HEALTH CARE AGENCY

Mothers with a Higher Pre-Pregnancy Body Mass Index are at Increased Risk for Gestational Diabetes Mellitus

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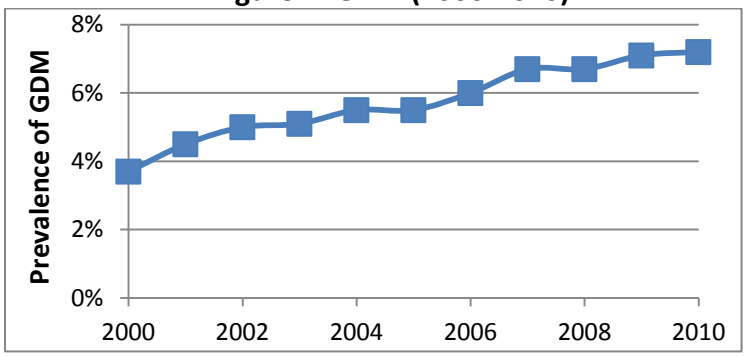
Introduction

A recent study by the Health Care Agency on the complications of pregnancy and childbirth found that gestational diabetes mellitus (GDM) was the most common, serious prenatal condition, affecting nearly 3,000 Orange County (7.1%) women in 2009 (Ramos et al., 2011). Nationally, GDM affects between 2% to 10% of pregnancies each year (CDC, 2012). GDM has been shown elsewhere (Brody et al, 2003; Langer et al, 2005) to increase a woman's risk of developing multiple complications, including hypertension and preeclampsia, which can affect both maternal and fetal health. Importantly, maternal GDM was associated with more than twice the likelihood of having a cesarean delivery in Orange County (Ramos et al., 2011).

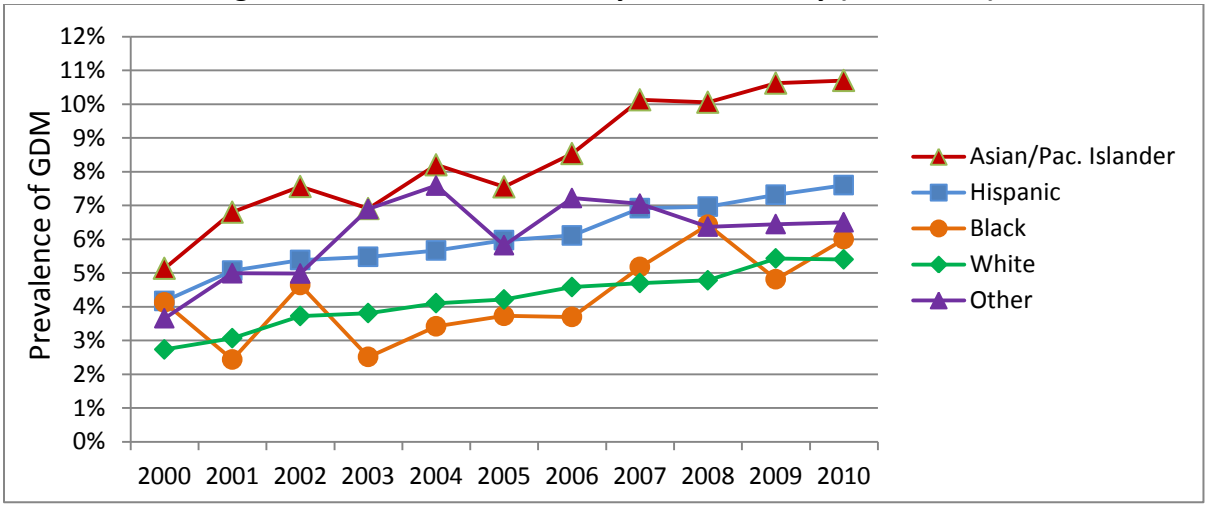
The following were some of the key findings for the GDM report, which have been extended to include more recent data through 2010. Some 475,200 birth records have been studied over the eleven-year period of 2000 to 2010. As shown in **Figure 1**, the prevalence of GDM systematically increased from 3.8% in 2000 to 7.2% in 2010.

