HEALTH CARE AGENCY

Increased Incidence of Gestational Diabetes Mellitus in Orange County

2000-2009

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Introduction

Increases in the rates of severe complications of pregnancy and delivery have been documented in the U.S. over the past few years (Berg et al, 2009; Kuklina et al., 2009). A recent study by the Health Care Agency on the complications of pregnancy and childbirth found that from 2006 to 2008 gestational diabetes mellitus (GDM) was the most common, serious prenatal condition, affecting some 3,100 women each year in Orange County (Ramos et al., 2011). GDM has been shown elsewhere (Brody et al, 2003; Langer et al, 2005) to increase a woman's risk of developing multiple complications such as hypertension and preeclampsia that can affect both the mother and the baby. Importantly, complications such as GDM, more than doubled the likelihood of having a c-section delivery (Ramos et al., 2011). Mothers in the county who had a serious prenatal condition *and* delivered via c-section were more than seven times more likely to have a major complication associated with delivery, compared to those who delivered vaginally with no antepartum conditions (Ramos et al., 2011).

Here we describe the characteristics of maternal illness and complications due to pregnancy as defined by the Healthy People 2010 objectives. The Healthy People initiative is a collection of 467 health indicators for the nation to achieve, including maternal illness and complications due to pregnancy. The target of the Healthy People 2010 objective for maternal illness and complications is less than 24% of all pregnancies. Thus, we sought to determine how the incidence of GDM, as well as other prenatal conditions defined by the Healthy People initiative have changed over the past decade for women giving birth in Orange County and identify factors that might influence such complications.

Methods

The data utilized in this report were from the California Office of Statewide Health Planning and Development (OSHPD) for hospitalizations related to labor and delivery for the years 2000 through 2009. This analysis included 437,757 cases of child birth by Orange County residents from 2000 to 2009. Most births occurred at Orange County hospitals and a small percent occurred outside of the county.

Maternal complications due to pregnancy were defined according to the Healthy People 2010 Maternal, Infant, and Child Health Objective 16-5a: *Maternal complications during labor and delivery*. These complications were identified by ICD-9 CM codes associated with a birthing patient's primary diagnosis and up to 24 other diagnoses. The maternal complications were grouped into 10 categories according to **Table 1**. To determine the likelihood of an event, odds ratios (OR) with a 95% confidence intervals (CI) were calculated and presented in the tables.

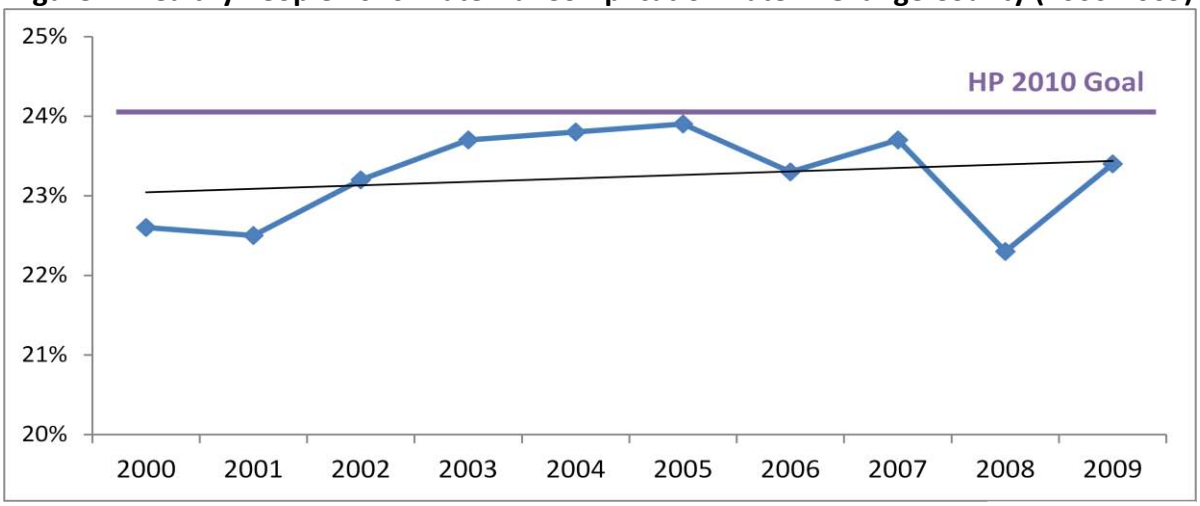
Table 1: Healthy People 2010-Defined Maternal Complications During Labor and Delivery

