to serious problems for both the mother and her baby. With careful planning and monitoring of her diabetes, however, she can look forward to a healthy pregnancy and birth.

Diabetes mellitus is a metabolic disorder in which the body cannot use the carbohydrates (sugars and starches) it takes in as food to make energy. Normally insulin, a hormone that is produced by the pancreas, helps the glucose (sugar) pass into the cells from the blood. When this process is blocked because of the body's inability to produce enough insulin or to use the insulin that is produced properly (insulin resistance), glucose builds up in the blood. This can eventually cause damage to blood vessels and nerves, as well as the body's organs, including the heart, kidneys, and eyes.

The three types of diabetes are Type 1, Type 2, and gestational.

- In **Type 1 diabetes**, the pancreas produces little or no insulin and daily insulin injections are required. Type 1 usually occurs under the age of 30, with diagnosis prevalence peaking at age 12. Treatment consists of multiple daily insulin injections or insulin pump therapy, meal planning, and exercise. Approximately 5% to 10% of the diabetic population has Type 1 diabetes; the prevalence is higher in whites than in other races.
- In **Type 2 diabetes**, the body either does not produce enough insulin or it cannot use the insulin that is made, leading to insulin resistance. Type 2 usually occurs in individuals over the age of 30 with a family history of the disease. However, since obesity increases the risk of Type 2 (about 80% of persons diagnosed with Type 2 are obese), as the prevalence of obesity increases among younger people, so does the onset of this type of diabetes at younger ages.

In addition to obesity, risk factors for Type 2 diabetes include a family history of diabetes, physical inactivity, hypertension, low HDL cholesterol and elevated triglyceride levels, a history of gestational diabetes, having given birth to a large-for-gestational-age (LGA) infant, or having polycystic ovary syndrome. Certain ethnicities are at higher risk, i.e., African Americans, Hispanics, and Native Americans and Alaska Natives. Women are more likely than men to develop Type 2 diabetes. The increase in obesity and shifts in ethnicity have resulted in a rising prevalence of Type 2 diabetes in the United States. Treatment varies, depending on severity of disease, ranging from exercise and dietary changes to oral diabetes medications and/or insulin injections.

- In **gestational diabetes** (GDM), glucose intolerance has its onset or first recognition during pregnancy. While gestational diabetes usually goes away after pregnancy, many of these women will develop Type 2 diabetes later in life. Risk factors for gestational diabetes include certain ethnicities (highest risk: Native Americans and those of Hispanic or Asian descent; lower risk: African American; lowest risk: non-Hispanic white women), obesity, a strong family history of diabetes, having had a stillbirth or a child with a birth defect, the previous delivery of an LGA infant, being over age 25, and previous GDM.

Women with GDM are more likely to develop Type 2 diabetes following pregnancy than other women. The National Institute of Diabetes and Digestive and Kidney Diseases estimates that 5% to 10% of women with GDM will have Type 2 diabetes after their pregnancy ends, with 20% to 50% developing the disease within 10 years (1). A recent study published in 2006 in *Diabetes* found that the eight-year postpartum risk of diabetes was 52.7%, with an increased risk among women who required insulin during pregnancy, obese women (BMI<sup>1</sup> >30), and women with more than two prior pregnancies (2). In addition, children of women with GDM are at higher risk of Type 2 diabetes later in life, and female children of women with gestational diabetes are at higher risk for GDM during their pregnancies.

## **Pregnancy Complications with Diabetes**

### **Preexisting Diabetes**

It is estimated that 1 in 100 women of childbearing age in the United States, or about 1.85 million women, has diabetes before becoming pregnant (3). Approximately 34% of pregnant women who have preexisting diabetes have Type 1 (4). Pregnancy for women with preexisting diabetes is problematic if their blood glucose levels are not controlled both before and during the pregnancy.

### **Fetal and Maternal Risks with Preexisting Diabetes**

- There is an increased risk of **miscarriage and stillbirth**; studies suggest this is due to the fetus growing at a slower rate as a result of maternal hypertension and resultant blood vessel damage from poor circulation. According to recent research, perinatal mortality occurs four times as often among infants of mothers with preexisting diabetes than among other infants; rates of perinatal mortality do not differ significantly between infants of mothers with Type 1 or Type 2 diabetes (5).

- **Birth defects** are two to six times more likely among infants of women with preexisting diabetes, especially insulin-dependent women. Major organs develop in the

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<sup>1</sup> Body Mass Index (BMI) = weight in kilograms divided by height in meters squared. Normal = BMI <25.0; Overweight = BMI 25.0-29.9; Obese = BMI 30+.



fetus during the first trimester; extra glucose in the mother's blood can interfere with the developmental processes, making this a crucial time for glucose control. However, many diabetic women are not aware of their pregnancy during these months. The Atlanta Birth Defects Case-Control Study (6) evaluated the risks among 4,929 live and stillborn infants with major malformations between 1968 and 1980. The findings indicated that the relative risk for major birth defects among infants of mothers with insulin-dependent diabetes was 7.9 times greater when compared with infants of mothers who did not have diabetes. The risks of major nervous system and cardiovascular system malformations were 15.5 and 18.0 greater, respectively, among infants of diabetic mothers.

- **Macrosomia** is defined by the American College of Obstetricians and Gynecologists (ACOG) as a birthweight greater than 4,000 grams (8 pounds, 14 ounces), an outcome four to five times more likely among infants of diabetic mothers. An LGA infant results from the excess glucose in the mother's blood that is carried to the fetus, which then produces more insulin in response. The combination of the extra glucose from the mother and the extra insulin produced by the fetus results in an excessively large infant. The trunks and shoulders of macrosomic infants are disproportionately larger than the head, increasing the risk of **birth injury**.

- **Growth restriction** can also occur in pregnancies complicated by diabetes, especially Type 1, the result of underlying maternal vascular disease and/or chronic hypertension.

- **Neonatal hypoglycemia** results when the infant's pancreas continues to produce high levels of insulin after delivery, following cessation of the mother's glucose supply. This occurs within the first 12 hours of life and requires oral or intravenous glucose to raise the newborn's blood sugar level. Untreated neonatal hypoglycemia can result in seizures, brain damage, and even death.

- Lung maturation can be delayed in the fetus if there is too much insulin or glucose in its system. This can cause **respiratory distress syndrome (RDS)** in the newborn, especially if the birth occurs before 37 weeks of gestation. RDS occurs at a rate of approximately 4% to 8% in births to mothers with preexisting diabetes (7).

- **Polycythemia**, the overproduction of red blood cells in the body, occurs more often among infants born to mothers with Type 1 and Type 2 diabetes than infants born to nondiabetic mothers. **Hyperbilirubinemia**, a condition of the newborn denoting immaturity of the liver that can be evidenced by jaundice, is more common in babies of diabetic mothers. **Low calcium and magnesium levels** are also more frequently found among infants of mothers with preexisting diabetes.

- **Maternal complications** can include chronic hypertension, preeclampsia (high blood pressure and protein in the urine), eclampsia (preeclampsia with unexplained seizures), gestational hypertension, and ketoacidosis. Hydramnios (too much amniotic fluid around the fetus), which is diagnosed in about 10% of pregnancies in diabetic women and 4% in nondiabetic women, can result in premature birth. Diabetic

complications that predate the pregnancy, such as diabetic retinopathy and diabetic nephropathy, can progress during pregnancy.

### **Gestational Diabetes**

Approximately 3% to 6% of women who become pregnant will develop gestational diabetes, or GDM. Like Type 2 diabetes, GDM is characterized by insulin resistance, but this usually does not occur until the second trimester. In all pregnancies, insulin resistance is actually decreased in the first trimester of pregnancy but then increases markedly in the second and third trimesters. In early pregnancy, hormones produced by the placenta can cause increased insulin secretion and decreased glucose production by the liver, resulting in reduced glucose levels. In later pregnancy, however, increased production of estrogen, cortisol, prolactin, and human placental lactogen can block insulin absorption by the cells, producing insulin resistance. Most women can produce the extra insulin needed at this time; the women who cannot develop GDM. GDM recurs in future pregnancies in 36% to 65% of women (8).