Figure 1: GDM (2000-2010)



The prevalence of GDM increased systematically with maternal age, from only 1.5% of mothers in the youngest age group (<18 years) increasing up to 17.6% of mothers 45 years of age and older (not shown). An analysis of the change in GDM prevalence by the mother's race/ethnicity showed an increase across all groups (**Figure 2**). With the exception of blacks who had the smallest increase (OR=1.49), all other race/ethnic groups increased by about twofold.

Figure 2: Prevalence of GDM by Race/Ethnicity (2000-2010)



Asian/Pacific Islander mothers, in particular, showed the highest overall prevalence of GDM in 2010 (10.7%) as well as the greatest increase from 2000 (OR=2.21); see also **Table 1**. Non-Hispanic whites, who were twice as likely to develop GDM in 2010 compared to 2000, increased to 5.4% (OR=2.02). The prevalence of GDM in Hispanic mothers increased from 4.2% in 2000 to 7.6% in 2010 (OR=1.89)

Table 1: Prevalence of GDM by Race/Ethnicity (2000 vs. 2010)

	2000		2010			95% CI	
Race/Ethnicity	**N**	**%**	**N**	**%**	**OR**	**Lower**	**Upper**
Hispanic	858	4.2%	1,267	7.6%	1.89	1.73	2.06
White	491	2.7%	697	5.4%	2.02	1.80	2.27
Black	20	4.1%	29	6.0%	1.49	0.83	2.67
Asian/Pacific Islander	268	5.1%	600	10.7%	2.21	1.90	2.57
Other	80	3.7%	109	6.5%	1.85	1.37	2.48
Total	1,717	3.7%	2,702	7.2%	2.03	1.90	2.16

Obesity is a known risk factor for GDM (Chu et al, 2007) as well as for cardiovascular conditions such as hypertension (WHO, 1998; Kim et al., 2007). Since obesity and GDM are increasing in parallel (Ramos et al., 2011), and given that obesity is a risk factor for GDM, we examined the relationship between a birth mother's body mass index (BMI) and the prevalence of GDM using newly available data from county birth files.

While the underlying reasons for this increase in the prevalence 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).

Methods

The data utilized in this report comes from the California Statistical Master Birth File for Orange County. The hospitalization data described earlier do not include information on the mothers' body weight or height. As of 2010, the county master birth file included each mother's body weight and height allowing for the determination of BMI, pre-pregnancy and at delivery. Unlike the hospitalization data, the birth data also allowed us to separate Asians from Pacific Islanders as they are coded separately in this data set. This information allowed us to examine the relationship between BMI and GDM, based on a mother's age, race/ethnicity, and ZIP code of residence.

Body Mass Index from 2010 OC Master Birth File

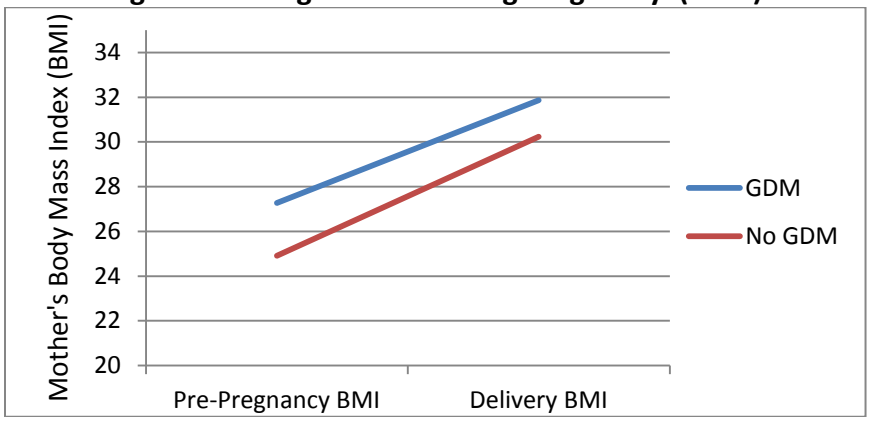
As might be expected, we found that BMI increased significantly during pregnancy (pre-pregnancy BMI vs. delivery BMI) for both groups – women who developed GDM during pregnancy and for those who did not (**Table 2**). As shown in **Figure 3**, during the course of pregnancy, BMI increased equally for both groups (+5.3 for women with no GDM and +4.6 for women diagnosed with GDM; no significant difference in change). However, women who developed GDM had a significantly higher pre-pregnancy BMI compared to women who did not develop the condition (27.3 vs. 24.9).