Hemorrhage:	641.00-64.193, 666.00-666.34
Hypertension/eclampsia:	642.00-642.79
Cardio/venous/pulmonary disease:	648.50-648.54, 648.60-648.64, 671.30-671.54, 673.00-673.84
Infection/fever:	646.60-646.64, 658.40-658.43, 659.30-659.33, 670.00-670.44, 659.20-659.23, 672.00-672.44
Laceration/trauma:	664.20-664.24, 664.30-664.34, 664.50-664.54, 665.00-665.94
Sedation/anesthesia complication:	668.00-668.94
Renal/hepatic complication:	646.20-646.24, 646.70-646.73
Diabetes Mellitus:	648.00-648.04
Gestational Diabetes Mellitus:	648.80-648.84
Other:	674.00-674.34, 674.50-674.54, 674.80-674.84, 674.90-674.94, 643.20-643.23

Findings

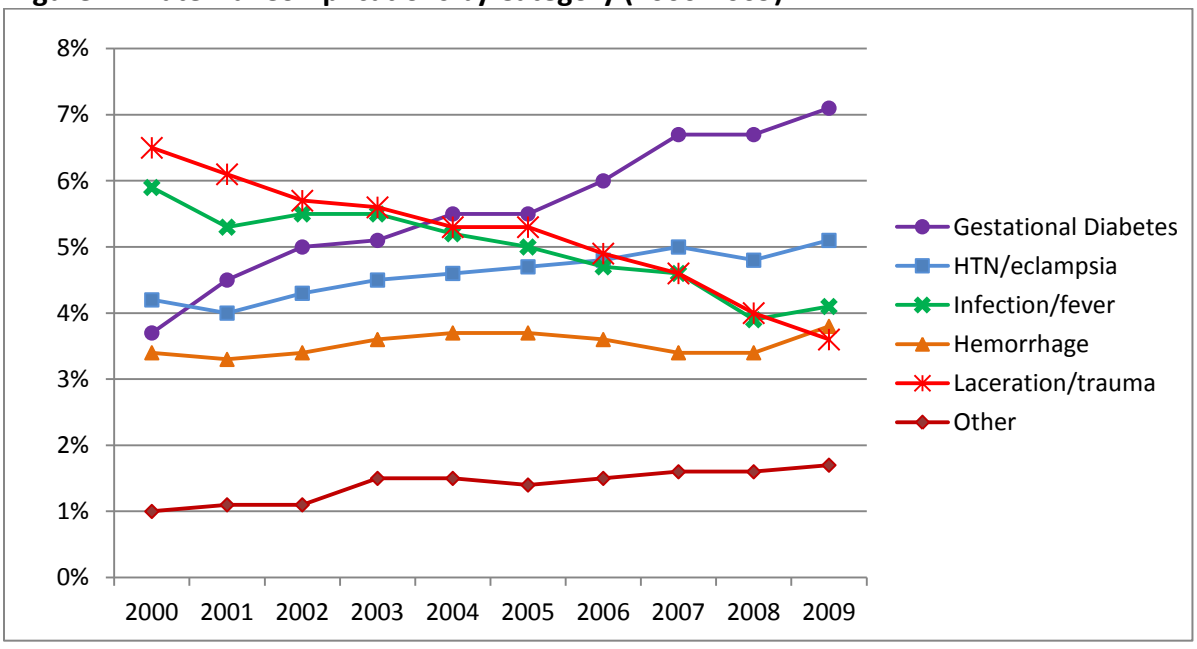
There were 437,757 births identified over the ten-year study period of 2000 to 2009, and 101,716 (23.2%) were associated with at least one Healthy People 2010-defined maternal complication. As shown in **Figure 1**, the overall complication rate rose slightly from 22.6% in 2000 to 23.4% in 2009, but remained below the national objective of 24% of all pregnancies.

Figure 1: Healthy People 2010 Maternal Complication Rate in Orange County (2000-2009)



Complications were separated into ten categories as described in **Table 1** and the ten-year change in each complication group was noted. The trends in complications with incidence ≥1.0% are shown in **Figure 2**. Variables not shown due to an incidence <1.0% included cardiovascular/venous/pulmonary disease, sedation/anesthesia complications, renal/hepatic complications, and *non*-gestational diabetes mellitus-related complications.

