

ORIGINAL RESEARCH

Increasing Prevalence of Gestational Diabetes and Pregnancy-Related Hypertension in Los Angeles County, California, 1991–2003

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Abstract

Introduction

Gestational diabetes and pregnancy-related hypertension can lead to adverse health effects in mothers and infants. We assessed recent trends in the rates of these conditions in Los Angeles County, California.

Methods

Hospital discharge data were used to identify all women aged 15–54 years who resided in the county, had a singleton delivery from 1991 through 2003, and had gestational diabetes or pregnancy-related hypertension listed as a discharge diagnosis at the time of delivery. The prevalence of each condition was calculated by calendar year, race/ethnicity, and age group. Temporal trends in the rates were assessed by using negative binomial regression models, controlling for race/ethnicity and age. Separate models were run for each racial/ethnic and age group.

Results

The age-adjusted prevalence of gestational diabetes increased more than threefold (from 14.5 cases per 1000

women in 1991 to 47.9 cases per 1000 in 2003). The age-adjusted prevalence of pregnancy-related hypertension also increased (from 40.5 cases per 1000 in 1991 to 54.4 cases per 1000 in 2003). In the multivariable regression analysis, the annual rate increase for gestational diabetes was 8.3% overall and was highest among Hispanics (9.9%). The annual rate increase for pregnancy-related hypertension was 2.8% overall and was highest among blacks (4.8%).

Conclusion

The rates of gestational diabetes and pregnancy-related hypertension are increasing in Los Angeles County. Further research is needed to determine the causes of the observed increases and the growing racial/ethnic disparities in those rates.

Introduction

Gestational diabetes and pregnancy-related hypertension are associated with adverse health effects among both mothers and infants. Gestational diabetes increases the risk for preterm and cesarean delivery and type 2 diabetes in the mother (1-5) and macrosomia, hyperinsulinemia, and future obesity and diabetes in the infant (4,6-9). Pregnancy-related hypertension increases the risk for preterm and cesarean delivery, renal dysfunction, placental abruption, chronic hypertension, and death in the mother (10-12) and respiratory distress syndrome and fetal growth restriction in the infant (10,13,14). Gestational diabetes occurs in approximately 4% of pregnancies and ranges from 1% to 14% among different racial/ethnic groups (15). Asian

and Hispanic mothers have the highest rates, whereas white mothers have the lowest (16-19). The prevalence of pregnancy-related hypertension ranges from 6% to 8% and also varies by race/ethnicity; black mothers have the highest rates and white mothers have the lowest (12,13,19).

Several studies have shown that the prevalence of gestational diabetes has increased (16,17,20), but only one population-based study has described trends in pregnancy-related hypertension (21). No studies have investigated trends in both conditions over time while also considering racial/ethnic and age distributions. We investigated whether the rates of gestational diabetes and pregnancy-related hypertension are on the rise in Los Angeles County, California, which has a large, urban population with substantial racial/ethnic diversity.

Methods

Study sample

For this analysis, we extracted data from the California Inpatient Hospital Discharge Data Files (1991–2003) obtained from the California Office of Statewide Health Planning and Development. These data files include individual-level patient discharge data for all licensed acute-care hospitals in California; each file contains no more than 20 procedure and diagnosis codes.

We included all Los Angeles County residents aged 15–54 years who were discharged from a California hospital after a singleton delivery during 1991–2003 by selecting records that had at least one of the following delivery-related (vaginal or cesarean) codes: *International Classification of Diseases, 9th Revision, Clinical Modification* (ICD-9-CM) (22) diagnosis codes 650–652, inpatient procedure codes 72–74, or Diagnosis-Related Group codes 370–375. We excluded from the analysis women who had a multiple-gestation delivery because they have a higher risk for pregnancy-related hypertension and gestational diabetes than do women with singleton pregnancies. A comparison conducted with birth certificate records indicated that more than 99% of all singleton births to Los Angeles County residents were captured in the hospital discharge data.

We used hospital discharge codes to identify women who had gestational diabetes or pregnancy-related hypertension. For gestational diabetes, we selected all records

containing the ICD-9-CM discharge code 648.8 (abnormal glucose tolerance/gestational diabetes complicating pregnancy, childbirth, or the puerperium). For pregnancy-related hypertension, we selected records containing the ICD-9-CM discharge code 642 (hypertension complicating pregnancy, childbirth, and the puerperium).