Thus, these results show that having a higher starting BMI may be a risk factor for GDM compared to how much a women's BMI increases during pregnancy (i.e., how much weight was gained). Indeed, women with a high BMI (≥ 25) were almost two (OR=1.9) times more likely to develop GDM compared to women with a BMI less than 25.

Table 2: Differences in Body Mass Index

Condition	Pre-Pregnancy BMI	Delivery BMI	Change
GDM	27.3	31.9	+4.6
No GDM	24.9	30.2	+5.3

Figure 3: Change in BMI During Pregnancy (2010)



Average BMIs, derived pre-pregnancy are summarized in **Table 3** below based on the mother's race/ethnicity and whether or not she developed GDM. Across all groups, women who developed GDM had higher pre-pregnancy BMIs relative to their respective race/ethnic group who did not develop GDM. For example, non-Hispanic white women who developed GDM had an average pre-pregnancy BMI of 27.6 compared to 24.2 for non-Hispanic white women who did not. Similarly, Hispanic women who developed GDM had an average pre-pregnancy BMI of 30.0 vs. 26.3 for those Latinas who did not. Asian women who developed GDM had an average pre-pregnancy BMI of 23.3 compared to 21.9 for those who did not.

Table 3: Average Pre-Pregnancy BMI for Non-GDM vs. GDM Cases

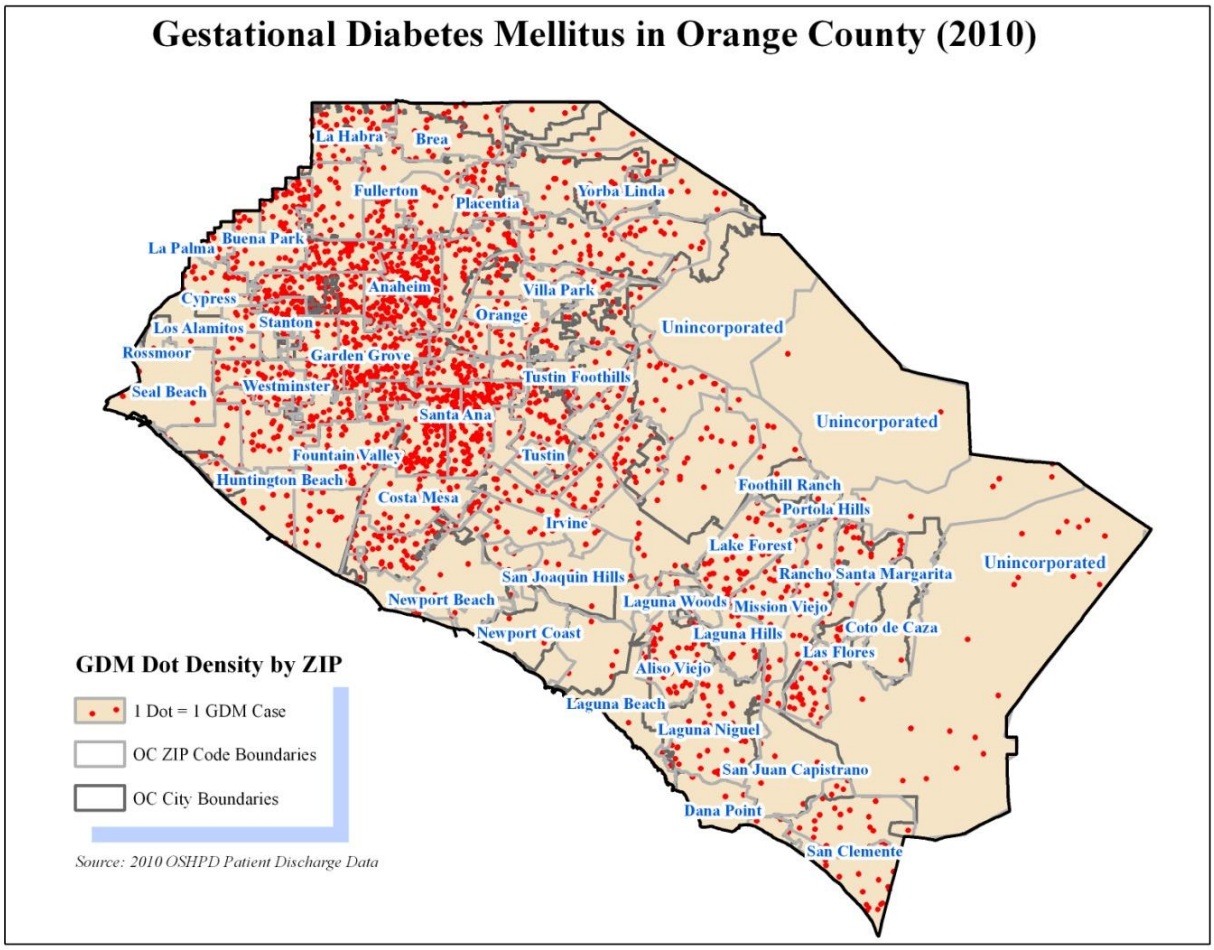
Group	(n=)	No GDM	*95% CI*		GDM	*95% CI*		*P-value*
Asian	6,204	**21.9**	*20.1*	*23.7*	**23.3**	*21.0*	*25.5*	<0.001
White	11,173	**24.2**	*21.6*	*26.8*	**27.6**	*24.1*	*31.1*	<0.001
Black	476	**26.1**	*23.2*	*29.1*	**33.1**	*28.3*	*37.9*	ns
Hispanic	17,670	**26.3**	*23.5*	*29.1*	**30.0**	*26.8*	*33.2*	<0.001
Pacific Islander	154	**29.4**	*25.7*	*33.1*	**30.0**	*26.8*	*33.3*	ns
Other/Unknown	506	**24.3**	*21.6*	*26.9*	**27.1**	*23.9*	*30.3*	ns