Figure 2: Maternal Complications by Category (2000-2009)



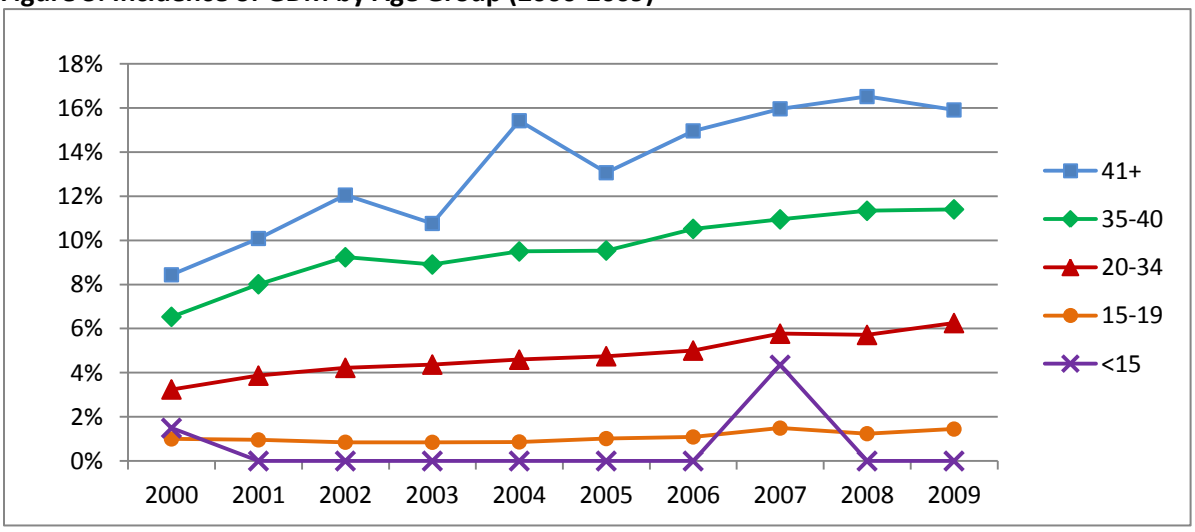
The change in the rates of complications from 2000 to 2009 are shown in **Table 2** for each complication type along with odds ratios (ORs). GDM was the complication with the greatest ten-year increase, doubling from 3.7% in 2000 to 7.1% in 2009 (OR=2.0). Conversely, laceration/trauma was the complication with the greatest ten-year decrease, from 6.5% in 2000 to 3.6% in 2009 (OR=0.54). The decrease in lacerations may be due in part to the observed increase in cesarean deliveries and decrease in the proportion of vaginal deliveries which can result in perineal trauma.

Table 2: Incidence of Healthy People 2010-Defined Maternal Complications (2000 vs. 2009)

	2000		2009			95% CI	
Complications	**N**	**%**	**N**	**%**	**OR**	**Lower**	**Upper**
Hemorrhage	1,567	3.4%	1,504	3.8%	1.12	1.05	1.21
Hypertension/eclampsia	1,960	4.2%	2,032	5.1%	1.22	1.15	1.30
Cardio/venous/pulmonary disease	297	0.6%	211	0.5%	0.83	0.69	0.99
Infection/fever	2,723	5.9%	1,650	4.1%	0.69	0.65	0.74
Laceration/trauma	3,005	6.5%	1,425	3.6%	0.54	0.50	0.57
Sedation/anesthesia complication	86	0.2%	102	0.3%	1.38	1.04	1.84
Renal/hepatic complication	78	0.2%	91	0.2%	1.36	1.01	1.84
Diabetes Mellitus	281	0.6%	341	0.9%	1.42	1.21	1.66
Gestational Diabetes Mellitus	1,717	3.7%	2,839	7.1%	2.00	1.88	2.13
Other	462	1.0%	695	1.7%	1.77	1.57	1.99
Cases with one or more complication	*10,500*	*22.6%*	*9,330*	*23.4%*	*1.05*	*1.01*	*1.08*

The two-fold increase in GDM over the ten-year period prompted further analysis regarding age, race/ethnicity, relation to c-section and obesity, and geographic location within the county. Age was categorized into 5 groups: <15 years, 15-19 years, 20-34 years, 35-40 years, and 41+ years. The incidence of GDM increased with age; the 41+ group had the highest overall incidence of GDM and accounted for 6% of GDM cases in 2009. The 20-34 age group increased at the greatest rate over the ten year period (1.99 times) and accounted for 63% of the total GDM cases in 2009. The ten-year trend in GDM for each age group is displayed in **Figure 3** and summarized in **Table 3**.