### **Fetal and Maternal Risks with Gestational Diabetes**

**Macrosomia** is the major risk for the fetus of a woman with GDM. It is the most common fetal complication in GDM, occurring in 15% to 45% of births. A macrosomic infant is at greater risk for obesity in childhood and adolescence. As with infants of mothers with preexisting diabetes, other fetal complications associated with GDM include **neonatal hypoglycemia, RDS, polycythemia, hyperbilirubinemia, and low calcium and magnesium levels**. While the risks for these complications are not as great with women with GDM as with women with preexisting diabetes, they are still more likely to occur than among women without diabetes.

Since gestational diabetes develops later in pregnancy, there is less chance that infants of mothers with GDM will have birth defects than infants of women with Type 1 or Type 2 diabetes. However, the Atlanta study cited above (6) found some **cardiovascular system defects** to be more prevalent among infants born to women with gestational diabetes who were insulin-dependent during the third trimester of pregnancy than among infants born to nondiabetic mothers. No differences were found among infants born to mothers with gestational diabetes who did not require insulin during pregnancy.

**Maternal complications** for women with GDM include hypertension, an increased risk of preeclampsia, and hydramnios. The most common complication for women with GDM is hypoglycemia, which can occur when a woman is on diabetes medication.

## **Detection, Management, and Treatment of Diabetes during Pregnancy**

The potential complications that face a woman with diabetes and her baby during her pregnancy make good preconception care very important. Studies have shown, however, that women with Type 2 diabetes are not referred for preconception counseling as often as women with Type 1 diabetes (4). Most women do not know they are pregnant during the crucial first weeks of pregnancy when the baby's organs are developing and there is a chance of birth defects occurring. Because of this, women with both Type 1 and Type 2 diabetes need to plan their pregnancies, ideally maintaining good blood glucose control for three to six months before pregnancy. If normal blood glucose levels are present around the time of conception, the chances of a woman with preexisting diabetes having a baby with a birth defect or having a spontaneous abortion are nearly the same as those of women without diabetes (3). Taking a multivitamin and folic acid before and during early pregnancy also helps prevent brain and spinal cord defects.

As noted, women in the first trimester of pregnancy often have lower glucose levels than nonpregnant women. Because of this, women with Type 1 diabetes may experience a decreased need for insulin during this period as their glycemic levels fall (4). However, the second and third trimesters are characterized by increased insulin resistance and decreased insulin sensitivity. In Type 1 diabetes, this may increase insulin requirements by two to threefold from prepregnancy needs.

Insulin requirements also increase as pregnancy progresses in women with Type 2 diabetes, especially in the latter two trimesters when maternal hormones increase. In fact, women with Type 2 diabetes can suffer from even greater insulin resistance than women with Type 1 diabetes, since women with Type 2 are more likely to be obese. If oral medications have been used to treat the diabetes, a switch to insulin use will probably be indicated as the safety of certain oral medications has not been established during pregnancy and these medications do not control glucose levels as well as insulin.

Good prenatal care for a woman with preexisting diabetes requires a team approach, including her diabetes specialist, her obstetrician, a pediatrician, a registered dietitian, and a diabetes educator. The tight glucose control needed during pregnancy also means strict self-management, with frequent self-monitoring of blood glucose (SMBG), sometimes as often as 10 times a day. Following an appropriate eating plan is essential to provide adequate nutrients, minimize blood glucose fluctuations, and result in an appropriate weight gain. While weight loss is contraindicated for all pregnant women, regardless of their prepregnancy weight, recommended weight gains range from 28-40 pounds for underweight women to less than 15 pounds for obese women. Exercise is a key factor in diabetes treatment, especially for women with Type 2, and a moderate

exercise program<sup>2</sup> is usually recommended to help maintain control of blood glucose levels.

Gestational diabetes is characterized by increased insulin resistance, which normally does not occur until the second trimester of pregnancy. Because of this, testing for GDM is usually performed between 24 and 28 weeks of gestation for women of normal risk. If a woman is determined to be at high risk, however, the screening may be done at her first prenatal visit to rule out preexisting, undiagnosed diabetes. As noted above, these risks include obesity, being a member of a high-risk ethnic group, being older than 25, having a family history of Type 2 diabetes, or having had GDM or a previous LGA infant. Screening may not be done if the woman is low risk, that is, is under the age of 25, is normal weight or underweight, and has none of the other risk factors.

The same nutritional guidelines are recommended for women with GDM as those for women with preexisting diabetes, a carbohydrate-controlled meal plan that provides adequate nutrition and appropriate weight gain. As with Type 2 diabetes, moderate physical activity is an important factor in maintaining glucose control and promoting overall health during pregnancy. SMBG is also important for women with GDM in order to maintain tight control of glucose levels. If diet and exercise aren't sufficient in controlling glucose levels, medication is required. The oral hypoglycemic medication glyburide has been found to be a clinically effective alternative to insulin in some women with GDM (9). Insulin therapy, however, can become necessary when adequate glucose control is not achieved.

Both preexisting and gestational diabetes increase the probability of a Cesarean delivery, even when tight glucose control has been maintained. The risk of Cesarean delivery is independent of infant birthweight, even though diabetic women are more likely to have an LGA infant (10).

Control of glucose levels is very important during labor and delivery, and insulin requirements can change rapidly after the birth. SMBG is important postpartum, since the period after delivery can have blood glucose swings. Even if a woman with GDM has a normal blood glucose level postpartum, she should be reassessed regularly to check for insulin resistance. A study released in 2005, however, found that only 37% of women with a history of GDM were screened for postpartum diabetes according to ADA guidelines (11).

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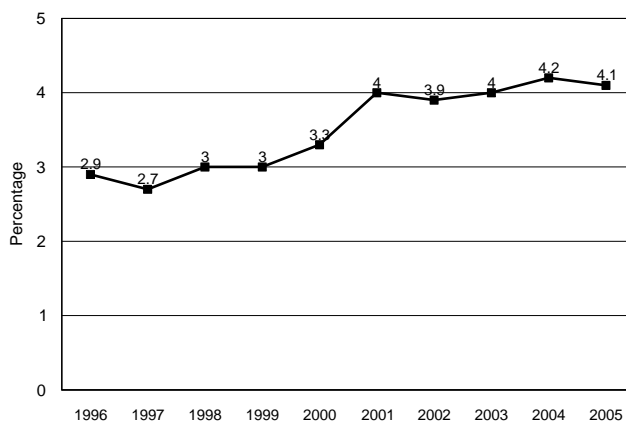
<sup>2</sup> The American Diabetes Association (ADA) defines “moderate” exercise as 20 to 30 minutes of aerobic activities such as walking or swimming on most days of the week.

## II. West Virginia Birth Certificate Data on Maternal Diabetes

Diabetes is one of 16 “medical risk factors for this pregnancy” that can be reported on the birth certificate. The West Virginia Health Statistics Center (WVHSC) provided both single year and aggregated data derived from birth certificates recorded in its Vital Registration Unit from 1996 through 2005 for comparisons of selected infant and maternal factors by maternal diabetes status. Limitations of these data include those encountered with any self-reported information, as well as the fact that the reporting of maternal diabetes on the birth certificate does not specify preexisting (Type 1 or Type 2) or gestational diabetes. Birth certificate data, however, remain the most comprehensive source of information on the effect of diabetes on a woman and her infant.

Single-year comparisons of the percentage of births that had maternal diabetes listed as a medical risk factor on the birth certificate from 1996 through 2005 are shown below in Figure 1. The rate of births with maternal diabetes has increased over the 10-year period, from 2.9% in 1996 to 4.1% in 2005. The most recent U.S. birth certificate data show that, in 2004, 3.6% of women reported having diabetes as a medical risk factor in their pregnancy.

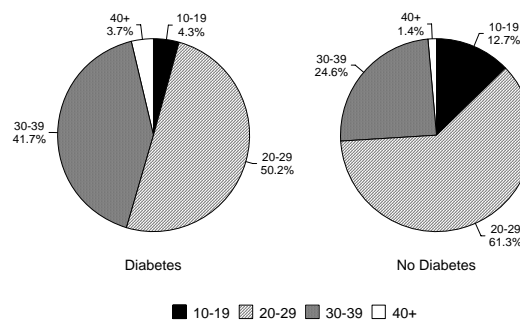
Figure 1. Percentage of Births with Maternal Diabetes\*  
West Virginia Resident Births, 1996-2005



\*Unspecified as to gestational, Type 1, or Type 2  
Source: WVHSC

**Maternal Age.** There were 103,886 total resident births recorded in West Virginia from 2001 through 2005, 4,206 or 4.0% of which listed maternal diabetes as a medical risk factor on the birth certificate (Table 1). Mothers reporting diabetes were more likely to be over the age of 30 than nondiabetic mothers; nearly half, or 45.4% of women with diabetes, were aged 30 or older at the time of birth, compared with only one-fourth (26.0%) of women without diabetes (Figure 2).

