

Gestational diabetes among Saudi women: prevalence, risk factors and pregnancy outcomes

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BACKGROUND AND OBJECTIVES: The prevalence of gestational diabetes (GDM) has increased recently worldwide, mainly due to adoption of the International Association of Diabetes and Pregnancy Study Group (IADPSG) criteria. The objectives of this study were to determine the prevalence of GDM in Saudi women and to assess risk factors and pregnancy outcomes using the IADPSG criteria.

DESIGN AND SETTING: A prospective descriptive study of pregnant Saudi women presenting at the Maternity and Children Hospital, Medina, Saudi Arabia, between October 2011 and June 2014.

METHODS: Fasting plasma glucose, glycated hemoglobin, and random plasma glucose concentrations were obtained for all participants at the first antenatal visit. In women with normal results, screening for GDM was performed at 24 to 28 weeks of gestation, with a 75-g oral glucose tolerance test (OGTT). Women who had GDM were treated with diet, exercise, and insulin as needed. Pregnancy outcomes were recorded after delivery. Multiple logistic regression was used to assess possible risk factors for GDM.

RESULTS: Early screenings showed abnormal glucose in 211 of 954 women (22.1%). In 445 women, the OGTT showed GDM in 183 women (39.4%). GDM cases identified by OGTT and by early screening increased the rate of GDM to 51% (292 women). Older maternal age, higher body mass index, higher blood pressure, past GDM, history of delivering a malformed child, and family history of diabetes were the main risk factors for GDM. GDM increased the risk of neonatal hypoglycemia (OR 9.353), low Apgar score (OR 5.546), and induction of labor (OR 2.33). The newborns of GDM mothers had a higher birth weight: 3043 g vs. 2890 g in the non-GDM group ($P=.004$). Other maternal and neonatal outcomes were not significantly different between the two groups.

CONCLUSION: The prevalence of GDM is high among Saudi women. Timely and effective treatment reduces perinatal morbidity and improves outcomes.

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with the onset or first recognition during pregnancy.^{1,2} Previously, the prevalence of GDM was reported to range from 1 to 14%, depending on the population studied and the diagnostic tests employed.^{3,4} However, the prevalence of GDM has increased since 2010 by 2- to 3-fold, ranging from 8.9 to 53.4%.⁵⁻¹⁵ This increment is mainly due to the adoption of the new criteria proposed by the International Association of Diabetes and

Pregnancy Study Groups (IADPSG) for the screening and diagnosis of GDM. The IADPSG recommends universal screening for GDM and requires a single glucose value above the cut-off value (instead of two) during the OGTT for diagnosis. Lower cut-off values are commended for fasting and 2-hour glucose.¹⁶

GDM has been associated with adverse maternal and neonatal sequelae.^{17,18} The Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study found significant associations between adverse pregnancy out-

comes and higher levels of maternal glucose, with no defined levels beyond which the risk increased.¹⁸ Thus, early diagnosis of GDM is essential to reduce maternal and fetal morbidity and to allow for subsequent attempts to prevent or delay the onset of type 2 diabetes.

There have been no studies examining the prevalence of GDM in Saudi women, using the IADPSG recommendations.¹⁹⁻²⁵ This prospective study was undertaken to determine the prevalence of GDM using the IADPSG criteria and to determine risk factors for and pregnancy outcomes with GDM among Saudi women.

METHODS

Design and study population

Consecutive pregnant women treated in the antenatal service at the Maternity and Children Hospital in Medina, Saudi Arabia, from October 2011 to June 2014, were screened for inclusion. Exclusion criteria included pre-existing diabetes, non-Saudi nationality, unwillingness to deliver at the study hospital, multiple pregnancies, and chronic diseases and drugs that might affect pregnancy outcomes. The study was approved by the ethical committees of King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia, and the Maternity and Children Hospital, Medina, Saudi Arabia. All of the participants provided written informed consent.

Demographic data were obtained from all of the women at the first antenatal visit using a questionnaire that consisted of details on medical and obstetric history, which included: age, parity, previous diagnosis of GDM, gestational hypertension or preeclampsia, family history of diabetes, history of polycystic ovary syndrome, hirsutism, and previous histories of delivering a large baby (birth weight ≥ 4000 g), stillbirth, malformed babies, and unexplained neonatal death. All of the women were examined, and weight, height, body mass index (BMI) (weight in kilograms [kg] divided by height in meters squared) and blood pressure were recorded. Women were examined for the presence of acanthosis nigricans. Urine analyses were performed in all of the women.

