Gestational Diabetes

Incidence, Maternal Characteristics, and Perinatal Outcome

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SUMMARY

Accurate estimates of the incidence of abnormal glucose tolerance during pregnancy are virtually nonexistent. Screening select populations of women with risk factors for the condition and the nonrandom, nonpopulation-based nature of most studies have given rise to wide variances in reported incidence. We analyzed data from the states of Mississippi and Washington and from the National Natality and Fetal Mortality Surveys conducted in 1980 in an attempt to provide more accurate population-based estimates of the incidence of gestational diabetes mellitus (GDM). In the national surveys GDM was noted (screening and diagnostic criteria were unavailable) as a complication in 0.38% of all sampled pregnancies; overt (type I and type II) diabetes was noted in 0.78%. Mean maternal age for the GDM group was 28.4 yr; 85% were white (81% controls) and 15% non-white (19% controls). Prepregnancy weights were higher in the GDM group by an average of 20 lb. However, mean weight gain was less in this group than in controls (23 versus 29 lb). Perinatal mortality was noted in approximately 2.8% (1.3% in controls) of the offspring in GDM-complicated pregnancies and congenital malformations in 6.4% (7.9% in controls). Methodologic problems were encountered and included lack of screening and diagnostic criteria, underreporting, and underrecording. DIABETES 1985; 34 (Suppl. 2):13–16.

Estimates of the frequency of abnormal glucose tolerance during pregnancy range from <1% to nearly 20%. A partial review of the literature (Table 1) beginning in 1970, however, indicates that the true incidence of gestational diabetes mellitus (GDM) probably lies somewhere between 1% and 5%.[1-13] Reasons for such wide estimates of the incidence of GDM are numerous and include screening selected populations, often with high-risk women and women with previous gestational glucose intolerance. The highest rates are from the studies of Mestman et al.[1] and Macafee and Beischer,[3] which were conducted on selected samples of pregnant women, many with numerous risk factors.

The study by Mestman and associates was done at the Los Angeles County Hospital. Patients screened were classified into three groups: (1) those with a family history of diabetes; (2) those with a previous adverse obstetric history—macrosomia, perinatal mortality, and prematurity or toxemia in two or more pregnancies; and (3) those with no history or risk factors. In the three groups abnormal glucose tolerance was seen in 18%, 24%, and 6%, respectively, with an overall rate of 12.3%. Macafee et al. also screened high-risk women. Abnormal glucose tolerance ranged from 17% to 36% in the groups with various risk factors, 16% in those with none, and 18% overall. The high percent of GDM discovered in women with no risk factors was most likely due to the diagnostic criteria (only one abnormal value required for diagnosis).

Perhaps the primary reason for lack of epidemiologically valid rates is that virtually no population-based studies of GDM have been undertaken. The ability to accurately assess the incidence of a particular condition requires that populations be defined and followed over time with incident cases carefully identified and recorded. Complete ascertainment is quite important especially when attempting to develop rates, e.g., adverse perinatal outcomes. In addition, use of different screening techniques and diagnostic test cutoff levels for the detection of GDM also result in different estimates of the incidence of the condition. Varying the cutoff levels affects the sensitivity (the ability to accurately detect a positive) and the specificity (ability to accurately detect a negative) of a test and that ultimately affects the reported incidence or prevalence of a particular condition.[14]

In this article we describe the prevalence of GDM as es-

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TABLE 1
Prevalence of gestational diabetes: a review of the literature and data from selected CDC states

	No. screened	%AGT*
Mestman et al.[1]	658	12.3
Chen et al.[2]	1269	1.1
Macafee and Beischer[3]	1000	18.0
Guttorm[4]	514	1.8
O'Sullivan[5]	752	2.5
Rhode Island[6]	1919	1.9
Washington State[7]	N/A	0.31
Merkatz et al.[8]	2225	3.1
Hadden[9]	30,300	2.2
Beard et al.[10]	3317	1.5
Mississippi[11]	1031	4.2
National Natality Survey[12]	N/A	0.82
Carpenter and Coustan[13]	381	3.4

*AGT = abnormal glucose tolerance.