Figure 2. Distribution of Births by Maternal Diabetes\* Status and Age  
West Virginia Resident Births, 2001-2005

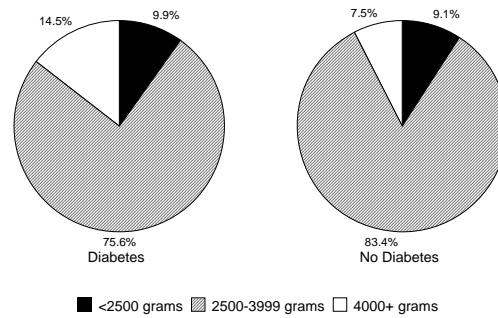


\*Unspecified as to gestational, Type 1, or Type 2  
Note: Excludes unknowns  
Source: WVHSC

**Maternal Race.** Little difference was noted by maternal race and diabetes status; 95.2% of mothers reporting diabetes were white, compared with 95.6% of nondiabetic mothers, while African American mothers represented 3.3% of both diabetic and nondiabetic women giving birth (Table 1).

**Birthweight and Prematurity.** Women with diabetes were more likely than women without diabetes to give birth to either a low-birthweight infant (9.9% vs. 9.1%, respectively) or an infant weighing 4000 grams or larger (14.5% vs. 7.5%, respectively) (Figure 3). Women with diabetes were also more likely than those without diabetes to have a premature birth, 18.5% of diabetic mothers vs. 11.6% of nondiabetic mothers (Table 1).

Figure 3. Distribution of Births by Maternal Diabetes\* Status And Infant Birthweight West Virginia Resident Births, 2001-2005

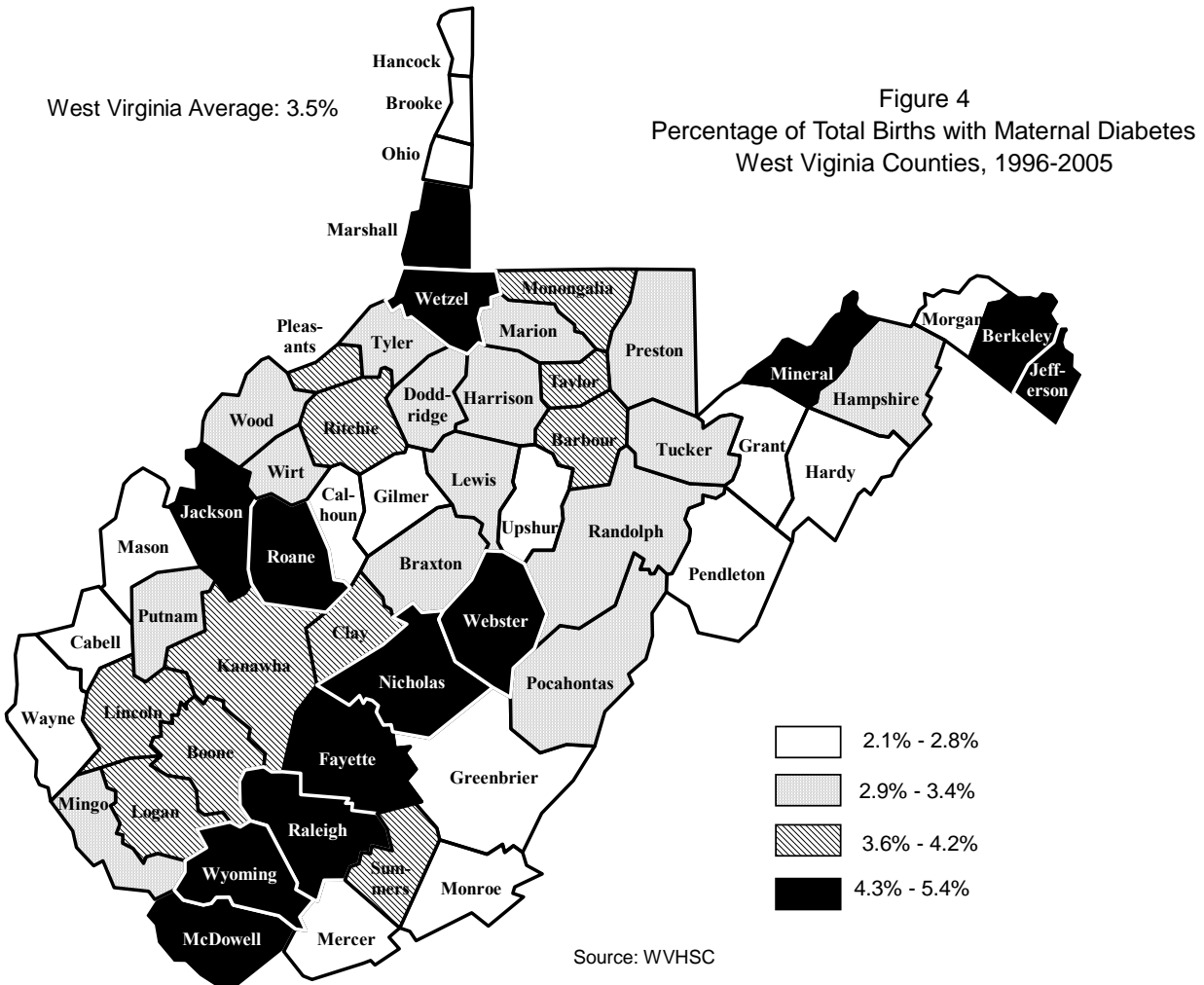


\*Unspecified as to gestational, Type 1, or Type 2  
Source: WVHSC

	Diabetes*		No Diabetes		Total	
	#	%	#	%	#	%
Total Births	4,206	100.0	99,680	100.0	103,886	100.0
(% of total)		(4.0)		(96.0)		
<b>Age</b>						
10-19	182	4.3	12,670	12.7	12,852	12.4
20-29	2,110	50.2	60,988	61.2	63,098	60.7
30-39	1,753	41.7	24,445	24.5	26,198	25.2
40+	156	3.7	1,428	1.4	1,584	1.5
Unknown	5	0.1	149	0.1	154	0.1
<b>Race</b>						
White	4,005	95.2	95,283	95.6	99,288	95.6
African American	137	3.3	3,300	3.3	3,437	3.3
Other	62	1.5	977	1.0	1,039	1.0
Unknown	2	0.05	120	0.1	122	0.1
<b>Infant birthweight</b>						
<2500 grams	417	9.9	9,049	9.1	9,466	9.1
2500-3999 grams	3,180	75.6	82,955	83.2	86,135	82.9
4000+ grams	609	14.5	7,467	7.5	8,076	7.8
Unknown	0	0.0	209	0.2	209	0.2
<b>Premature infant</b>						
Unk. gestational age	780	18.5	11,528	11.6	12,308	11.8
	9	0.2	381	0.4	390	0.4

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

**County-Level Data.** Ten-year aggregate data were used to examine maternal diabetes on the county level in the state. While the state rate of maternal diabetes was 3.5% over the 10-year period from 1996 through 2005, individual county rates ranged from a low of 2.1% in Hardy County to a high of 5.4% in Jefferson County. (Individual county rates can be found in Appendix A.) In general, as illustrated by Figure 4, the highest rates of maternal diabetes were reported for births occurring to women residing in the southern counties of the state.



**Pregnancy History.** Information gathered on pregnancy history indicated that women with diabetes who gave birth from 2001-2005 were slightly more likely to have other living children than women without diabetes (61.3% vs. 57.7%, respectively) (Table 2). They were also slightly more likely to report having had a child or children who died, as well as having had more terminations of pregnancy.