Figure 3: Incidence of GDM by Age Group (2000-2009)



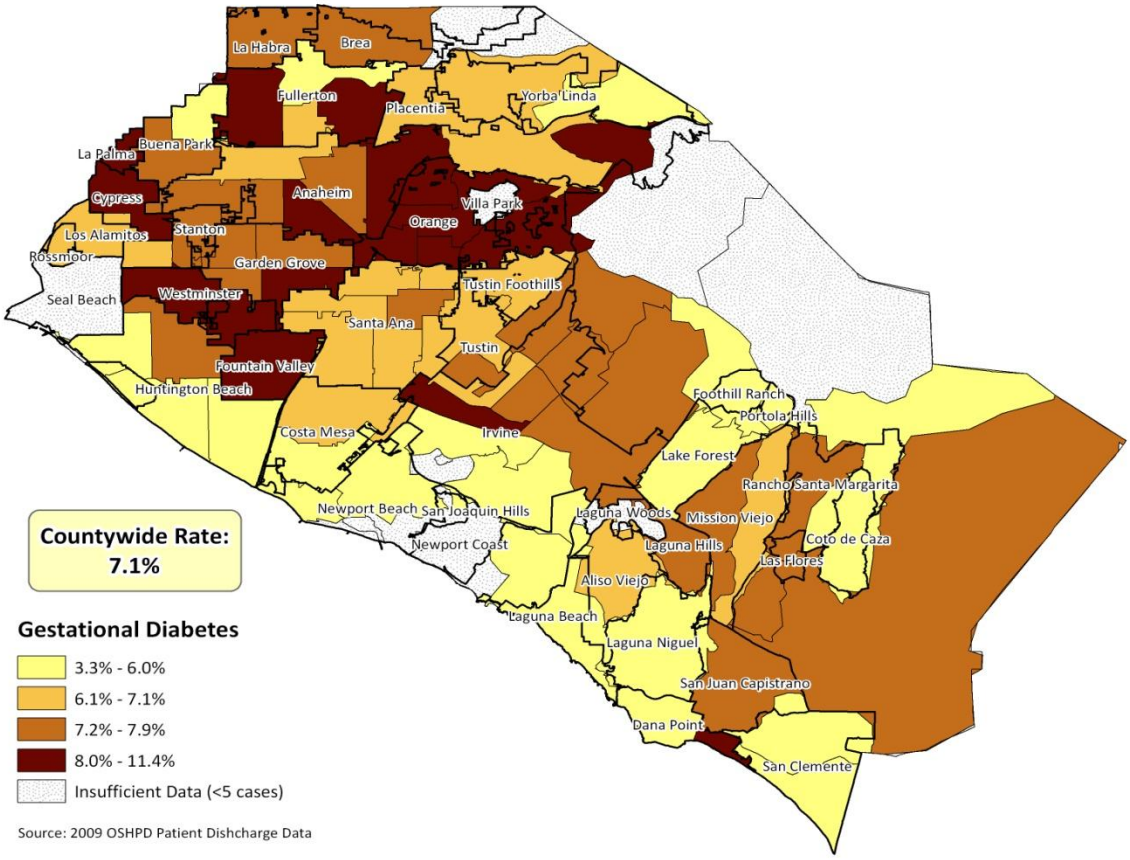
The change in the rate of GDM by age group from 2000 to 2009 is shown in **Table 3**. The 41+ age group had the greatest interval increase in GDM (8.4% to 15.9%, OR=2.05). Mothers in the 20-34 age group were also two-times more likely to develop GDM in 2009 than in 2000.