TABLE 3
Fetal, neonatal, and perinatal mortality associated with gestational diabetes, Washington state, 1979–80

	N	Mortality rate—DM*	Mortality rate—non-DM	RR†
Fetal deaths	8	20.6	7.5	2.7
Neonatal deaths	5	13.6	7.1	1.9
Perinatal deaths	13	33.4	14.5	2.3

*Per 1000 live births.
†RR = relative risk.

timated in two state surveys and a national survey. In addition, we have attempted to address issues of health services delivery (e.g., prenatal care visits, place of delivery), maternal characteristics, and perinatal outcomes.

MATERIALS AND METHODS

Data were obtained from State Diabetes Control Programs and the National Center for Health Statistics. The state data were compiled under cooperative agreements with the Division of Diabetes Control at the Centers for Disease Control (CDC) in Atlanta. The overall goal of the CDC Diabetes Control Program is to reduce morbidity, mortality, and cost burdens from the preventable complications of diabetes at the community level. The basic approach of CDC, in cooperation with states, is to (1) conduct a series of demonstration projects and special studies to identify strategies for addressing the public health problem of diabetes and (2) establish mechanisms for rapidly translating proven effective control strategies into community practice to improve patient outcomes.

The second source of data was the National Natality and Fetal Mortality Surveys of 1980.[15,16] These surveys were based on a national probability sample of the registered live births and fetal deaths that occurred in the United States in 1980. The natality component includes data from an unselected random sample of births that were registered (99.3%) in the United States in 1980. Twenty-five of each 10,000 birth certificates were selected randomly to form the final sample of 9941.

In the National Natality Survey, the source of information is the birth certificate, and the names and addresses of mothers are used to contact and obtain information on prenatal health practices, prenatal care, previous pregnancies, and demographic and social characteristics of the women and their husbands. Questionnaires are also mailed to hospitals and to the attendants at delivery. These are designed to obtain information on labor and delivery, the health characteristics of mother and infant, and prenatal care visits. This survey is unique in that it represents the largest natality survey to date.

The National Fetal Mortality Survey was based on a probability sample of late fetal deaths (≥28 wk gestation or a delivery weight of ≥1000 g) in the United States during 1980. The final sample size was 6386. As with the National Natality Survey, information from fetal death certificates was supplemented by information obtained from several other sources, including mothers, hospitals, physicians, and other providers of medical care.

Since detailed data on mothers' underlying medical conditions were obtained only through hospitals, analyses were restricted to inhospital deliveries of liveborns and stillborns.

Relative risk was defined as rate of occurrence of X in GDM pregnancies divided by the rate of occurrence of X in non-diabetes mellitus pregnancies.

RESULTS

State data. In Mississippi, approximately 18,000 women per year receive prenatal care in county health department clinics that generally provide services to women of lower socioeconomic status—a high-risk group. This represents approximately 40% of all pregnant women delivering each year in Mississippi. We have data from 21 of the 82 county health departments. Of 1031 women screened, 41 were identified as having GDM, for a prevalence of 4.1%. Screening and diagnostic methods are unknown. In addition, this population has a large number of black women of lower socioeconomic status. We were, however, unable to stratify by these variables due to insufficient data.

One of the largest population-based studies of diabetes in pregnancy was recently done in Washington state. Cases of GDM were identified through a careful review of birth certif-

TABLE 2
Number of diabetic pregnant women and rate per 100 births by type of diabetes, Washington state, 1979–80

Group	N	Rate per 100 births
IDDM	191	0.15
NIDDM	69	0.05
Total overt	260	0.21
Gestational	389	0.31
Total DM	649	0.51

TABLE 4
Frequency and other characteristics of gestational diabetes by hospital service level, Washington state, 1979–80

	Tertiary	Secondary	Primary
Incidence (detection rate, %)	0.47	0.30	0.23
Perinatal mortality rate/1000 total births	20.8	53.6	29.2
Test for hypoglycemia, not recorded (%)	21.4	23.1	34.6

TABLE 5
Gestational and overt diabetes by maternal race and age, National Natality and Fetal Mortality Surveys, 1980