Statistical analyses

To determine the prevalence of gestational diabetes and pregnancy-related hypertension in Los Angeles County for 1991–2003, we calculated the age-adjusted prevalence rate (number of women with the condition listed on the discharge record per 1000 women hospitalized for a singleton birth) for each condition, by year. The prevalence of each condition was calculated for the sample as a whole and for each racial/ethnic and age group. Age groups were divided into the following categories: 15–24 years, 25–34 years, and 35–54 years. The age distribution of women who delivered in the United States in 2003 was used as the standard population.

Temporal trends in the rates of gestational diabetes and pregnancy-related hypertension for 1991–2003 were assessed by using negative binomial regression with a log-link function. This analytical technique was used to correct for any overdispersion in the data. First, regression models that included all the women in the sample were calculated for each condition. These models contained the variables of year, age group, and race/ethnicity; the independent variable of interest was year, which described the average annual change in rates across time. Second, separate models were run for each racial/ethnic group to determine whether rates for each condition changed differentially by race/ethnicity, after controlling for age group. Finally, models were run for each age group, controlling for race/ethnicity. The racial/ethnic categories included in the multivariable models were white, black, Hispanic, Asian/Pacific Islander, and other/unknown, although we do not present race/ethnicity-specific results for women in the other/unknown category. All statistical analyses were conducted with the SAS statistical package, version 10.0 (SAS Institute Inc, Cary, North Carolina).

Results

From 1991 through 2003, a total of 2,156,459 Los Angeles County residents were hospitalized for a singleton

delivery. The number of residents with singleton births declined from 1991 to 2003, which reflected a decline in the birth rate rather than a decrease in the number of women of childbearing age. The racial/ethnic distribution of women who gave birth changed over the course of the study period: Hispanics accounted for an increasing percentage and whites accounted for a decreasing percentage of women giving birth (Table 1).

The age distribution of women who gave birth also changed during the study period. Women aged 15–24 accounted for a smaller percentage of women who gave birth in 2003 than in 1991, whereas women aged 35–54 accounted for a larger percentage in 2003 than in 1991 (Table 1). This trend toward increasing maternal age was observed in all racial/ethnic groups.

Gestational diabetes

The age-adjusted prevalence of gestational diabetes for the entire study sample increased steadily from 14.5 cases per 1000 women in 1991 to 47.9 cases per 1000 women in 2003 (Figure 1). The prevalence among Asian/Pacific Islander women was the highest among all racial/ethnic groups throughout the study period, but Hispanic women had the highest overall increase in prevalence during the study period. White women had the lowest prevalence and relative rate increase.

Gestational diabetes prevalence was highest among women aged 35–54. However, the rates for all age groups

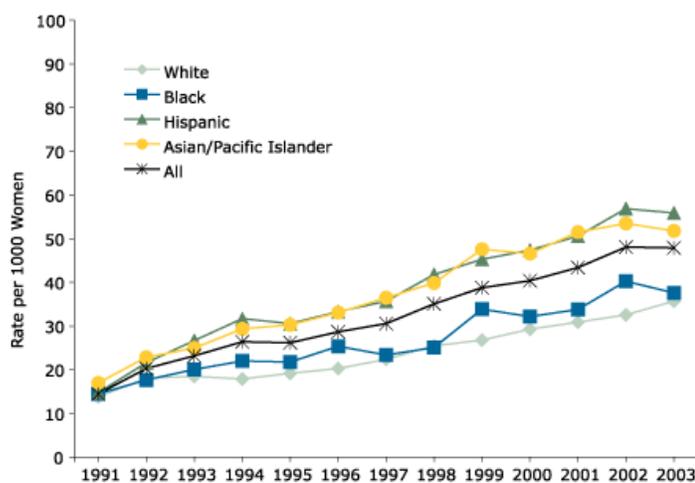


Figure 1. Age-Adjusted Rates of Gestational Diabetes Among All Women and by Race/Ethnicity — Los Angeles County, California, 1991–2003

increased during the study period. The rates per 1000 women increased more than 3.5-fold among those aged 15–24 (from 4.8 in 1991 to 17.5 in 2003), approximately 4-fold among those aged 25–34 (from 15.1 to 55.2), and more than 2.5-fold for those aged 35–54 (from 37.1 to 98.2).