Table 3: Incidence of GDM by Age Group (2000 vs. 2009)

	2000		2009			95% CI	
Age Groups	**N**	**%**	**N**	**%**	**OR**	**Lower**	**Upper**
<15 yrs	1	1.5%	0	0.0%	N/A	N/A	N/A
15-19 yrs	36	1.0%	40	1.4%	1.45	0.92	2.29
20-34 yrs	1,118	3.2%	1,787	6.3%	1.99	1.84	2.15
35-40 yrs	482	6.5%	844	11.4%	1.84	1.64	2.07
41+ yrs	80	8.4%	168	15.9%	2.05	1.55	2.72
Total	1,717	3.7%	2,839	7.1%	2.00	1.88	2.13

The incidence of GDM was mapped below for the year 2009 in **Figure 4** by the percentage of cases within each ZIP code (i.e., #GDM births /#births per ZIP code). The highest incidence rates of GDM (8.0-11.4%) were found in western and northern regions of the county, specifically ZIP codes in Westminster, Fountain Valley, La Palma, Anaheim, Fullerton, and Orange. ZIP codes along the coast and in southern parts of the county tended to have incidence rates of GDM below the countywide rate of 7.1%.

Figure 4: Incidence of GDM by ZIP Code of Residence (2009)



An analysis of the ten-year trends in GDM incidence by the mother's race/ethnicity showed an increase across all groups (**Figure 5**). With the exception of blacks who remained relatively level at 4.8%, all other race/ethnic groups increased by about two times. Asian/Pacific Islander mothers, in particular, showed the highest overall incidence of GDM in 2009 (10.6%) as well as the greatest increase from 2000 (OR=2.19); see also **Table 4**).

Whites, who were twice as likely to develop GDM in 2009 compared to 2000, increased to 5.4% (OR=2.04; **Table 4**). The incidence of GDM in Hispanic mothers increased from 4.2% in 2000 to 7.3% in 2009 (OR=1.81)

Figure 5: Incidence of GDM by Race/Ethnicity (2000-2009)