Procedures

Universal screenings for GDM were performed in the participants according to IADPSG recommendations. At the first antenatal visit, measurements of fasting plasma glucose (FPG), glycated hemoglobin (HbA1C), and random plasma glucose were obtained from the participants (early screenings). Overt diabetes in pregnancy was diagnosed if one of the following was found; FPG

≥ 7.0 mmol/L (126 mg/dL) or A1C $\geq 6.5\%$ (DCCT/UKPDS standardized) or random plasma glucose ≥ 11.1 mmol/L (200 mg/dL) plus confirmation. If fasting plasma glucose was < 7.0 mmol/L (126 mg/dL) but ≥ 5.1 mmol/L (92 mg/dL), GDM was diagnosed. In women with normal results, a two hour 75-g oral glucose test (OGTT) was performed at 24 to 28 weeks of gestation. However, women with multiple risk factors were screened with the OGTT at the first antenatal visit. GDM was diagnosed if one or more the following values equaled or exceeded its threshold: FPG, 1-h plasma glucose, 2-h plasma glucose: 5.1 mmol/L (92 mg/dL), 10 mmol/L (180 mg/dL), and 8.5 mmol/L (153 mg/dL), respectively. The women who did not have GDM were followed up by obstetricians monthly until the third trimester of pregnancy and then every two weeks during the third trimester of pregnancy. For the GDM group, antenatal care occurred at visits every two weeks during the first and second trimesters (if diagnosed early) and then weekly during the third trimester. A specialist team, consisting of obstetricians, an internal medicine physician, a diabetes educator, and a dietician, followed up the GDM patients. Glucose values were evaluated weekly by self-monitoring of blood glucose. Every woman with GDM was provided with a glucometer. Glycemic targets were based on ADA recommendation: fasting glucose 5.2 mmol/L (≤ 95 mg/dL), 1-h post-meal 7.8 mmol/L (≤ 140 mg/dL) or 2-h post-meal 6.7 mmol/L (≤ 120 mg/dL).²⁶ If the glucose level was not controlled, blood glucose was evaluated twice or three times weekly. If the glucose values were persistently greater than glycemic target on 3 or more occasions over a 1- to 2-week period, insulin was prescribed by a physician. All measurements of serum glucose were performed by the glucose oxidase method. Formal laboratory measurements of HbA1C were performed at study entry and were measured by standardized HPLC.

Pregnancy outcomes

Maternal and neonatal outcomes recorded after delivery included gestational age at delivery, polyhydramnios, premature delivery, premature rupture of membranes, type of delivery, reason for cesarean delivery (if any), induction of labor (if any), lacerations, shoulder dystocia and intensive care admission. Fetal/neonatal outcomes included abortion, stillbirth, neonatal death, birth weight, Apgar score at 5 min, neonatal hypoglycemia, hyperbilirubinemia, congenital malformation, respiratory distress syndrome, fetal injury and neonatal intensive care unit (NICU) admission.

The diagnosis of polyhydramnios was based on

clinical suspicion and confirmation by findings on ultrasonography if the amniotic fluid index exceeded 24 cm, or a single deepest pocket of fluid was at least 8 cm. Preterm deliveries referred to deliveries before 37 weeks of gestation. Stillbirth was defined as delivery of a dead baby at or after 22 weeks of pregnancy, while abortion referred to delivery of a dead baby before 22 weeks. Premature rupture of the membranes was defined as a rupture of the membranes prior to the beginning of the labor and before 37 weeks of pregnancy. Neonatal hypoglycemia was defined as a blood glucose level less than 2.2 mmol/L (40 mg/dL) on 2 or more occasions during the first 24 hours after birth. Apgar scores at 5 min >7 were considered acceptable. Macrosomia was defined as a birth weight of 4000 g or more. Low birth weight was defined as a birth weight less than 2500 g. Hyperbilirubinemia was defined as at least 1 laboratory report of a bilirubin level of 220 µmol/L or greater or neonatal treatment with phototherapy. Respiratory distress syndrome was defined as the need for supplemental oxygen in the nursery at 4 hours after birth. The presence of major congenital malformations was defined as an abnormality that required surgery and/or resulted in permanent injury.