Table 2 Pregnancy History by Diabetes Status West Virginia Resident Births, 2001-2005				
	Diabetes*		No Diabetes	
	#	%	#	%
Other living children	2,577	61.3	57,513	57.7
1	1,461	34.7	34,793	34.9
2	726	17.3	15,497	15.5
3+	390	9.3	7,223	7.2
No information	0	0.0	126	0.1
Any children now dead	92	2.2	1,448	1.5
No information	0	0.0	136	0.1
Other terminations**	1,159	27.6	21,968	22.0
No information	2	0.05	128	0.1

\*Unspecified as to gestational, Type 1, or Type 2 diabetes  
\*\*Unspecified as to spontaneous or induced

**Weight Gain.** In general, women reporting diabetes gained less weight during their pregnancies than did women who did not report diabetes (Table 3). Thirty-seven percent (36.6%) of diabetic women gained less than 20 pounds, compared with 22.8% of nondiabetic women. Fifteen percent (15.4%) gained over 40 pounds, as opposed to 20.9% of women without diabetes.

**Prenatal Care.** Little difference was noted between women who reported diabetes and those who did not in time of entry into prenatal care (Table 3). Eighty-six percent (85.9%) of mothers with diabetes began prenatal care during their first trimester, as did 82.6% of mothers without diabetes. Women with diabetes reported a larger number of prenatal visits, however. One in 4 diabetic mothers (25.4%) reported 16 or more prenatal visits; only about 1 in 10 nondiabetic mothers (11.1%) reported that many visits.

**Hypertension.** Among the other maternal medical risk factors that may be noted on the birth certificate is hypertension. Women reporting diabetes were much more likely to report high blood pressure than women not reporting diabetes, both chronic and pregnancy related (Table 4). Chronic hypertension was reported more than five times as often among mothers with diabetes than nondiabetic mothers (6.8% vs. 1.3%, respectively), while the risk for pregnancy-related diabetes was more than twofold (12.6% vs. 5.5%, respectively).



Table 3 Prenatal Information by Diabetes Status West Virginia Resident Births, 2001-2005				
	Diabetes*		No Diabetes	
	#	%	#	%
<b>Weight gain</b>				
<0-20 pounds	1,538	36.6	22,752	22.8
21-40 pounds	1,679	39.9	50,605	50.8
41-55 pounds	455	10.8	15,643	15.7
56+ pounds	193	4.6	5,178	5.2
Unknown	341	8.1	5,502	5.5
<b>Entry into prenatal care</b>				
1 <sup>st</sup> trimester	3,613	85.9	82,340	82.6
2 <sup>nd</sup> trimester	413	9.8	11,628	11.7
3 <sup>rd</sup> trimester or no care	53	1.3	2,210	2.2
Unknown	127	3.0	3,502	3.5
<b># of prenatal visits</b>				
<11	973	23.1	32,263	32.4
11-15	2,106	50.1	54,809	55.0
16+	1,070	25.4	11,,110	11.1
Unknown	57	1.4	1498	1.5

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

**LGA Infant and Smoking.** Women with diabetes were over three times as likely to have had a previous birth of a large-for-gestational-age (LGA) infant (4000+ grams) than were those without diabetes (2.1% of diabetic mothers vs. 0.6% of nondiabetic mothers) (Table 4). On the positive side, diabetic women were slightly less likely to smoke during pregnancy than were nondiabetic women.

Table 4 Medical and Other Risk Factors by Diabetes Status West Virginia Resident Births, 2001-2005				
	Diabetes*		No Diabetes	
	#	%	#	%
<b>Chronic Hypertension</b>	284	6.8	1,260	1.3
<b>Pregnancy-Related Hypertension</b>	530	12.6	5,512	5.5
<b>Previous Large Infant (4000+ grams)</b>	90	2.1	645	0.6
<b>Tobacco Use**</b>	945	22.5	26,486	26.6
<b>No information</b>	15	0.4	788	0.8

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

	Diabetes*		No Diabetes	
	#	%	#	%
Amniocentesis	161	3.8	1,379	1.4
Electronic fetal monitoring	3978	94.6	91,110	91.4
Induction of labor	1575	37.4	31785	31.9

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

### Obstetrics Procedures.

Amniocentesis was nearly three times more likely to be performed when a woman had diabetes (Table 5). Four percent (3.8%) of women reporting diabetes during pregnancy had amniocentesis performed, compared with 1.4% of women without diabetes. Induction of labor was also more likely among women with diabetes (37.4% vs. 31.9%), while electronic fetal monitoring was

performed on more than 9 out of 10 of women giving birth from 2001-2005, regardless of diabetes status.

**Method of Delivery.** Women with diabetes were markedly more likely to have a Cesarean section performed than women without diabetes according to the aggregated 2001-2005 data (Table 6). Nearly one-half (48.5%) of mothers with diabetes had a Cesarean section, either primary or repeat, compared with 30.3% of mothers without diabetes.

	Diabetes*		No Diabetes	
	#	%	#	%
Vaginal	2,099	49.9	67,808	68.0
Cesarean section	2,040	48.5	30,193	30.3
Primary	1,235	29.4	18,688	18.7
Repeat	805	19.1	11,505	11.5
Unknown	67	1.6	1679	1.7

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

**Labor and/or Delivery Complications.** As shown in Table 7, women with diabetes had a 34% greater risk for any complication of labor and/or delivery than women without diabetes. The greatest differences were noted in frequency of breech deliveries (5.9% among diabetic mothers vs. 4.2% among nondiabetic mothers), fetal distress (4.1% among diabetic mothers vs. 2.6% among nondiabetic mothers), and cephalopelvic disproportion (3.4% among diabetic mothers vs. 2.3% among nondiabetic mothers).

Table 7 Complications of Labor and/or Delivery by Diabetes Status West Virginia Resident Births, 2001-2005				
	Diabetes*		No Diabetes	
	#	%	#	%
Any complication	1,813	43.1	32,093	32.2
Unk. if complication	20	0.5	816	0.8
Breech	250	5.9	4,184	4.2
Fetal distress	171	4.1	2,637	2.6
Meconium	157	3.7	3,349	3.4
Cephalopelvic disproportion	143	3.4	2,288	2.3
Premature rupture	83	2.0	1,704	1.7
Dysfunctional labor	73	1.7	1,108	1.1
Precipitous labor	60	1.4	1,316	1.3
Abruptio placenta	41	1.0	824	0.8

\*Unspecified as to gestational, Type 1, or Type 2 diabetes

Table 8 Abnormal Conditions of the Newborn by Maternal Diabetes Status West Virginia Resident Births, 2001-2005				
	Diabetes*		No Diabetes	
	#	%	#	%
Birth injury	6	0.1	69	0.07
Hyaline membrane disease/RDS**	38	0.9	513	0.5

\*Unspecified as to gestational, Type 1, or Type 2 diabetes  
\*\*Respiratory distress syndrome

### Newborn Conditions.

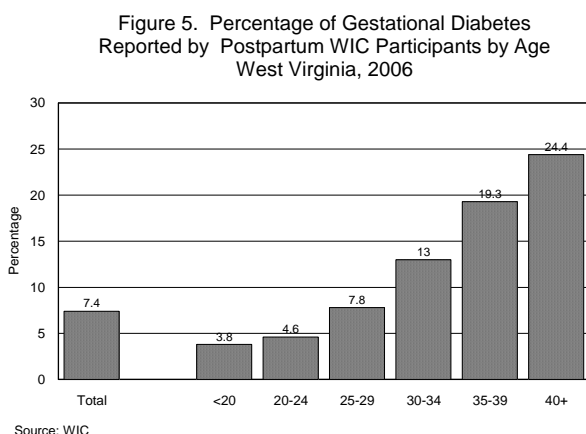
Although births to diabetic mothers have been shown generally to be at higher risk for birth injury and respiratory distress syndrome (RDS), infants born to mothers with diabetes in West Virginia from 2001-2005 were only slightly more likely to have a birth injury or be diagnosed with RDS than infants born to mothers without diabetes, as shown in Table 8.

**Congenital Anomalies.** Studies indicate that infants born to mothers with preexisting diabetes are more likely to have certain birth defects, in particular nervous system and cardiovascular system malformations, than infants born to nondiabetic mothers. The 2001-2005 data showed only slight differences in the occurrences of these defects in births to diabetic and nondiabetic women. Only 0.05% and 0.04% of births to diabetic and nondiabetic women, respectively, had a defect of the nervous system, while 0.12% and 0.07% of infants born to diabetic and nondiabetic women, respectively, had a heart malformation detected at the time of the birth.