From 1991 through 2003, the annual rate increase for gestational diabetes among all women, controlling for race/ethnicity and age, was 8.3% (Table 2). When the models were run separately by race/ethnicity, controlling for age, Hispanics had the highest annual rate increase, followed by Asian/Pacific Islanders, blacks, and whites.

Women aged 15–24 had the highest increase per year in gestational diabetes, while women aged 35–54 had the lowest increase per year (Table 2). Among the racial/ethnic groups, Asian/Pacific Islander women aged 15–24 had the highest increase, followed by Hispanic women aged 25–34. Among women aged 35–54, Hispanics and blacks had the greatest increases per year.

Pregnancy-related hypertension

The age-adjusted prevalence of pregnancy-related hypertension for the entire sample increased from 40.5 per 1000 women in 1991 to 54.4 per 1000 women in 2003 (Figure 2). Black women had the highest overall prevalence as well as the largest increase; rates for Hispanic women were the second highest during the study period, while Asian/Pacific Islander women had the lowest overall prevalence and rate increase.

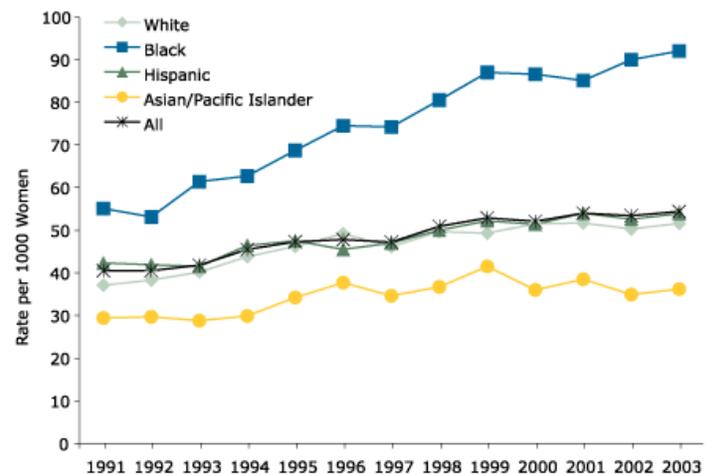


Figure 2. Age-Adjusted Rates of Pregnancy-Related Hypertension Among All Women and by Race/Ethnicity — Los Angeles County, California, 1991–2003

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The prevalence of pregnancy-related hypertension per 1000 women increased the most among women aged 15–24, from 37.6 in 1991 to 57.0 in 2003. The prevalence also increased among women aged 25–34 (from 36.2 to 48.1) and those aged 35–54 (from 63.3 to 70.0).

Rates for pregnancy-related hypertension increased 2.8% per year among all women during the study period (Table 3). Black women had the highest annual increase, followed by white women. Asian/Pacific Islander women had the lowest increase per year.

The prevalence of pregnancy-related hypertension increased most in women aged 15–24 and least in those aged 35–54 (Table 3). Black women had the highest increase within each age group, and black women aged 15–24 had the largest increase of all age and racial/ethnic groups. White, Asian/Pacific Islander, and Hispanic women had similar increases among all age groups, except among those aged 35–54, where whites had a larger increase. The results for Hispanic and Asian/Pacific Islander women aged 35–54 were not statistically significant.

All analyses were repeated excluding women with preexisting diabetes and hypertension, which accounted for 1% ($n = 22,786$) and 0.2% ($n = 5184$) of the total sample, respectively. The results were unchanged (data not shown).

Discussion

Our findings demonstrate that age-adjusted prevalences of gestational diabetes and pregnancy-related hypertension increased among women in Los Angeles County from 1991 through 2003. The increase in rates of gestational diabetes was especially pronounced and was higher than that observed in another large, multiethnic population study (20). However, this latter study was done in a private health-maintenance organization population that may have had greater access to prenatal care than did women in our study, which included women without health insurance as well as those with public and private insurance.