Statistics

Statistical analyses were performed using SPSS software (version 16.0; SPSS Inc., Chicago, IL, USA). Fisher's exact test and chi-square analysis were performed to test for differences in the proportions of categorical variables between the two groups. The *t* test (two-tailed) was used to determine the significance of differences between two continuous variables. Logistic regression analysis was used to assess the relationships between variables and to adjust for potential confounders. The level $P < .05$ was used as the cut-off value for significance.

RESULTS

From October 2011 to June 2014, 1250 pregnant women were screened, of whom only 1124 women met the inclusion criteria. The mean age of the participants was 30.5 (6.1) years old (range 16-49 years), and mean weight and BMI at the first antenatal visit were 70.5 (16.6) kg and 29.3 (6.6) kg/m², respectively. Multiparity was present in 56.8% of the participants and a family history of diabetes in 60.8%.

GDM prevalence

Early screenings for GDM completed in 954 women found abnormal glucose levels in 211 women (22.1%). OGTT completed in 465 women revealed GDM in 183 (39.4%). Of those who completed the OGTT, 103

of the 465 (22.2%) were positive at the early screening. Notably, 20 patients with negative OGTT had high fasting glucose on early screening that was diagnostic of GDM, and two patients with negative OGTT ultimately developed GDM later on based on high blood glucose levels on self-monitoring.

Of the total of 573 women who completed the required screening, early screening and OGTT, 292 women (51%) were diagnosed with hyperglycemia in pregnancy (Figure 1). Overt diabetes constituted 8.9% (26 women), early GDM, i.e., GDM diagnosed at or before 20 weeks of gestation constituted 34.8% (101), and late GDM constituted 56.4% (165). The prevalence of GDM was recalculated based on the previous ADA criteria, before adoption of the IADPSG criteria,⁴ and was found to be 16.2% vs. 51% by the IADPSG criteria. The increase in GDM prevalence when applying the IADPSG criteria was mainly a consequence of a single abnormal glucose value in 89.7% of the cases. The percentages of GDM cases diagnosed by each glucose measurement during OGTT when fasting, 1-h, and 2-h values were considered sequentially, were 48%, 25% and 27%, respectively. Thirty-seven women with GDM (13%) required insulin therapy to control their blood glucose. The mean insulin dose was 21.93 units per day.

Risk factors for GDM

The prevalence of GDM increased with older maternal age, weight, BMI, and blood pressure. In addition, GDM in previous pregnancies, multiparity, previous recurrent abortions, previous preterm deliveries, a history of delivering a malformed child, and a family history of diabetes were more common in the GDM group than in the non-GDM group. The presence of acanthosis nigricans and glycosuria was associated with an increased prevalence of GDM (Table 1). However, in the multiple logistic regression analysis, only age, BMI, prior GDM, a history of delivering a malformed child, diastolic BP elevation and a family history of diabetes were found to affect GDM prevalence significantly (Table 2). As expected, the means of fasting glucose, 1 hour and 2 hour glucose levels post-OGTT and mean HbA1c were significantly higher in the GDM group than in the non-GDM group (Table 1). There were no differences between the two groups in history of delivering a large baby, stillbirth, or neonatal death. Similarly, there were no differences in histories of gestational hypertension, preeclampsia, history of PCO, or hirsutism.

Pregnancy outcomes

Pregnancy outcomes were obtained from the 573 women who completed the required screening. Gestational

diabetes was found to increase the risk of neonatal hypoglycemia (OR 9.353 [95% CI 2.79–31.25, $P=.000$]), a low Apgar score at 5 minutes, (OR 5.546 [95% CI 1.579–19.482, $P=.003$]), induction of labor (OR 2.33 [95% CI 1.102–4.962, $P=.025$]) and CS delivery (OR 1.571 [95% CI 1.062– 2.326, $P=.029$]). In addition, the newborns of the GDM mothers had heavier birth weights: 3043 g vs. 2890 g in the non-GDM group ($P=.004$). The number of infants requiring NICU admission was higher among those born to GDM mothers than among those born to non-GDM mothers; however, the differences did not reach statistical significance. Other maternal and neonatal outcomes were not significantly different between the two groups (Table 3).