### III. WIC and PRAMS Data on Births with Maternal Diabetes

#### Women, Infants and Children Program Data

The West Virginia Women, Infants and Children (WIC) Program serves pregnant women, breastfeeding women (up to one year after delivery), postpartum women (up to six months after delivery), infants, and children to the age of five. WIC clients must be determined to be income eligible (185% of the federal poverty level) and also found to be at nutritional risk to receive benefits. In recent years, approximately two-thirds of all women who gave birth in the state were WIC clients.



Women who enroll in WIC are asked “During this pregnancy, were you told by a doctor that you had gestational diabetes?” Overall, in 2006, 1,032 or 7.4% of the 13,986 postpartum women enrolled in the program answered yes to this question (Figure 5). The prevalence of gestational diabetes among the WIC population had a direct association with maternal age. While only 5.6% of women aged less than 30 had gestational diabetes, nearly one-fourth (24.4%) of women aged 40 and older were told they had diabetes.

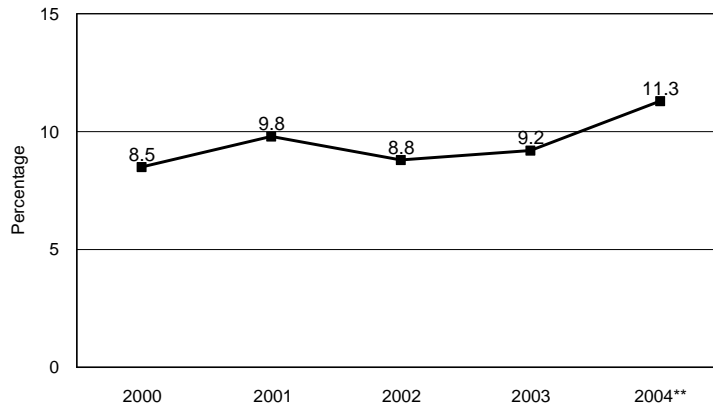
#### Pregnancy Risk Assessment Monitoring System

The Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing, population-based surveillance system designed to identify and monitor selected maternal experiences and behaviors that occur before and during pregnancy, as well as during the child’s early infancy, among a stratified sample of women delivering a live birth. West Virginia has participated in PRAMS since its initiation by the U.S. Centers for Disease Control and Prevention in 1987<sup>3</sup>.

<sup>3</sup> PRAMS was initiated in 1987 as part of the CDC initiative to help state health departments establish and maintain an epidemiologic surveillance system of selected maternal behaviors and experiences. West Virginia was one of six initial states to begin collecting data in 1988 and has had continuous data collection since that time. West Virginia samples roughly 2,400 women per year.

Before 2005, respondents to PRAMS were asked only if they had diabetes during their pregnancy; type of diabetes was not specified. The prevalence of maternal diabetes among PRAMS respondents from 2000 through 2004 is shown in Figure 6. According to these data, the percentage of women reporting diabetes increased from a low of 8.5% in 2000 to a high of 11.3% in 2004. Beginning in 2005, respondents were asked if their diabetes started before or during pregnancy. In that year, 3.1% of women with diabetes reported preexisting diabetes, while 10.2% reported gestational diabetes.

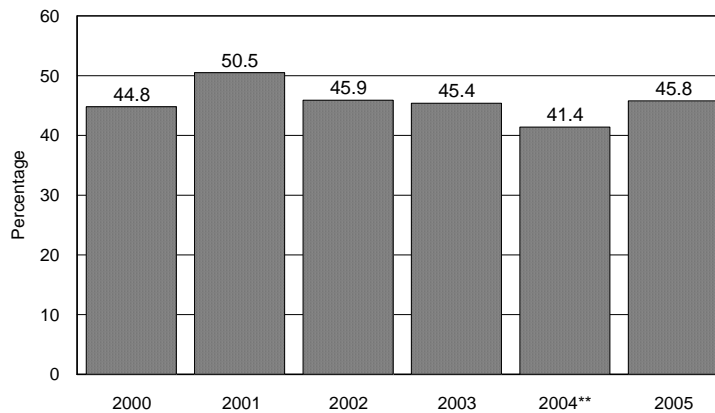
Figure 6. PRAMS Participants Reporting Diabetes\* during Pregnancy  
As a Percentage of Total PRAMS Births  
WV Residents, 2000-2004



\*Unspecified as to gestational, Type 1, or Type 2  
\*\*7/2004-12/2004 only  
Source: PRAMS

Although the prevalence of diabetes among PRAMS participants has increased since 2000, health care professionals are not more likely to discuss diabetes with their patients, as indicated in Figure 7. While one-half (50.5%) of health care workers talked about diabetes with patients either during or after pregnancy in 2001, this percentage had dropped to 45.8 % in 2005.

Figure 7. Prevalence of a Discussion of Diabetes with a  
Health Care Professional\* among PRAMS Participants  
WV Residents, 2000-2005



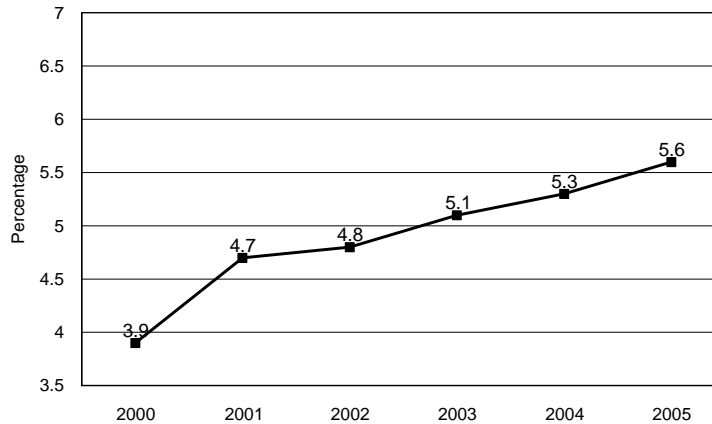
\*Doctor, nurse, or other health care worker  
\*\*7/2004-12/2004 only  
Source: PRAMS

## IV. West Virginia Hospitalization Discharge Data on Births with Maternal Diabetes

Hospitalization discharge data provide an additional source of information on the prevalence of disease and the financial burden on the state. The West Virginia Health Care Authority (WVHCA) collects inpatient data from all nonfederal licensed hospitals in the state.<sup>4</sup> WVHCA data from 2000-2005 were analyzed both as individual years and in the six-year aggregate to (1) determine trends over time and (2) make certain comparisons between women with diabetes and women without diabetes giving birth in West Virginia hospitals, as well as comparisons among women diagnosed with Type 1, Type 2, and gestational diabetes<sup>5</sup>.

**Prevalence of Maternal Diabetes.** Figures 8 and 9 illustrate the upward trend from 2000 to 2005 in births to West Virginia residents with maternal diabetes occurring in West Virginia hospitals. As presented in Figure 8, WVHCA data show an increase in births with maternal diabetes from 3.9% of all births in 2000 to 5.6% of all births in 2005.

Figure 8. Births with Maternal Diabetes\* as a Percentage of Total Deliveries WV Residents in WV Hospitals, 2000-2005



\*Unspecified as to gestational, Type 1, and Type 2  
Source: WVHCA

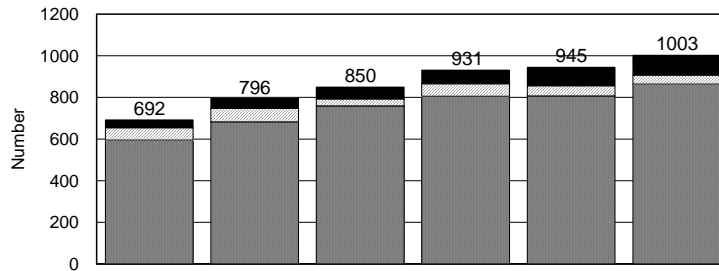
Figure 9 presents the number of births among women with diabetes annually from 2000 through 2005, with a breakdown by type of diabetes. While no trend is apparent in the number of women with Type 1 diabetes giving birth over the six-year period,

<sup>4</sup> The Hospital Uniform Billing Database (UB-92) includes information on admittance and discharge dates; patient characteristics (e.g., age, gender); diagnoses codes; length of stay, facility, and payer. Up to nine diagnoses (one principal and eight secondary) are recorded and coded according to the International Classification of Disease, 9<sup>th</sup> Revision, Clinical Modification (ICD-9-CM).

