Comparison of the American Diabetes Association and World Health Organization criteria for gestational diabetes mellitus and the outcomes of pregnancy

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Summary: Two to five percent of pregnancies are complicated by diabetes, of which 90% are classified as gestational diabetes mellitus. The aims and objectives of this study were to analyse the screening and diagnostic procedure for gestational diabetes mellitus (GDM) recommended by American Diabetes Association (ADA) in comparison with the World Health Organization (WHO) criteria and to study the outcome of GDM diagnosed by both the criteria. This prospective study was carried out in the Department of Obstetrics and Gynaecology, JIPMER between August 2006 and July 2008. Three-hundred-and-fifty antenatal cases of gestational age ≥ 24 weeks attending the outpatient department, with any one of the risk factors for GDM, were included in the study. A seventy-five gram oral glucose tolerance test (GTT) was performed on each subject. Results were interpreted using both ADA and WHO criteria. Antenatal complications of GDM, mode of delivery, intrapartum or postnatal maternal and neonatal complications in cases diagnosed with GDM by either criterion were noted. The data collected were analysed using the SPSS software program. The prevalence of GDM was 4% by ADA criteria versus 19.4% by WHO criteria. The diagnostic pick-up rate was approximately five times more with WHO than with ADA criteria. In total, 43% (ADA) and 29% (WHO) of GDM cases had antenatal complications. Seventy-four percent of mothers with macrosomic babies were identified by WHO criteria whereas only 26% of mothers with macrosomic babies were diagnosed by ADA criteria. ADA criteria identify more severe cases of GDM but mild cases diagnosed by WHO are missed. The GTT by WHO criteria was abnormal in a greater percentage of women with adverse outcomes especially macrosomia, than the GTT using ADA criteria.

Keywords: gestational diabetes mellitus, screening, diagnosis, WHO and ADA criteria, outcome

INTRODUCTION

Diabetes mellitus (DM) is one of the most common medical complications of pregnancy. Two to five percent of pregnancies are complicated by DM, of which 90% are classified as gestational DM (GDM).¹

GDM is defined as glucose intolerance of various degrees that is first detected during pregnancy, irrespective of treatment with diet and/or insulin.¹ Indian women have an 11-fold increase in the risk of developing glucose intolerance during pregnancy compared with Caucasian women.^{2,3} Among the ethnic groups in south Asia, Indian women have the highest incidence of GDM.

GDM is detected through the screening of pregnant women with clinical risk factors. Though universal screening of all pregnant women is ideal, it is not possible to screen all women due to limited resources and a high burden of patients in developing countries.

It is important to screen for GDM in pregnancy as it is associated with adverse maternal and fetal outcome and because these women and their children are at risk of developing DM in future.

The prevalence of GDM in India is 16.55%.² There is a need for a simple, cheap, safe and effective test to screen women for GDM. This study was undertaken to compare the efficacy of the World Health Organization (WHO) one-step procedure using a 75 g glucose load after overnight fast and 2-hour plasma glucose with the American Diabetes Association (ADA) criteria using three samples obtained fasting, 1 hour and 2 hours after a 75 gm glucose load. Very few studies are available comparing these two criteria.

AIMS AND OBJECTIVES

The objective of this study was to compare the WHO and ADA criteria for diagnosing GDM, and to compare their association with adverse pregnancy outcomes including macrosomia, preeclampsia and perinatal death.

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ADA CRITERIA⁴

Time (hours)	Plasma glucose (mg/dL)	
	100 g	75 g
Fasting	95	95
1	180	180
2	155	155
3	140	–

The ADA has recommended the use of a 2-hour 75-g oral glucose tolerance test (OGTT). The fasting, 1-hour and 2-hour diagnostic cut-off points are used; two of three abnormal values are required for the diagnosis of GDM. One abnormal value is considered as impaired glucose tolerance (IGT).

WHO CRITERIA⁵

The WHO has adopted the same diagnostic criteria applied to a 2-hour 75-g (OGTT) as in non-pregnant individuals. A standard oral GTT should be performed after an overnight fast by giving 75 g of glucose. Fasting and 2-hour plasma glucose levels are measured. Pregnant women who meet WHO criteria for impaired glucose tolerance (2-hour plasma glucose ≥ 140 mg/dL) are classified as having GDM.

WHO CRITERIA

	Fasting plasma glucose (mg/dL)	2-hour plasma glucose (mg/dL)
Non-pregnancy		
IGT	<126	140–200
Diabetes	>126	>200
Pregnancy		
Diabetes		≥ 200
GDM		≥ 140
DGGT		≥ 120

IGT = impaired glucose tolerance

GDM = gestational diabetes mellitus

DGGT = decreased gestational glucose tolerance

MATERIALS AND METHODS

The study was conducted in the Department of Obstetrics and Gynecology, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Pondicherry, from August 2006 to July 2008.

Pregnant women at gestational age ≥ 24 weeks attending the outpatient department with any one of the following risk factors for GDM were included in the study.