DISCUSSION

To our knowledge, this study was the first prospective study examining the prevalence of GDM and its outcomes in Saudi Arabia using the new proposed IADPSG criteria. The main finding was a very high prevalence of GDM among Saudi women. Increases in the GDM prevalence by 2- to 3-fold have been reported worldwide when applying the IADPSG criteria⁵⁻¹⁵ (Table 4) because the IADPSG recommends universal screening, requires only a single abnormal glucose value during OGTT to diagnose GDM and uses lower cut-off values for fasting and 2-hour glucose. The other reasons for the high prevalence of GDM in Saudi women could likely be attributed to the rising incidence of obesity, the high prevalence of type 2 diabetes and the custom of Saudi women to conceive at an older age. In the women who completed the OGTT, the prevalence of GDM when recalculated using the previous ADA criteria⁴ was 16.2% (vs. 51% by the IADPSG criteria). This finding indicated a 3.17-fold increase in the GDM prevalence when applying the IADPSG criteria. The prevalence of GDM in Saudi women was reported previously as 12.5%.^{20,22} Recently, Al-Rubeaan et al²⁵ reported a higher prevalence of GDM among Saudi women of 36.6%, when applying partial IADPSG criteria. The latter study was a community household-based study, and screening for GDM was based on fasting glucose levels only, without performing OGTT, which explains the lower prevalence of GDM in the latter study than in the current study.²⁵

In our study, fasting glucose was diagnostic in approximately half of the GDM cases (48%), and 1-h and 2-h OGTT contributed to the remaining cases of GDM, in 25% and 27%, respectively. Thus, although performing an FPG is a good choice as an initial step to screen for GDM in our population, to decrease the

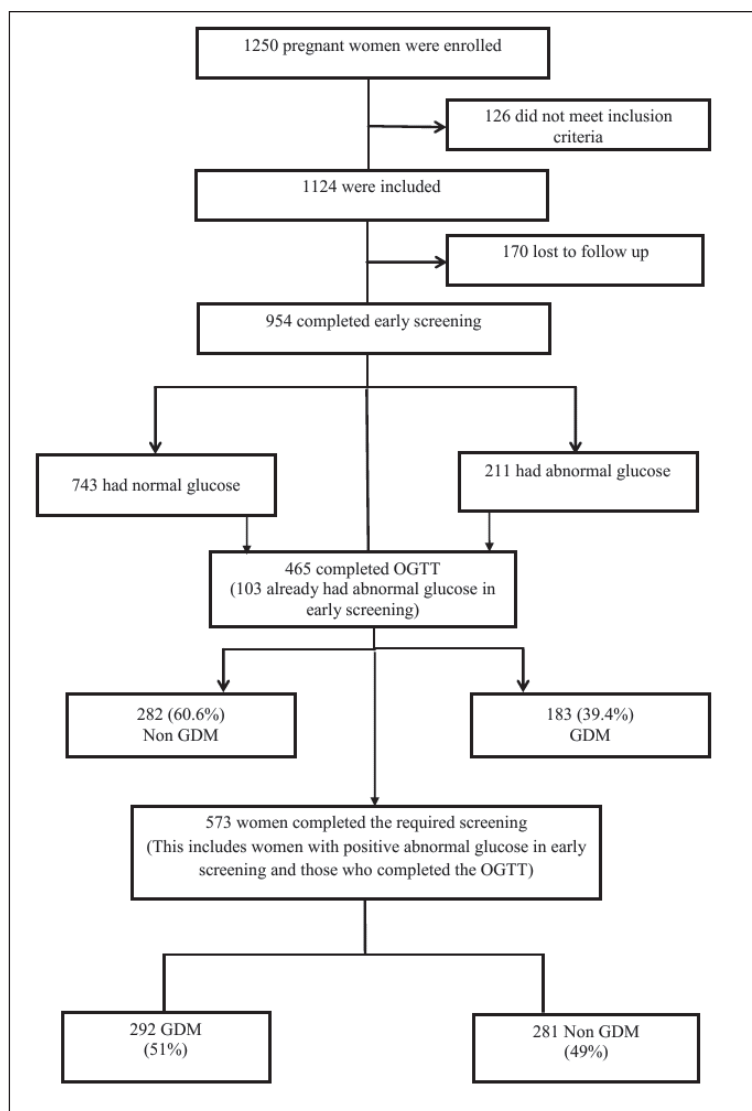


Figure 1. Enrollment, screening and follow-up of the study participants.

economic burden of universal screening, as suggested by Agarwal et al,⁶ the 1-h and 2-h glucose concentrations during the OGTT are important for GDM diagnosis because they were diagnostic in more than half of the GDM cases. In accordance with previous studies,^{5,27} we found an increase in GDM prevalence by the IADPSG criteria that was mainly the result of a single abnormal glucose value during the OGTT in nearly 90% of the cases.