<sup>5</sup> ICD-9-CM codes used to identify Type 1 diabetes: 250.1, 250.3; Type 2 diabetes: 250.0, 250.2; gestational diabetes: 648.80-84, 648.01-04.

consistent increases have occurred among women with Type 2 and gestational diabetes. There was a 45% increase in the number of women with gestational diabetes from 2000 to 2005. The largest rise, however, was in the number of women giving birth who had Type 2 diabetes, an increase of 153% over the six years.

Figure 9. Number of Births with Maternal Diabetes  
Gestational, Type 1, and Type 2  
WV Residents in WV Hospitals, 2000-2005

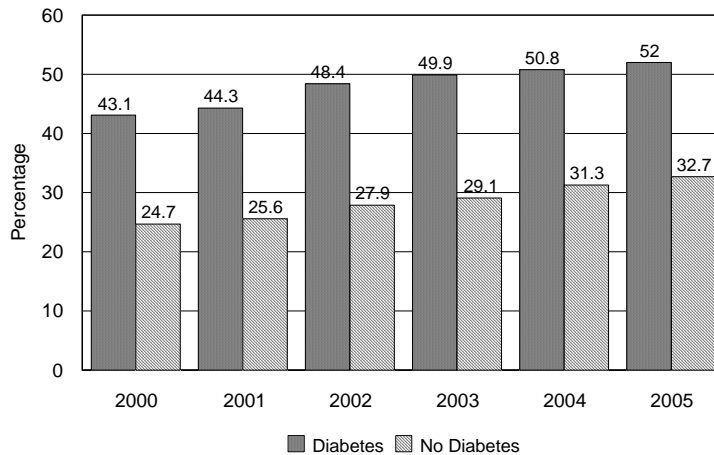


	2000	2001	2002	2003	2004	2005
■ Gestational	595	683	759	806	807	864
□ Type 1	59	64	34	60	49	43
■ Type 2	38	49	57	65	89	96

Source: WVHCA

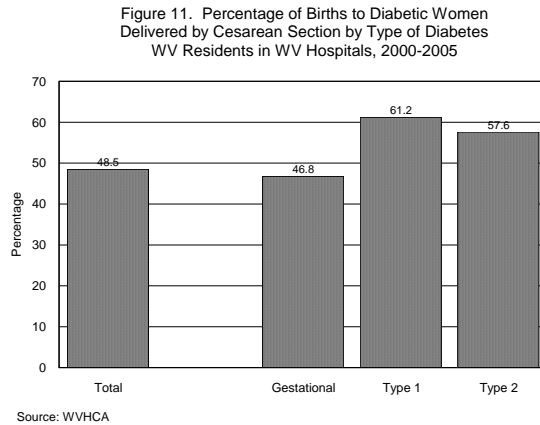
**Method of Delivery.** Figure 10 depicts the trend in percentage of Cesarean births among diabetic and nondiabetic women in West Virginia hospitals from 2000-2005. The percentage of births among diabetic mothers delivered by Cesarean section steadily increased from 43.1% to 52.0% over the six years. Among women without diabetes, the percentage of Cesarean births rose from 24.7% in 2000 to 32.7% in 2005.

Figure 10. Percentage of Births Delivered by Cesarean Section  
By Maternal Diabetes\* Status  
WV Residents in WV Hospitals, 2000-2005



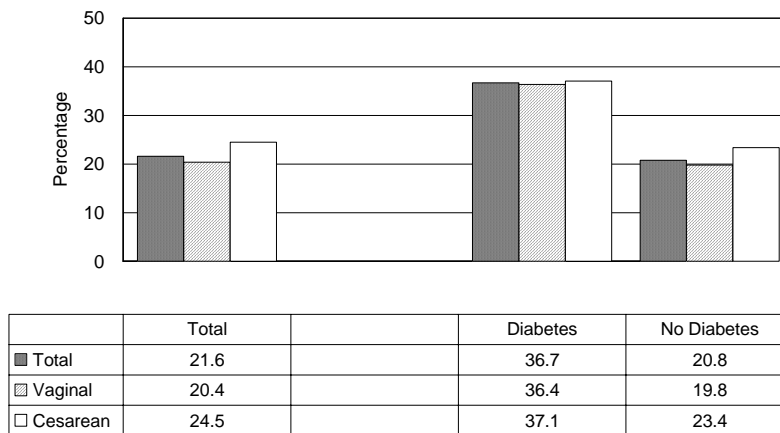
\*Unspecified as to gestational, Type 1, or Type 2  
Source: WVHCA

The breakdown of Cesarean deliveries by type of diabetes is presented in Figure 11 using aggregated 2000-2005 data. Women with gestational diabetes were less likely than women with preexisting diabetes to have a Cesarean section. Sixty-one percent (61.2%) of women with Type 1 diabetes and 57.6% of women with Type 2 diabetes had a Cesarean delivery, compared with 46.8% of women with gestational diabetes.



**Delivery Complications.** Figure 12 compares the percentage of births that had delivery complications<sup>6</sup> by maternal diabetes status and type of delivery. Overall, births delivered by Cesarean section were more likely to have had a complication than were vaginal births, 24.5% vs. 20.4%, respectively. Little difference was noted among births with maternal diabetes by delivery method, with over one-third of both vaginal (36.4%) and Cesarean (37.1%) births involving a complication. A complication was reported in approximately one in five births to nondiabetic women.

Figure 12. Percentage of Births with Delivery Complications\* by Maternal Diabetes\*\* Status and Type of Delivery WV Residents in WV Hospitals, 2000-2005



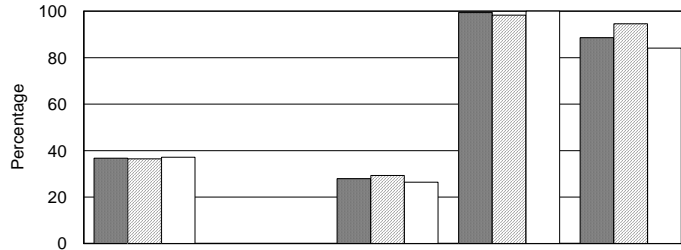
\*Had a delivery complication or required an operating room procedure  
 \*\*Unspecified as to gestational, Type 1, or Type 2  
 Source: WVHCA

Striking differences were noted in the occurrence of complications in births to women with diabetes between those with preexisting diabetes and those with gestational diabetes (Figure 13). Virtually all of women with Type 1 diabetes had a delivery complication, as did 94.6% of women with Type 2 diabetes who had a vaginal delivery and 84.1% who had a Cesarean section. In contrast, 29.3% of women with gestational diabetes who delivered vaginally and 26.4% who had a Cesarean section had a delivery complication.

<sup>6</sup> ICD-9-CM codes used to identify deliveries with complications: 370, 372, 374, and 375.



Figure 13. Percentage of Births to Diabetic Women with Delivery Complications,\* by Type of Delivery and Type of Diabetes WV Residents in WV Hospitals, 2000-2005

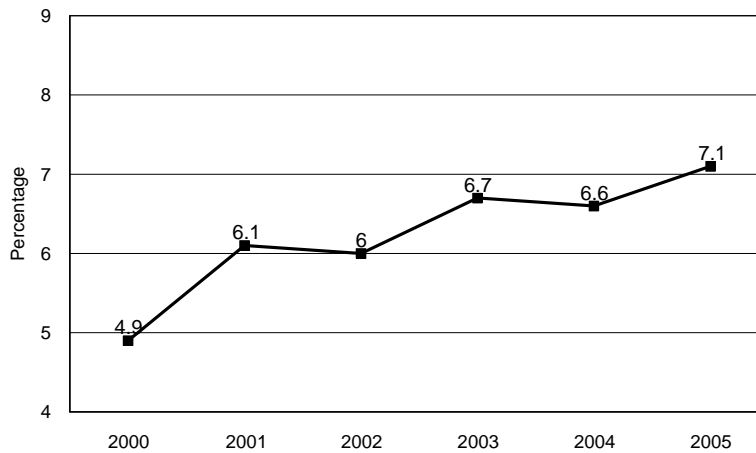


	Total	Gestational	Type 1	Type 2
Total	36.7	27.9	99.4	88.6
Vaginal	36.4	29.3	98.3	94.6
Cesarean	37.1	26.4	100	84.1

\*Had a delivery complication or required an operating room procedure  
Source: WVHCA

**Inpatient Hospitalization Charges.** From 2000 through 2005, births with maternal diabetes accounted for 4.9% of total births to West Virginia women in West Virginia hospitals (5,217 out of a total of 106,200 births). These births, however, accounted for 6.3% of the charges for all births during that period (\$31,473,778 out of \$497,863,697). The percentage of charges for births with maternal diabetes increased from 4.9% of the total in 2000 to 7.1% of the total in 2005, as illustrated in Figure 14.