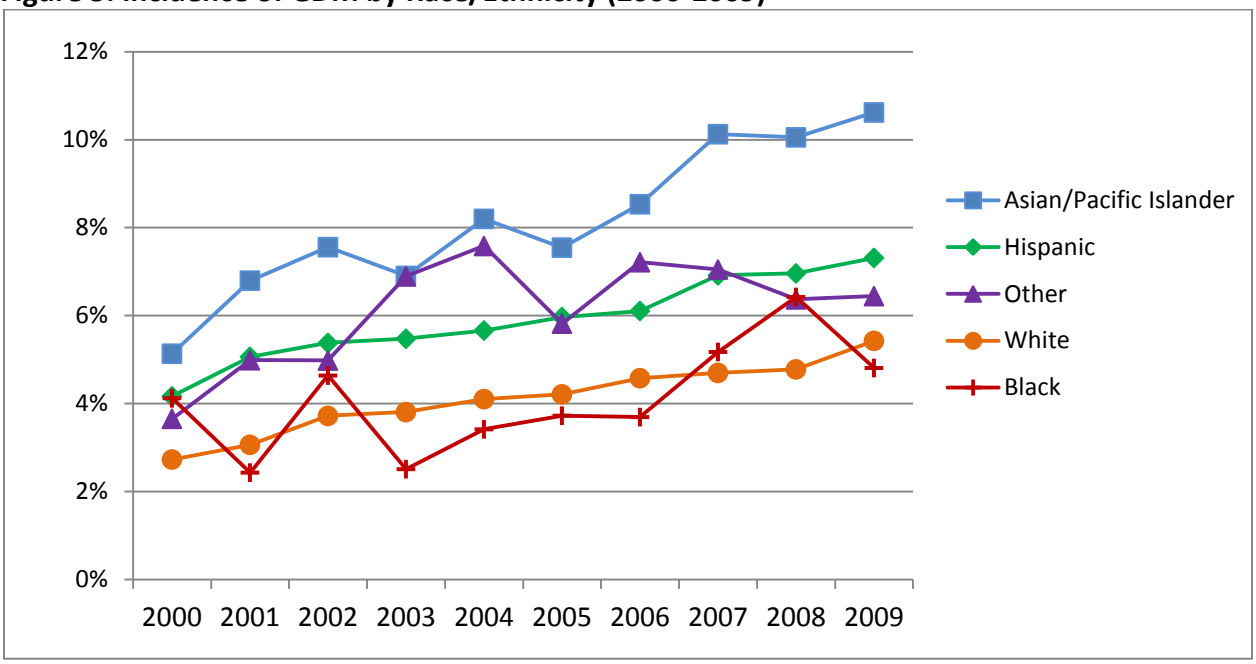
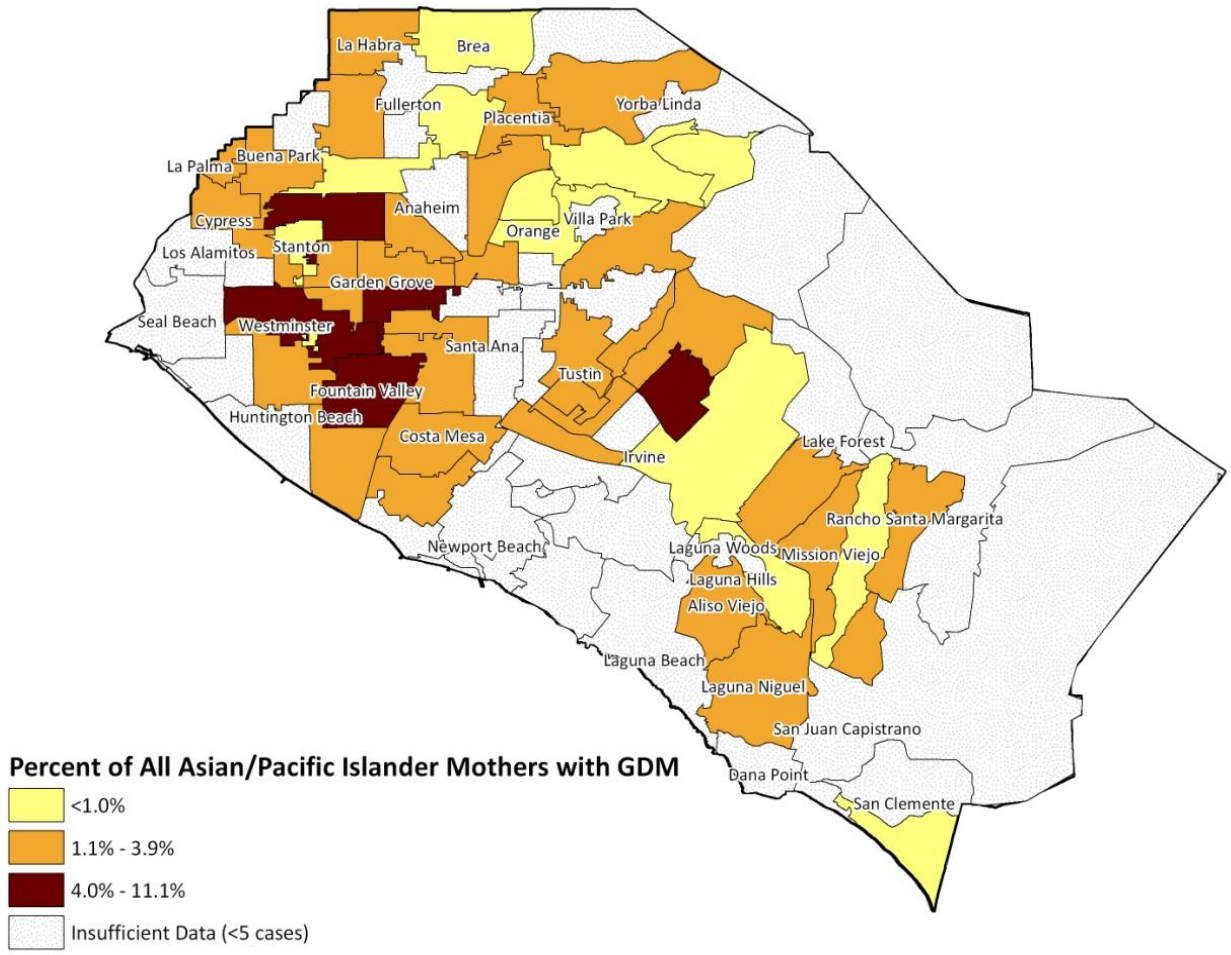


Table 4: Incidence of GDM by Race/Ethnicity (2000 vs. 2009)

	2000		2009			95% CI	
Race/Ethnicity	**N**	**%**	**N**	**%**	**OR**	**Lower**	**Upper**
Hispanic	858	4.2%	1,346	7.3%	1.81	1.66	1.98
White	491	2.7%	721	5.4%	2.04	1.82	2.30
Black	20	4.1%	23	4.8%	1.18	0.64	2.17
Asian/Pacific Islander	268	5.1%	646	10.6%	2.19	1.89	2.54
Other	80	3.7%	103	6.4%	1.82	1.35	2.45
Total	1,717	3.7%	2,839	7.1%	2.00	1.88	2.13

Given that one in ten mothers of Asian/Pacific Islander decent experienced GDM in 2009, we analyzed the geographic distribution of the disease by the mother's ZIP code of residence. The highest percentage of Asian/Pacific Islander mothers with GDM resided in parts of Fountain Valley, Westminster, Garden Grove, Anaheim, and Irvine (**Figure 6**).