The increase in GDM prevalence by the IADPSG criteria will be a major burden on the health care system. In addition, labelling a large number of women with GDM raises concerns about the consequences of the increased “medicalization” of pregnancies previously classified as normal, which could increase the

Table 1. Prevalence of GDM risk factors.

Variable	Non-GDM (n=281)	GDM (n=292)	95% CI	P value
	Mean (SD)	Mean (SD)		
Age	29.37 (6.11)	32.69 (6.08)	-0.435 - -2.30	.001
Weight	65.66 (15.25)	77.57 (16.93)	- 14.61- -9.21	.001
BMI	27.27 (6.01)	32.30 (6.66)	-6.11- -3.94	.001
Height	154.90 (5.95)	154.94 (6.62)	-1.10- 1.03	1.953
Systolic BP	115.59 (14.01)	119.68 (13.07)	-6.40 - -1.78	.001
Diastolic BP	65.90 (7.65)	68.35 (8.33)	-3.82 - -1.08	.001
Fasting OGTT	4.28 (0.36)	5.05 (0.84)	-0.89 - -0.66	.001
1 hour OGTT	7.16 (1.28)	9.47 (2.24)	-2.64 - -1.98	.001
2 hour OGTT	6.12 (1.33)	8.63 (2.31)	-2.85 - -2.17	.001
HbA1C	5.35 (0.60)	5.77 (0.82)	-0.55 - -0.26	.001

	Number (%)	Number (%)	95% CI	P value	Odd ratio
Multiparity ^a	117 (46.1)	210 (68.2)	1.77-3.54	.001	2.50
History of recurrent abortion ^b	99 (39.0)	178 (58.0)	1.53-3.03	.001	2.16
GDM in prior pregnancies	14 (5.9)	60 (20.5)	2.24-7.61	.001	4.139
Acanthosis nigricans	24 (10.5)	76 (27.0)	1.92-5.11	.001	3.16
Family history of DM	140 (54.9)	210 (68.2)	1.24-2.43	.002	1.76
History of preterm delivery	15 (6.4)	34 (11.6)	1.01-3.59	.043	1.90
Glycosuria	8 (4.6)	25 (11.3)	1.16- 6.02	.017	2.64
History of stillbirth	9 (4)	22 (7.6)	0.89-4.38	.096	1.97
History of neonatal deaths	10 (4.3)	14 (4.8)	0.48-2.57	.83	1.12
History of large baby	15 (6.4)	30 (10.2)	0.86-3.14	.157	1.65
History of malformed baby	6 (2.6)	20 (6.8)	1.08-6.96	.027	2.75
History of gestational HTN	10 (4.3)	24 (8.2)	0.93-4.25	.076	1.99
History of preeclampsia	6 (2.6)	15 (5.1)	0.77-5.31	.180	2.03
History of medical illness	41 (16.5)	61 (20.1)	0.82-1.97	.321	1.27
History of hirsutism	12 (4.8)	15 (4.8)	0.46-2.21	1.001	1.01
History of PCO	15 (6.0)	24 (7.8)	0.67-2.58	.505	1.32

^aDefined as 2 or more previous deliveries.

^bDefined as 2 or more previous abortions.

likelihood of interventions. In contrast, the expected benefits to these pregnancies and offspring include reduced rates of large-for-gestational-age births, and they could provide an opportunity to help more pregnant women to avoid diabetes in the future.

For these reasons, there remains much controversy on the adoption of the IADPSG criteria worldwide. In

January 2011, the ADA standards of care endorsed the IADPSG recommendations.²⁸ Recently, the Endocrine Society and the WHO endorsed the IADPSG recommendations.^{29,30} In contrast, the American College of Obstetricians and Gynecologists³¹ and the National Institutes of Health (NIH)³² have not endorsed these recommendations. In the 2014 Standards of Care,

ADA readdressed the NIH consensus along with the IADPSG guidelines because there were insufficient data to demonstrate strongly the superiority of one strategy over the other.³³

The prevalence of GDM increased significantly with increasing age, BMI, and diastolic blood pressure. In addition, a history of GDM in previous pregnancies, a history of delivering a malformed child, and a family history of diabetes were other risk factors for GDM. Multiparity, previous recurrent abortions, previous preterm deliveries, the presence of acanthosis nigricans and glycosuria were associated with an

Table 2. Risk factors for gestational diabetes (multiple logistic regression).