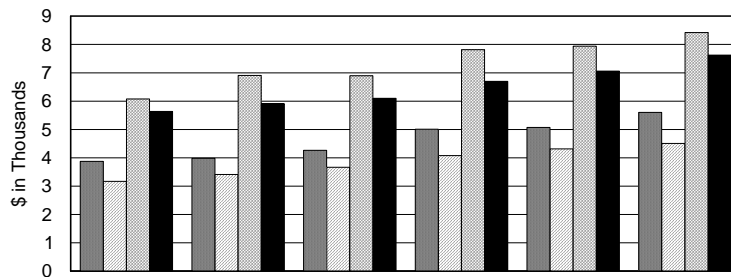
Figure 14. Hospital Inpatient Charges for Births with Maternal Diabetes\* as Percentage of Charges for All Births WV Residents in WV Hospitals, 2000-2005



\*Unspecified as to gestational, Type 1, and Type 2  
Source: WVHCA

The average charge per stay over the six-year study period for births with maternal diabetes was \$6,033, compared with an average charge per stay of \$4,618 for births without maternal diabetes. Figure 15 breaks down the inpatient charges associated with births by diabetes status and type of delivery from 2000 through 2005. While the average charge per stay has risen among both diabetic and nondiabetic women regardless of type of delivery, charges among women with diabetes consistently remain higher than those among other women. In 2005, the average charge for a vaginal delivery for a birth with maternal diabetes was \$5,603, compared with \$4,508 for a birth with no diabetes. The average charge per stay for a Cesarean delivery was \$8,425 if maternal diabetes was present, \$7,626 if diabetes was not present.

Figure 15. Average Charges per Stay for Births by Diabetes Status and Type of Delivery  
WV Residents in WV Hospitals, 2000-2005

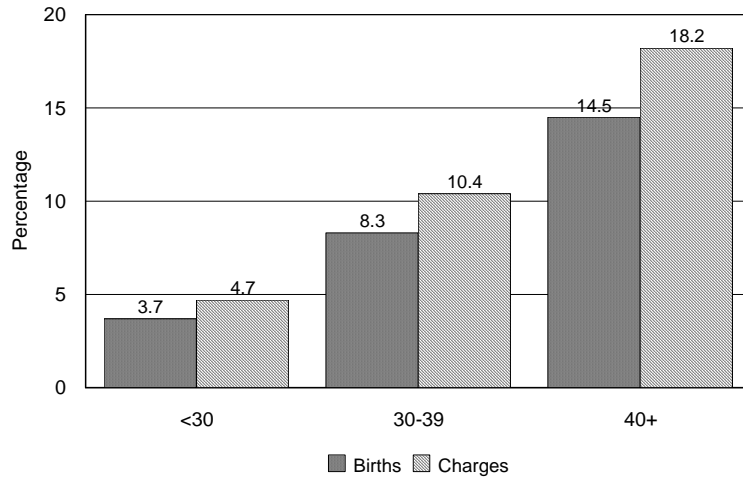


	2000	2001	2002	2003	2004	2005
■ Vaginal D	3877	3981	4265	5011	5072	5603
□ Vaginal ND	3169	3411	3669	4076	4315	4508
▨ CS D	6080	6905	6893	7813	7938	8425
■ CS ND	5636	5910	6100	6698	7062	7626

D = Diabetes (unspecified as to gestational, Type 1, or Type 2); ND = No Diabetes  
Source: WVHCA

As in the analysis of birth certificate data, age was found to be a factor in maternal diabetes; women with diabetes were generally older than other women when giving birth. Aggregated hospital discharge data from 2000-2005 show that the percentage of births with maternal diabetes, as well as the percentage of birth-related hospitalization charges, increased with age (Figure 16). Women with diabetes represented only 3.7% of women who were under the age of 30 when they gave birth, compared with 14.5% of all women who gave birth at age 40 and older. The percentage of associated charges, while consistently higher, showed an even greater increase with age, from 4.7% of all birth-related charges among women under the age of 30 to 18.2% of charges among women aged 40 and older.

Figure 16. Births and Inpatient Charges Associated with Maternal Diabetes\* as a Percentage of Total Births and Inpatient Charges, by Age Group WV Residents in WV Hospitals, 2000-2005



\*Unspecified as to gestational, Type 1, or Type 2  
Source: WVHCA

## V. Discussion

The first step in addressing any health problem is determining the scope of that problem. In this document, three data sources were examined to ascertain the prevalence of maternal diabetes among West Virginia women giving birth from 2000 through 2005; these findings are presented in Table 9 below.

There are limitations to the data derived from the data sets used in the present study. Birth certificate data on maternal medical risk factors during pregnancy are based upon self reporting by the mother after an infant's birth. PRAMS (Pregnancy Risk Assessment Monitoring System) survey data represent prevalence estimates (presented as the midpoint of a range) based upon survey responses given by the mother after the birth and are also reliant upon self reporting. Hospital discharge data, on the other hand, reflect diagnoses recorded by hospital personnel on the patient's record. Regardless of how the data were obtained, however, as well as the differences reflected in prevalence, an upward trend in prevalence in maternal diabetes is evident in all three data sources and should be of considerable concern to women and their health care providers.

Data Source	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	% Increase 2000-2005
Birth Certificate	3.3	4.0	3.9	4.0	4.2	4.1	24.2
PRAMS**	8.5	9.8	8.8	9.2	11.3	14.3	68.2
Hospital Discharge Record	3.9	4.7	4.8	5.1	5.3	5.6	43.6

NOTE: Birth certificate and hospital discharge data reflect actual frequencies of birth records noting maternal diabetes; PRAMS data represent estimates based on survey responses.

\*Unspecified as to gestational, Type 1, or Type 2

\*\*Pregnancy Risk Assessment Monitoring System

Information obtained from birth certificates does not indicate type of maternal diabetes, i.e., whether the diabetes was preexisting (Type 1 or Type 2) or gestational (GDM). As the prevalence of diabetes increases, so does the need to specify the type of the disease. The more detailed data available through hospitalization records show that the increase in maternal diabetes over the study's time period was due to increases in both GDM and Type 2 diabetes. Between 2000 and 2005, there was a 45% increase in the number of births with GDM and a staggering 153% increase in the number of births with Type 2 diabetes (see page 17).

The potential complications for both mother and infant when diabetes is present are many, as discussed earlier. Chronic and pregnancy-related hypertension, two of the complications for which state-specific data are available, were found to be more common among West Virginia women with diabetes than among those without diabetes. Higher percentages of macrosomia and prematurity were found among infants born to diabetic women than among those born to other women. Even more disturbing is the fact that recent research released by the American Diabetes Association indicates that the risk for

certain complications, including macrosomia and newborn hypoglycemia, as well as the risk of Cesarean section, rises with maternal blood glucose levels, even at those levels previously thought to be within the normal range for pregnant women and not classified as diabetic (12).

State data derived from birth certificates and hospital discharge records indicate that Cesarean deliveries are more likely among West Virginia women with diabetes; one-half of all deliveries among diabetic women in the state from 2000-2005 were Cesarean sections, compared with approximately one-third of deliveries among nondiabetic women. A Cesarean section is a major operation and as such poses greater risks to a woman than does a vaginal delivery, including higher occurrences of infection, hemorrhage, adhesions, surgical wounds, gallbladder disease, genital or urinary complications, heart or lung complications, or blood clots (13). Birth certificate data indicate that diabetic women in West Virginia are more likely than nondiabetic women to have a complication of labor and/or delivery. In addition, hospital records show that women giving birth in West Virginia have a higher occurrence of delivery complications, regardless of type of delivery, if diabetes is present, with complications far more likely if the diabetes is preexisting.

Uncontrolled diabetes during pregnancy results in higher economic costs and greater health risks to mother and child. Inpatient hospitalization records confirm the additional costs associated with these births, especially as women continue to postpone childbearing into their thirties and forties. In addition, these excess costs and risks can be compounded years after the actual birth. Subsequent pregnancies and births are more likely to have complications, and women with GDM are markedly more likely than other women to be diagnosed with Type 2 diabetes within 10 years of giving birth. The children of mothers with diabetes during pregnancy have been found to face further problems later in their lives, including obesity, abnormal glucose tolerance, and Type 2 diabetes (14).