ALL	36,183	**24.9**	*22.2*	*27.6*	**27.3**	*23.9*	*30.6*	<0.001

Importantly, Asian mothers developed GDM at much lower average pre-pregnancy BMIs (23.3) compared to women of other race/ethnicities (typically 27 or higher). Moreover, Asians had a relatively small difference in average BMI between women who developed GDM (23.3) and those who did not (21.9). The difference in body weight for Asian women corresponds to only about 4.5 additional pounds. By comparison, Hispanic and white women with GDM averaged 18 to 20 pounds more pre-pregnancy weight than those who did not develop GDM. A BMI over 25 is generally considered as a sign of being overweight, while a BMI of 30 or more indicates obesity for the general population. These standards may not be entirely applicable to Asian women with respect to their risk of developing GDM.

Geographic Distribution of GDM Cases

The ZIP code point density of GDM cases in 2010 was mapped below in **Figure 4** to demonstrate the relative burden and distribution of disease in the county. Higher density clustering was present in the central region of the county – almost half (48%) of all GDM cases in 2010 were found within ZIP codes in Anaheim, Santa Ana, Garden Grove, and Irvine. The prevalence of GDM by city is summarized in the table in the Appendix with the highest prevalence rates in Placentia (11.0%), Stanton (10.45%), and Fountain Valley (10.02%), all above 10%.

Figure 4



Given that one in ten mothers of Asian/Pacific Islander descent developed GDM in 2010, 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, while GDM cases to Hispanic women were primarily concentrated with over half (51%) of all cases in Santa Ana and Anaheim. Conversely, GDM cases among non-Hispanic white women were distributed evenly throughout the county.