Variables	Odds Ratio	95% CI	P value
Age	1.07	1.02–1.12	.003
Hx of malformed child	8.39	1.00–69.94	.049
Family history of diabetes	1.88	1.07–3.30	.028
Body mass index	1.08	1.03–1.14	.000
Diastolic BP elevation	1.04	1.00–1.08	.042
History of prior gestational diabetes	2.76	1.09–6.99	.032

Table 3. Maternal and neonatal outcomes.

Outcome variable	Non-GDM	GDM	P value	Odd ratio	95% CI
Maternal outcomes					
Polyhydramnios	5.0	5.5	.051	0.627	0.603–41.441
GA at delivery- wk	38.20 (1.96)	38.15 (1.758)	.834	–	-0.382–0.473
Preterm delivery	13.3	9.2	.219	0.666	0.365–1.216
PROM	13.3	9.2	.219	0.666	0.365–1.216
Induction of labor	5.2	11.4	.025	2.338	1.102–4.962
SC delivery	36.8	47.8	.029	1.571	1.062–2.326
Primary SC delivery	63.9	46.5	.044	0.491	0.250–0.961
Lacerations	5.1	5.1	1.000	0.992	0.419–2.348
Shoulder dystocia	0.5	0.4	1.000	0.819	0.051–13.17
ICU admission	1	2.5	.301	2.532	0.505–12.69
Neonatal outcomes					
Abortion	2.1	2.1	1.000	0.983	0.260–3.712
Stillbirth	2.9	2.3	.753	0.784	0.172–3.573
Neonatal death	0.9	4.4	.214	4.861	0.558–42.31
Fetal injury	0	0.9	.502	0.537	0.490–0.589
Apgar score <7 at 5 minutes	1.1	7.8	.003	5.546	1.579–19.482
Birth weight – g	2890 (510)	3043 (541)	.004	–	-0.254– -0.049
Macrosomia	2.1	3.1	.761	1.492	0.430–5.176
Low birth weight	15.9	12.9	.402	0.788	0.454–1.368
Hypoglycaemia	1.6	13.6	.000	9.353	2.79–31.25
Hyperbilirubinemia	7.1	10.8	.224	1.574	0.773–3.204
Congenital malformation	4.3	7	.282	1.667	0.690–4.025
RDS	6.1	6.6	1.000	1.093	0.483–2.471
NICU admission	18.4	26.1	.076	1.566	0.975–2.515

Results are given as the means (SD) or percentages (%). Preterm delivery refers to delivery before 37 weeks of gestation; PROM, premature ruptures of membranes; macrosomia, defined as birth weight of 4000 g or more; low birth weight defined as birth weight less than 2500 g; RDS: respiratory distress syndrome.

Table 4. Prevalence of GDM using IADPSG criteria in different parts of the world.

Country	Prevalence of GDM
Italy ⁵	53.4
Saudi Arabia ^a	51
United Arab Emirates ⁶	37.7
Norway ^{10b}	31.5
Mexico ¹⁴	30.1
Australia ⁹	25.6
Japan ¹²	23.6
Italy ⁸	20
Australia ¹³	13
Sir Lanka ⁷	8.9

^aPresent study;

^bUsed modified IADPSG criteria.

increased risk of GDM; however, these factors were no longer significant after adjusting for confounding variables.

More than two thirds (68.2%) of the women with GDM had a family history of diabetes, which was significantly different from the non-GDM women (54.9%) ($P=.002$). The extremely high prevalence of a family history of diabetes in the studied cohort reflected the high prevalence of type 2 diabetes in Saudi Arabia.^{25, 34}

Acanthosis nigricans was present in one third of our GDM patients, and its presence was highly indicative of abnormal glucose tolerance because 76% of women with acanthosis nigricans were diagnosed with GDM. Consistent with this finding, Yilmaz E et al reported a higher prevalence of GDM among women with acanthosis nigricans.³⁵

Although multiparity was more common in the GDM group than in the non-GDM group, it was found not to affect GDM prevalence significantly in multiple logistic regression analysis. This finding could be explained by increased parity often being associated with other risk factors for GDM, such as increased age, body weight and abdominal fat. Although macrosomia complicates pregnancies with GDM,¹⁷ we did not find that women with histories of macrosomia in their previous pregnancies had GDM more commonly in their current pregnancies because the occurrence of macrosomia is not attributed solely to abnormal glycemic control, and maternal age, parity, ethnicity and obesity are possible contributory risk factors for excessive fetal growth.³⁶

It was shown earlier that untreated or undiagnosed gestational diabetes mellitus carries significant risks for

perinatal morbidity, and timely and effective treatment can substantially improve outcomes.^{37,38} In the current study, we found a lower rate of perinatal morbidity, which could be explained by the effective treatment and follow-up of women with GDM. Another possible reason for the lower perinatal morbidity in the present study could be related to the milder form of GDM we identified using the IADPSG criteria.