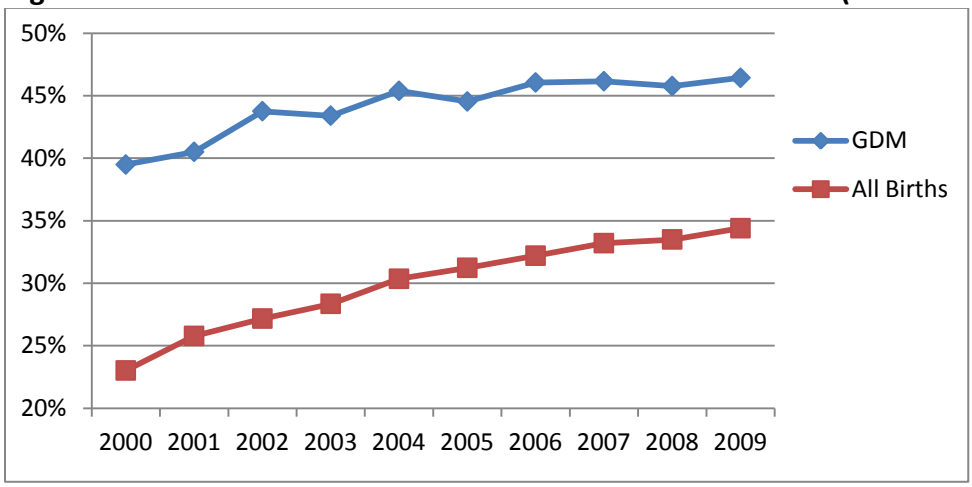
Figure 6: Percent of all Asian/Pacific Islander Mothers with GDM by ZIP Code of Residence (2009)



Source: 2009 OSHPD Patient Dishcharge Data

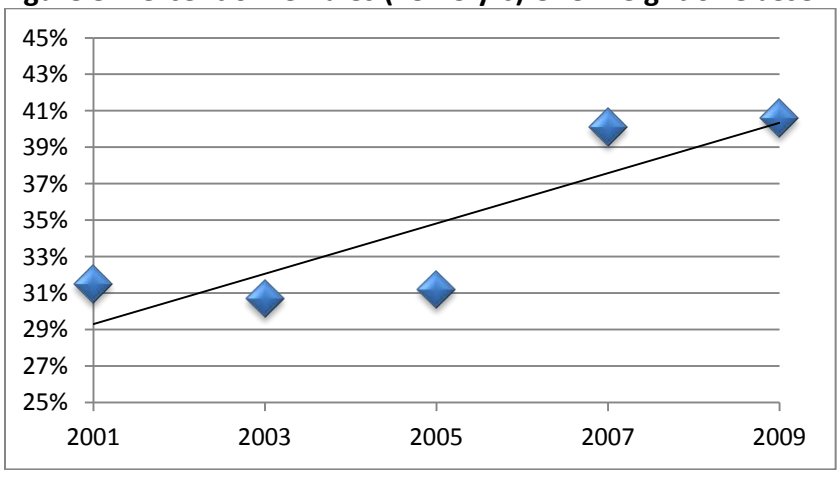
As shown in **Figure 7**, throughout the ten-year period mothers with GDM were much more likely to have a c-section compared to the entire population giving birth in a given year. The percentage of births by c-section among patients with GDM increased from 39.5% in 2000 to almost half (46.4%) in 2009.

Figure 7: Percent of C-Section Deliveries in Mothers with GDM (2000-2009)



While the underlying reasons for this increase in the incidence of GDM are not entirely clear, researchers have reported that the risk for developing GDM increased substantially as the mother's body mass index (BMI) increased (Chu et al, 2007). The hospitalization data do not include information on the mothers' body weight or body mass index. However, the California Health Interview Survey (CHIS) from UCLA researchers provides prevalence estimates of overweight/obesity for Orange County women. As shown in **Figure 8**, the percentage of overweight/obese females (ages 18-45 years) increased 9.1%, from 31.5% in 2001 to 40.6% in 2009. This trend was found to be highly correlated with the interval increase in cases of GDM ($r^2 = 0.93$, $p=0.02$) and indicates that an increasing trend in obesity in Orange County may be related to the increasing trend in GDM.