We found increases in gestational diabetes and pregnancy-related hypertension among all racial/ethnic and age groups studied. However, the age-adjusted rates of gestational diabetes were highest among Hispanic and Asian/Pacific Islander mothers and lowest among white

mothers, whereas the age-adjusted rates of pregnancy-related hypertension were highest among black mothers and lowest among Asian/Pacific Islander mothers. These racial/ethnic differences are consistent with findings of previous studies (18,23–25). Older mothers had higher rates of both conditions than did their younger counterparts, which is also consistent with other studies (14,15,25).

The observed increases in gestational diabetes and pregnancy-related hypertension from 1991 through 2003 persisted after controlling for age and race/ethnicity in multivariable analyses. The race/ethnicity-specific rate increase was highest for gestational diabetes among Hispanic mothers and highest for pregnancy-related hypertension among black mothers. The highest age-specific rate increase of gestational diabetes was observed among the youngest age group (15–24 years) of Asian/Pacific Islander mothers, and similarly, the highest rate increase of pregnancy-related hypertension was observed among the youngest age group of black mothers.

Our study had several strengths. First, our data captured nearly all births in Los Angeles County, a large and highly diverse population, during a 13-year period. Second, this study is, to our knowledge, the first to report population-based trends in both gestational diabetes and pregnancy-related hypertension. Third, we controlled for race/ethnicity and age in the analysis and analyzed trends separately for each racial/ethnic and age group. Because race/ethnicity and age are strong risk factors for both conditions, understanding how the rates change independently of these factors is important given the change in racial/ethnic demographics in Los Angeles and the increasing proportion of births among older women.

Other studies have reported increases in the prevalence of gestational diabetes, including racial/ethnic disparities (16,17,20,26) and a greater relative increase in prevalence among younger women (17). However, only one of these studies captured information on all mothers who gave birth in the target population, and this study did not control for race/ethnicity or age (17). One previous study investigated trends in hypertensive diseases in pregnancy and found, in contrast to our findings, a decrease in these conditions (21). However, that study relied solely on birth certificate data, which may be less sensitive than hospital discharge data or medical record review in identifying cases (27).

Our study had several limitations. First, the diagnoses were based on hospital discharge codes and did not include medical chart review. Though hospital discharge records have been reported to accurately determine rates of gestational diabetes (28), we cannot rule out the possibility that the observed increases may have been due to increased coding of gestational diabetes and pregnancy-related hypertension as discharge diagnoses because of change in hospital policies or coding errors. A second limitation is that we could not directly assess the degree to which increased screening or changes in diagnostic criteria might have influenced our findings. However, diagnostic criteria and screening guidelines did not change during our study (29-31), so this limitation is unlikely to substantially bias our findings. A third limitation is that we did not have data on other factors that may have contributed to an increase in gestational diabetes and pregnancy-related hypertension, in particular data on maternal weight. During the past decade, the prevalence of obesity has increased among women of childbearing age in the United States and in Los Angeles County (32,33, M. Shih, written communication, April 2006), and obesity increases the risk of gestational diabetes and pregnancy-related hypertension by as much as 5-fold (15,17,23,33). Our results are consistent with other research that has found a parallel increase in gestational diabetes and obesity prevalence among women of childbearing age in a large, urban setting (17). Further research is needed to determine the degree to which the obesity epidemic might be contributing to an increase in rates of gestational diabetes and pregnancy-related hypertension. Our findings highlight the need for enhanced surveillance of gestational diabetes, pregnancy-related hypertension, and maternal weight. This surveillance could be accomplished through medical record review at sentinel health care sites or collection of data on birth certificates.

Our findings also underscore the need to further investigate the racial/ethnic disparities in the prevalence rates and rate increases of gestational diabetes and pregnancy-related hypertension. Our results are consistent with findings that minority women are at higher risk of gestational diabetes (16-19) and pregnancy-related hypertension (12,13,19). The causes of the disproportion are unclear, although biological, cultural, and socioeconomic factors may all play a role. One study found that the biological response to lipid and carbohydrate metabolism in Asian-born women puts them at higher risk of gestational diabetes compared with

white women (18). Another study found that maternal and paternal ethnicity affected the risk of preeclampsia. Women whose mothers were black or whose parents were of different races or ethnicities were at increased risk of preeclampsia, whereas those whose fathers were Asian had the lowest risk, which suggests a possible genetic or cultural influence or combination of the two (25). Socioeconomic and cultural factors may also predispose nonwhite or Hispanic women to unhealthy diets and obesity (17) and reduce access to prenatal care (34). However, other research found that even after controlling for early access to prenatal care, minority women were still more likely to have poor perinatal outcomes, including gestational diabetes and preeclampsia (35), which suggests that health care access and healthy lifestyle are crucial even before conception (36).