We found no significant differences in most of the maternal outcomes between the GDM and non-GDM groups except for the higher frequencies of induction of labor and CS delivery in the GDM group (Table 3). However, repeated cesarean deliveries were more frequent in the GDM group than in the non-GDM group. In addition, the diagnosis of GDM itself might incur unnecessary risk for interventions, as suggested by the Toronto Tri-Hospital Study.³⁹ The rate of shoulder dystocia among the GDM group in this study was very low at 0.5%. This finding was in accordance with the HAPO study, in which shoulder dystocia was one of the least common outcomes, affecting only 1.3% of the women.¹⁸

Similarly, in our study there were no significant differences in most of the neonatal outcomes between the GDM and non-GDM groups, except for a higher rate of neonatal hypoglycemia, a low Apgar score at 5 minutes and heavier mean birth weight of the infants born to GDM mothers (Table 3). The infants of GDM mothers were 9 times more likely to experience hypoglycemia than the infants of non GDM mothers. The basis for neonatal hypoglycemia is maternal hyperglycemia, which leads to excess fetal glucose exposure and fetal hyperinsulinemia. Subsequently, neonatal hypoglycemia can develop after birth when there is insufficient glucose available in the newborn circulation to surmount the baby's hyperinsulinemia. The reported prevalence of clinical hypoglycemia in infants born to GDM mothers is 2.1%-12%.^{18,37,40}

Despite, the mean birth weight of the infants born to GDM mothers being significantly heavier than that of the infants born to non-GDM mothers (3043 g vs. 2890, respectively; $P=.004$), the frequency of macrosomia did not differ significantly between the two groups. Fetal overgrowth might have been partially controlled in the current study by effective antenatal care.

As shown above, the rate of hypoglycemia was higher in the infants of GDM mothers than in those of non-GDM mothers; however, there was no difference in the rate of macrosomia between the two groups. In agreement with this finding, two clinical trials subjected pregnant women with varying degrees of abnormal glucose tolerance test results to either active

management of their hyperglycemia or routine antenatal care, and both trials showed a significant reduction in the rate of macrosomia in the treatment group but no effect on the rate of hypoglycemia.^{37,38} In these two studies, the mean birth weight of the infants born to the treated GDM mothers was 3302 to 3335 g, which was heavier than the mean birth weight in the present study.^{37,38}

When compared to infants born to mothers without GDM, those born to mothers with GDM had a higher risk of having a lower Apgar score at 5 minutes (OR 5.546 [95% CI 1.579–19.482, $P=.003$]).

The number of infants who needed NICU admission was higher among infants born to GDM mothers than among those born to non-GDM mothers; however, the differences did not reach statistical significance. In the Australian Carbohydrate Intolerance Study in Pregnant Women (ACHOIS), the reported rate of NICU admission among the infants of GDM women was 71%, which was higher than in the present study.³⁷

The strengths of our study included its prospective, population-based nature, the universal screening and the analysis of large amounts of data of maternal characteristics and pregnancy outcomes separately. A limitation of the study was that it was conducted in only one region of Saudi Arabia, so the high prevalence of GDM in Saudi women cannot be generalized.

CONCLUSION

The prevalence of GDM is high among Saudi women. Older maternal age, higher BMI, higher blood pressure, a history of GDM in previous pregnancies, a history of delivering malformed child, and a family history of diabetes were the main risk factors. Timely and effective treatment of gestational diabetes reduces perinatal morbidity and improves outcomes.

In populations at high risk for GDM, as in Saudi Arabia, universal screening is recommended to reduce maternal and fetal morbidity and to allow for subsequent attempts to prevent or delay the onset of type 2 diabetes. Larger studies from different regions of Saudi Arabia are needed to confirm our results.

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Conflict of interest

The author has no conflicts of interest.

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