	Diabetes status			% GDM (per 100 births)	% Types I and II (per 100 births)
	Gestational	Types I and II	None		
Race					
White	11,464	21,097	2,887,327	0.39	0.72
Non-white	2040	6915	666,268	0.30	1.02
Age	28.4	27.6	24.9		

icates and hospital medical records in 75 of the 77 hospitals in the state with obstetric services. In Washington state, birth certificates contain information on maternal health and any complications of pregnancy. For a 2-yr period (1979–80), there were 125,356 live births and 949 fetal deaths. Preliminary data on the number of diabetic pregnant women by type of diabetes for the years 1979–80 in Washington state are listed in Table 2. The small numbers highlight the inadequacy of using birth certificates and hospital records to measure accurately the incidence of GDM. Nonetheless, 389 GDM-complicated pregnancies were identified, representing 0.31% of the total population. As with the data from Mississippi, diagnostic criteria are unknown. Detailed information on these 649 diabetes-complicated pregnancies as well as on over 900 nondiabetic control pregnancies was then abstracted from hospital charts. Fetal, neonatal, and perinatal mortality rates and relative risks were calculated (Table 3). Although the numbers are small, they indicate that offspring of women with GDM have relative risks of approximately two for mortality in the fetal, perinatal, and neonatal periods. One must keep in mind that a morbid or mortal event increases the probability of reporting of GDM as a complication of pregnancy on a birth certificate. Consequently, the relative risk is probably lower than shown here. Of the 389 infants of mothers with GDM, 6.0% received assisted ventilation (RR = 2.4); 17.0% were hypoglycemic (RR = 12.5); and 24.8% were large for gestational age (RR = 5.2). Of the 260 infants of mothers with overt diabetes, 19.8% received assisted ventilation (RR = 7.8); 42.0% were hypoglycemic (RR = 31.1); and 36.2% were large for gestational age (RR = 7.6).

Hospitals of birth for infants of mothers with GDM were stratified by complexity into tertiary (major medical centers), secondary, and primary services (Table 4). Incidence (detection rate) increased with increasing hospital complexity. Perinatal mortality was highest in secondary level hospitals. Testing for neonatal hypoglycemia increased with increasing hospital complexity, but was still not recorded in the charts in over 20% of births in tertiary hospitals. Testing for hypoglycemia may be useful as a proxy measure to examine quality of care at the community level.

National data. Using the data from the National Natality and Fetal Mortality Surveys of 1980, we were able to select for inhospital deliveries where GDM was noted as a complication of pregnancy. The incidence of gestational and overt (types I and II) diabetes in the National Natality and Fetal Mortality Surveys sample was 0.376% and 0.780%, respectively. Unreported cases and unrecognized or unidentified cases of GDM may account for this seemingly low incidence. Although we have no information on the number of women actually screened in the community, this figure represents the incidence of women actually diagnosed as having GDM. The incidence of 0.780% reported for overt diabetes in the Surveys is within range of that expected for the incidence of overt diabetes as a complication of pregnancy, and suggests that reporting is complete.[17] Because of likely underdiagnosis, it is difficult to accurately assess GDM-associated morbidity and mortality.

With these considerations in mind we proceeded to look at selected maternal and infant characteristics in the GDM group. Mean maternal ages (Table 5) for pregnancies complicated by gestational and overt diabetes were calculated. As expected, the average age of women with GDM is 3.5 yr higher than for control women; it is very near that of mothers with overt diabetes. Although we were unable to stratify age by type I and type II diabetes because of insufficient sample size, this higher-than-expected age is probably due to pregnancies complicated by type II diabetes.

Stratifying by race (Table 5) indicated that 0.39% of white and 0.30% of black pregnancies were complicated by GDM. Type I and type II diabetes occurred in 0.72% of white pregnancies and 1.02% of non-white pregnancies. These differences are probably due to underreporting and underdiagnosis in the GDM group and non-white, type II diabetic women in the overt group.

We were able to analyze data on maternal weight (Table 6). Mean prepregnancy weights were 16 lb higher for women with overt diabetes and 20 lb higher for women with GDM as compared with women without diabetes. Again, the number of women with type II diabetes in the sample will affect the maternal weights of women with overt diabetes mellitus.