The problem of diabetes in West Virginia is becoming more challenging each year. The percentage of the adult population that had been diagnosed with diabetes in 2006 was 12.1%, up from 5.9% just 10 years earlier. More women of childbearing ages are being diagnosed with Type 2 diabetes, and many of these women will not realize they are pregnant during the crucial first weeks of their baby's development, making prepregnancy counseling of diabetic women imperative. Conversely, some women who become pregnant may not realize they have diabetes. The need, therefore, to screen pregnant women early in their pregnancy if they are at risk for diabetes is equally important.

PRAMS data reveal that less than half of the women surveyed in 2005 had a discussion of diabetes with a health care professional either during or following their pregnancy. Other statistics have shown that fewer than 4 of every 10 women who have gestational diabetes are being screened for Type 2 diabetes after the birth of their baby. The need to address the increasing concurrence of diabetes and pregnancy is not being met by the health care community. This is a serious failing: As the prevalence of

diabetes during pregnancy rises, so does the potential for spiraling economic costs and long- and short-term health problems for mothers and infants alike.

## References

1. National Institute of Diabetes and Digestive and Kidney Diseases. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2005. Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, 2005.
2. Lobner K, Knopff A, Baumgarten A, et al. Predictors of postpartum diabetes in women with gestational diabetes mellitus. *Diabetes* 2006;55:792-797.
3. March of Dimes. Having a healthy pregnancy with diabetes: preexisting diabetes. Available online at: <http://www.marchofdimes.com/pnhec/188-1064.asp>. Accessed April 2007.
4. Thomas A. Pregnancy with preexisting diabetes. In Mensing C, ed. *The Art and Science of Diabetes Self-Management Education*. Chicago: American Association of Diabetes Educators, 2006.
5. Macintosh MCM, Fleming KM, Bailey JA, et al. Perinatal mortality and congenital anomalies in babies of women with type 1 or type 2 diabetes in England, Wales and Northern Ireland. *BMJ* 2006;333:177.
6. Becerra JE, Khoury MJ, Cordero JF, Erickson JD. Diabetes mellitus during pregnancy and the risks for specific birth defects: a population-based case-control study. *Pediatrics* 1990;85:1-9.
7. Moore TR and Warshak C. Diabetes mellitus and pregnancy. Available online at: <http://www.emedicine.com/med/topic3249.htm>. Accessed July 2007.
8. Reader DM. Gestational diabetes. What's new? Presentation given at Team Management of Diabetes, International Diabetes Center, Minneapolis, MN: May 16-18, 2007.
9. Reader DM. Gestational diabetes mellitus. In Mensing C, ed. *The Art and Science of Diabetes Self-Management Education*. Chicago: American Association of Diabetes Educators, 2006.
10. Kjos SL, Berkowitz K, Xiang A. Independent predictors of cesarean delivery in women with diabetes. *J Matern Fetal Neonatal Med* 2004; 15(1):61-67.
11. Smirnakis KV, Chasan-Taber L, Wolf M, et al. Postpartum diabetes screening in women with a history of gestational diabetes. *Obstetrics & Gynecology* 2005;106:1297-1303.
12. American Diabetes Association. Fetus at risk at lower levels of maternal blood glucose than thought. Paper presented at the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Highlights Symposium, ADA 67<sup>th</sup> Annual Scientific Sessions, Chicago: June 22, 2007.

13. Lydon-Rochelle M, et al. Association between method of delivery and maternal rehospitalization. *JAMA* 2000; 283(18):2411-2416.
14. National Institutes of Health. National Institute of Child Health and Human Development. Diabetes during pregnancy. Available online at [http://www.nichd.nih.gov/health/topics/Diabetes\\_During\\_Pregnancy.cfm](http://www.nichd.nih.gov/health/topics/Diabetes_During_Pregnancy.cfm). Accessed April 2007.



**APPENDIX A**  
**Maternal Diabetes Prevalence by County**  
**West Virginia, 1996-2005**

<b>County</b>	<b>%</b>	<b>Rank</b>	<b>County</b>	<b>%</b>	<b>Rank</b>
Barbour	3.6	22	Monongalia	3.8	18
Berkeley	4.3	12	Monroe	2.4	52
Boone	4.2	14	Morgan	2.8	40
Braxton	2.9	37	Nicholas	4.9	3
Brooke	2.8	41	Ohio	2.2	54
Cabell	2.5	51	Pendleton	2.6	47
Calhoun	2.6	49	Pleasants	3.6	24
Clay	3.9	15	Pocahontas	3.4	26
Doddridge	3.4	27	Preston	3.4	29
Fayette	4.3	13	Putnam	3.1	34
Gilmer	2.2	53	Raleigh	4.3	11
Grant	2.6	48	Randolph	2.9	38
Greenbrier	2.7	46	Ritchie	3.8	17
Hampshire	3.1	33	Roane	4.4	9
Hancock	2.6	50	Summers	3.8	20
Hardy	2.1	55	Taylor	3.9	16
Harrison	3.3	32	Tucker	3.3	31
Jackson	4.3	10	Tyler	3.4	25
Jefferson	5.4	1	Upshur	2.8	42
Kanawha	3.7	21	Wayne	2.7	44
Lewis	3.0	35	Webster	5.0	2
Lincoln	3.6	23	Wetzel	4.8	5
Logan	3.8	19	Wirt	3.3	30
McDowell	4.4	8	Wood	2.9	39
Marion	3.0	36	Wyoming	4.8	4
Marshall	4.8	6	Total WV	3.5	
Mason	2.7	45			
Mercer	2.8	43			
Mineral	4.6	7			
Mingo	3.4	28			

Ranked highest (1) to lowest (55)

**APPENDIX B**  
**Selected Inpatient Hospitalization Data Tables on Maternal Diabetes**  
**Births to WV Residents in WV Hospitals, 2000-2005**  
**(D=Diabetes [Gestational, Type 1, or Type 2]; ND=No Diabetes)**

<b>Number of Births by Age and Diabetes Status WV Residents in WV Hospitals, 2000-2005</b>								
	<30		30-39		40+		Total	
	D	ND	D	ND	D	ND	D	ND
2000	383	13,297	284	3,613	25	191	692	17,101
2001	450	12,337	305	3,584	41	182	796	16,103
2002	488	12,928	335	3,819	27	184	850	16,931
2003	542	12,973	364	4,069	25	198	931	17,240
2004	528	12,622	379	3,988	38	208	945	16,818
2005	547	12,582	411	3,983	45	225	1,003	16,790
Total	2,938	76,739	2,078	23,056	201	1,188	5,217	100,983

<b>Number of Births by Delivery Type and Diabetes Status WV Residents in WV Hospitals, 2000-2005</b>						
	Vaginal		Cesarean		Total	
	D	ND	D	ND	D	ND
2000	395	12,885	297	4,216	692	17,101
2001	443	12,065	353	4,038	796	16,103
2002	439	12,213	411	4,718	850	16,931
2003	466	12,223	465	5,017	931	17,240
2004	465	11,554	480	5,264	945	16,818
2005	481	11,312	522	5,478	1,003	16,790
Total	2,688	72,252	2,529	28,731	5,217	100,983

<b>Inpatient Hospitalization Charges (\$) for Births by Diabetes Status WV Residents in WV Hospitals, 2005-2005</b>			
	Diabetes	No Diabetes	Total
2000	3,337,028	64,593,836	67,930,864
2001	4,201,068	65,020,446	69,221,514
2002	4,705,298	73,558,234	78,263,532
2003	5,968,562	83,424,532	89,393,094
2004	6,168,731	87,025,870	93,194,601
2005	7,093,091	92,767,001	99,860,092
Total	\$31,473,778	\$466,389,919	\$497,863,697

## **APPENDIX C**

### **Web Sites for Data Sources**

West Virginia Health Statistics Center

<http://www.wvdhhr.org/bph/oehp/hsc/default.htm>

West Virginia Women, Infants & Children Program

<http://www.wvdhhr.org/ons/wic.asp>

West Virginia Pregnancy Risk Assessment Monitoring System

<http://www.wvdhhr.org/wvprams/>

West Virginia Health Care Authority

<http://www.hcawv.org/>