Figure 8: Percent of Females (18-45 yrs) Overweight or Obese



Conclusions

The incidence of GDM has increased in Orange County more than any other perinatal complication in the last decade, doubling to 7.1% in 2009 (or 1 in 14 women). The risk for GDM increased with maternal age. Though the 41+ age group showed the highest incidence of GDM (16%) in 2009, this group accounted for only 6% of the total GDM cases. The 20-34 age group, on the other hand, had a GDM incidence of 6.3%, but accounted for 63% of the total GDM cases in 2009. The GDM incidence in the 20-34 age group has also nearly doubled over the last decade. Prenatal care providers should be aware that, though pregnant women ages 20-34 are not at the greatest risk for GDM, their incidence of GDM is increasing at the highest rate relative to other age groups, and they provide the greatest burden of the disease in Orange County.

Among various race/ethnic groups, Asian/Pacific Islanders had the highest incidence of GDM (10.6%) in 2009 and experienced the greatest increase in GDM cases over the last ten years. This finding is supported by a recent population-based survey in Oregon that showed that Asian/Pacific Islander women had the highest prevalence of GDM (14%) regardless of BMI (Hunsberger et al, 2010). This study also showed that Asian women were more likely to develop GDM than Pacific Islanders, and Asian/Pacific Islander women were significantly more likely to develop GDM than non-Hispanic whites (OR=2.26). Other data suggests that Asians are at risk for diabetes mellitus at lower BMI levels (> 23) than other populations (WHO, Lancet 2004; Chan, 2009), and thus Asian women with a BMI below the overweight range may not be recognized as being at risk for diabetes mellitus. In our study, the highest number/percentage of GDM cases among Asian/Pacific Islander mothers were for women residing in parts of Fountain Valley, Westminster, Garden Grove, Anaheim, and Irvine.

Whites and Asian/Pacific Islanders were twice as likely to develop GDM in 2009 as they were in 2000. Hispanics in Orange County had a GDM incidence of 7.3% in 2009. Hispanic mothers, who accounted for half of all births in 2009, accounted for 47% of the total GDM cases, which is about the same as the total number of GDM cases contributed by whites and Asian/Pacific Islanders combined (25% and 23%, respectively). Prenatal care providers should be aware that 1 in 10 mothers of Asian/Pacific Islander descent will develop GDM, and that Hispanics contribute to almost half of all cases.

Mothers in Orange County with GDM were more likely to have a c-section compared to mothers with no complications. Previous research has shown that GDM can lead to macrosomia or big baby syndrome (birth weight >4000 grams or 8 lb 13 oz; Langer et al, 2005). Macrosomia can lead to trauma during birth and a greater chance of having a cesarean delivery. Indeed, we found that the proportion of mothers with GDM who received a c-section has increased from 40% in 2000 to 46% in 2009. A GDM diagnosis is also associated with increased risk of developing the disease in future pregnancies and type 2 diabetes later in life (MacNeill et al, 2001).

Though case-specific data regarding weight and BMI was not available for this study, a statistically significant correlation between an increased prevalence of overweight/obese females of childbearing age and an increased incidence of GDM was noted. While we cannot conclude there is a causal relationship in the present study, obesity is a known risk factor for GDM (Chu et al, 2007) as well as cardiovascular conditions such as hypertension (WHO, 1998; Kim et al., 2007). Moreover, a recent report by the California Pregnancy-Associated Mortality Review (2011) found there were high rates of obesity among the pregnancy-related deaths reported in California from 2002 to 2003. Given that obesity and GDM are increasing in parallel, and since obesity is a risk factor for GDM, increased efforts to identify and manage such risk factors are needed to reduce the burden of GDM and other maternal complications in Orange County.

In conclusion, to address this important problem, prenatal providers, practitioners and agencies who work with pregnant women or women planning pregnancy should be aware of the significant increase in incidence of GDM on and the disproportionate impact of GDM on older age groups, Asian/Pacific Islanders and Hispanics, and should enhance educational and screening efforts in these populations. Increased attention to BMI during the pre-conceptual period, with early implementation of lifestyle modification to reduce overweight and obesity, may help to reverse the trends seen in incidence of GDM over the last 10 years.

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