TABLE 6
Mean weight and weight gain among women with gestational and overt diabetes, National Natality and Fetal Mortality Surveys, 1980

Diabetes status	Mean prepregnancy wt (lb)	Mean delivery wt (lb)	Mean wt gain (lb)	Mean wt gain delivery minus first visit (lb)
Gestational	154	177	23	20
Types I and II	150	176	25	20
None	134	163	29	24

TABLE 7
Mean birth weights, gestational age, and number of prenatal visits of offspring and women with gestational and overt diabetes mellitus, National Natality and Fetal Mortality Surveys, 1980

Diabetes status	Mean birth weight (g)	Mean gestational age (wk)	Number of prenatal visits
Gestational	3466	39.2	11.4
Type I and type II	3359	38.6	10.6
None	3336	39.3	10.3

TABLE 8
Perinatal mortality and congenital malformations by diabetes status, National Natality and Fetal Mortality Surveys, 1980

Diabetes status	Perinatal mortality (%)	Congenital malformations (%)
Gestational	2.79	6.41
Types I and II	2.23	12.19
None	1.27	7.93

These differences in maternal weight and weight gain do not seem to be explainable by differences in birth weights or gestational age. Only about a ¼-lb difference (130 g) was found (Table 7) between birth weights of infants of mothers with GDM and control infants. In addition, mean gestational age is <1 day different between the two groups.

The number of prenatal visits (Table 7) was calculated for each group. Women with GDM had more prenatal visits than women without diabetes mellitus. Rather surprisingly, the number of prenatal visits for women with overt diabetes did not differ greatly from that for those without diabetes.

Except for birth weight, we have thus far concentrated mainly on the characteristics of mothers. We were also able to link pregnancies complicated by diabetes to perinatal outcomes, mainly mortality and congenital malformations. In Table 8, perinatal mortality and percent congenital malformations are stratified by the type of diabetes and compared with data of those pregnancies not complicated by diabetes. The relative risk of perinatal mortality (defined as status at discharge) in the GDM group as compared with the control group is 2.2. This means that infants of women with diagnosed GDM are over twice as likely to suffer a mortal event than infants of nondiabetic mothers. For overt diabetes, the relative risk for perinatal mortality is 1.8. The relative risk for perinatal mortality in the GDM group parallels that noted earlier from Washington state.

On the other hand, it appears that GDM may in fact be protective for congenital malformations. The relative risk is <1. As expected, the prevalence of congenital malformations in the overt group is clearly higher than that of either of the other two groups.

DISCUSSION

A number of issues are raised as a result of this review. Many of these cannot be addressed by this survey because of the relatively small sample size. It is apparent that available data cannot estimate adequately the incidence of GDM at the population or community level because of differences in criteria for diagnosis and completeness of ascertainment. The seemingly low incidence figures noted for GDM in this report may be due in part to these factors. Clinical series (similar screening and diagnostic criteria), screening selected high-risk populations, and frequencies of GDM based on these groups are usually not valid. To assess the true incidence of the condition would require a rather large, population-based community study in which all women were screened and diagnosed using similar criteria and then followed throughout pregnancy to assess the frequency and severity of clinical outcomes in offspring. Studies of this kind would then allow us to determine whether or not the higher-than-normal rates of fetal, perinatal, and neonatal mortality as evidenced by the Washington State and National Natality and Fetal Mortality Surveys are actually due to GDM or to other confounders that may be characteristic of this group of women.

Health services delivery issues need to be addressed. Data we have presented indicate that infants of mothers with GDM born in large hospitals are identified more frequently, receive more appropriate testing, and suffer fewer adverse outcomes than do infants born in small hospitals. These data also raise the issue of appropriate prenatal care. As assessed by number of prenatal visits, neither GDM nor overt (types I and II) diabetes resulted in significantly more visits than no diabetes. More careful monitoring of women with diabetes during pregnancy may decrease the frequencies of adverse outcomes noted in this review. Patient and professional education regarding the benefits of strict glucose control in both gestational and overt diabetes needs to be addressed, and the message needs to be delivered.

A well-designed, population-based study of GDM would go a long way to assess accurately these issues and their public health significance and impact.

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