Health care systems should ensure that women have timely access to preconception and prenatal care that effectively addresses risks for and management of gestational diabetes and pregnancy-related hypertension. Early identification and clinical management of women at risk for these conditions is critical. Health care providers should counsel women at risk on prevention measures such as nutrition, weight and stress management, and early and continual monitoring of gestational diabetes and pregnancy-related hypertension throughout the pregnancy. Community education efforts for women of childbearing age are also needed to reinforce the importance of healthy diets, regular physical activity, and maintaining a healthy weight before and during pregnancy.

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Tables

Table 1. Demographic Characteristics of Los Angeles County, California Residents Hospitalized for a Singleton Birth in 1991 and 2003

Characteristic	1991 (N = 198,162), n (%) ^a	2003 (N = 147,950), n (%) ^a
Race/ethnicity		
White	50,398 (25.4)	31,579 (21.3)
Hispanic	109,715 (55.4)	88,035 (59.5)
Black	19,675 (9.9)	11,156 (7.5)
Asian/Pacific Islander	16,121 (8.1)	13,162 (8.9)
Other/unknown	2253 (1.1)	4018 (2.7)
Age, y		
15–24	77,275 (39.0)	47,077 (31.8)
25–34	98,517 (49.7)	75,561 (51.1)
35–54	22,370 (11.3)	25,312 (17.1)

^a Percentages may not total 100% because of rounding.

Table 2. Annual Percentage Increase in Gestational Diabetes by Race/Ethnicity and Age, Los Angeles County, California, 1991–2003^a

Race/Ethnicity	Annual % Increase (95% Confidence Interval)			
	Age Group			All Women ^b
	15–24 y	25–34 y	35–54 y	
White	8.3 (7.1–9.5)	8.1 (7.0–9.3)	5.5 (4.8–6.2)	7.1 (6.4–7.9)
Hispanic	10.4 (8.3–12.6)	10.8 (9.0–12.5)	8.5 (6.7–10.0)	9.9 (8.8–11.0)
Black	8.4 (5.7–11.1)	7.7 (6.7–8.8)	8.0 (6.6–9.5)	7.9 (7.1–8.8)
Asian/Pacific Islander	12.1 (9.1–15.2)	10.0 (8.6–11.5)	6.0 (5.0–7.0)	8.7 (7.6–9.8)
All women ^c	9.5 (8.3–10.7)	9.1 (8.3–9.8)	6.8 (6.1–7.5)	8.3 (7.6–9.0)

^a All results significant at the $P < .001$ level.

^b Adjusted for age.

^c Adjusted for race/ethnicity; includes those in the other/unknown racial/ethnic category.

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Table 3. Annual Percentage Increase in Pregnancy-Related Hypertension by Race/Ethnicity and Age, Los Angeles County, California, 1991–2003^a

Race/Ethnicity	Annual % Increase (95% Confidence Interval)			
	Age Group			All Women ^b
	15–24 y	25–34 y	35–54 y	
White	3.8 (2.7–4.8)	2.5 (1.9–3.1)	1.5 (0.7–2.4)	2.6 (2.0–3.1)
Hispanic	3.3 (2.7–3.9)	2.5 (2.1–2.8)	0.1 (0.01–1.4) ^c	2.3 (1.8–2.7)
Black	5.8 (4.7–7.0)	5.3 (4.2–6.3)	2.8 (2.1–3.5)	4.8 (4.1–5.5)
Asian/Pacific Islander	3.9 (2.2–5.6)	2.2 (1.2–3.2)	0.2 (0.01–1.8) ^d	1.8 (0.9–2.7)
All Women ^e	4.1 (3.6–4.7)	3.0 (2.6–3.4)	1.2 (0.7–1.7)	2.8 (2.4–3.3)

^a Except where noted otherwise, all results significant at the $P < .001$ level.

^b Adjusted for age.

^c $P = .60$.

^d $P = .78$.

^e Adjusted for race/ethnicity; includes those in the other/unknown racial/ethnic category.