Conclusions

The prevalence of GDM has increased in Orange County more than any other perinatal complication in the last decade, doubling to 7.2% in 2010 (or 1 in 14 women). With case-specific data regarding maternal weight and BMI now available in the county birth file, we found that elevation in a mother's pre-pregnancy BMI was a risk factor for developing GDM. Women with a BMI of 25 or higher (generally considered overweight) were two times more likely to develop GDM compared to women with a pre-pregnancy BMI less than 25. 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 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). 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.

Among various race/ethnic groups, Asian/Pacific Islanders had the highest prevalence of GDM (10.7%) in 2010 and experienced the greatest increase in GDM cases over the past decade. 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). Thus Asian women with a BMI below the overweight range may not be recognized as being at risk for diabetes mellitus. Our results are consistent with these findings. Asian women in Orange County who developed GDM had an average pre-pregnancy BMI of 23, much lower than the countywide average of 27.3 and other groups such as Hispanics and Pacific Islanders who averaged 30 pre-pregnancy.

While Asian/Pacific Islander women have the highest prevalence (10.7%, n=600), Hispanic women had the highest number of GDM diagnoses (n=1,267; 7.6%) in 2010. White women had the second highest number of cases (n=697) and a prevalence rate of 5.4%. Hispanic mothers, who accounted for almost half of all births in 2010, 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 (26% and 22%, 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.

These results might also influence enhancements to the new interconception and preconception care guidelines being developed by the American Congress of Obstetricians and Gynecologists (ACOG) regarding maternal overweight and obesity to take into account differences in BMI risk by race/ethnicity, especially for Asian mothers.

In conclusion, to address this important problem, prenatal providers, women's health practitioners and agencies who work with pregnant women or women planning to become pregnant should be aware of the significant increase in GDM prevalence and the disproportionate impact of GDM among older age groups, Asians and Hispanics, and should enhance educational and screening efforts in these populations. Increased attention to BMI during both the preconception and interconception periods, with early implementation of lifestyle modification to reduce overweight and obesity, may help to reverse the trends seen in the prevalence of GDM and related pregnancy complications in Orange County over the past decade.

Appendix 1: Prevalence of GDM by City

2010 GDM Prevalence by City	# GDM Cases	Total # Births	GDM Prevalence by City
PLACENTIA	68	618	11.00%
STANTON	49	469	10.45%
FOUNTAIN VALLEY	44	439	10.02%
BREA	42	452	9.29%
ANAHEIM	489	5,467	8.94%
GARDEN GROVE	198	2,289	8.65%
WESTMINSTER	82	958	8.56%
LA PALMA	11	136	8.09%
LAKE FOREST	63	795	7.92%
BUENA PARK	79	1,027	7.69%
YORBA LINDA	40	535	7.48%
ORANGE	98	1,314	7.46%
VILLA PARK	42	575	7.30%
ALISO VIEJO	51	699	7.30%
TUSTIN	81	1,138	7.12%
SANTA ANA	438	6,202	7.06%
IRVINE	169	2,420	6.98%
LAGUNA NIGUEL	39	565	6.90%
MISSION VIEJO	56	836	6.70%
LAGUNA BEACH	10	150	6.67%
UNINCORPORATED	51	780	6.54%
RANCHO SANTA MARGARITA	36	555	6.49%
CYPRESS	28	432	6.48%
SAN JUAN CAPISTRANO	28	440	6.36%
LAGUNA HILLS	18	284	6.34%
COSTA MESA	93	1,549	6.00%
LA HABRA	52	874	5.95%
FULLERTON	80	1,483	5.39%
SAN CLEMENTE	45	847	5.31%
HUNTINGTON BEACH	84	1,880	4.47%
NEWPORT BEACH	22	619	3.55%
SEAL BEACH	4	128	3.13%
DANA POINT	9	314	2.87%
LOS ALAMITOS	3	171	1.75%
LAGUNA WOODS	0	3	0.00%
ORANGE COUNTY	**2,702**	**37,443**	**7.22%**

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