Age > 25 years, obesity ($> 15\%$ of non-pregnant ideal body weight), family history of diabetes, history of prematurity, unexplained neonatal death, intrauterine death, stillbirth, congenital anomaly in previous pregnancy, history of delivery of a large infant (> 3.5 kg), history of preeclampsia as a multigravida, early onset preeclampsia, polyhydramnios, history of recurrent pregnancy loss (> 3 spontaneous abortions in first or second trimester), chronic hypertension, history of gestational diabetes in previous pregnancy.

Known cases of type I or type II DM were excluded from the study. All patients were subjected to clinical examination after a detailed history and informed consent were taken.

No preparatory diet was given. Venous blood samples were collected fasting and then a 75 g oral glucose load was given. Venous blood samples were then collected at 1 and 2 hours. The plasma glucose was estimated by the oxidation method.

The results of the 75 g GTT were interpreted using both ADA and WHO criteria. Complications including macrosomia, perinatal death, preeclampsia and abnormal body mass index (BMI) were recorded.

We defined macrosomia according to the Indian consensus definition of birth weight ≥ 3.5 kg at term ($> 2SD$ from the average weight in this population).⁶ Perinatal death was defined by loss of a fetus > 1 kg or with estimated gestational age ≥ 28 weeks, or by an early neonatal death (up to 7 days). Preeclampsia (or eclampsia) was defined as hypertension after the 20th week of gestation associated with proteinuria or convulsions, regardless of whether it was of new onset or superimposed upon chronic hypertension.¹ We calculated BMI using reported prepregnancy weight and then grouped values into nutritional categories according to the 1997 WHO recommendations.⁷ We defined gestational age according to hierarchical criteria based on serial clinical examinations, ultrasound in either 1st/2nd trimester consistent with neonatal age estimation or last menstrual period.

The study was observational in nature. Antenatal women with GDM by either ADA or WHO criteria received dietary therapy and were observed for two weeks. They then had blood glucose checked. Other GDM women were admitted for blood glucose (BG) monitoring (BG performed before breakfast, lunch and dinner and 1.5 then 2.0 hours after breakfast, lunch and dinner). If the fasting value exceeded 90 mg/dL, and/or postprandial value exceeded 120 mg/dL, insulin was started. If the fasting plasma glucose concentration on the OGTT was ≥ 120 mg/dL, then the patient was started on insulin immediately along with a diabetic meal plan. A combination of short- and intermediate-acting insulin was given in the morning and evening. Insulin was adjusted according to blood glucose values.

Maternal complications (ante partum, intra partum or post partum) and mode of delivery were noted. All babies were examined immediately after birth. Their birth weights were recorded and they were screened for hypoglycaemia. A note of any congenital anomalies or birth injuries was made.

The data collected were analysed using χ^2 test and Fisher's exact test in the SPSS software program.

RESULTS

A total of 350 pregnant women of gestational age ≥ 24 weeks with any one risk factor for GDM were included in this study.

Age > 25 years and a positive family history of DM were the most common indications for screening. (Table 1).

The majority of the cases (45%) were of age 20–25 years. The prevalence of GDM by WHO criteria increased with age from 18.5% in the < 20 years group to 26% in the ≥ 30 years group.

In the present study, around 30% were primigravidae. The prevalence of GDM was 18% in primigravidae and 20% in multigravidae by WHO criteria versus 5% and 4%, respectively, by ADA criteria. Thirty-three percent of patients had a positive family history of diabetes (Table 2).

Among 350 cases, 14 cases (4%) were diagnosed as GDM by ADA criteria, whereas applying the WHO diagnostic criteria,

Table 1 Indications for screening

Risk factors	No. of cases	No. of GDM diagnosed	
		ADA criteria	WHO criteria
Age >25 years	192	9	44
Family history	115	2	25
Polyhydramnios	69	5	16
IUD*	44	2	9
Congenital anomaly*	23	2	4
Prematurity*	14	0	2
Unexplained neonatal death*	18	1	1
Macrosomia*	10	1	3
Still birth*	13	0	0
Obesity	5	1	1
Early onset preeclampsia	3	0	0
Preeclampsia in multigravidas	4	0	1
Recurrent pregnancy loss	6	0	0
GDM*	4	0	1

*Indicates events in previous pregnancy complications

GDM = gestational diabetes mellitus; ADA = American Diabetes Association;

WHO = World Health Organization; IUD = intrauterine device

Table 2 Demographic characteristics of the women

	No. of patients	Percentage
Age distribution		
<20	27	7.7
20–25	158	45.1
26–29	84	24.0
≥30	81	23.1
Gravidity		
G1	101	28.9
G2	129	36.9
G3	75	21.4
G4	25	7.1
≥G5	20	5.7
Family history		
Positive	115	32.9
Negative	235	67.1

68 cases (19%) were identified as GDM (odds ratio [OR] = 0.17, 95% CI = 0.09–0.32; Table 3).

Most of the women diagnosed with GDM were managed with diet (dietary therapy) alone. Eight cases only required insulin along with diet. All eight cases were controlled with 4–20 units of insulin.

The positive association between antenatal complications and GDM was not statistically significant P value = 0.2 (ADA); 0.8 (WHO).

In all, 43% and 29% of those with GDM by ADA and WHO criteria, respectively, had antenatal complications (Table 4).

Table 3 Numbers of positive GTT results using ADA and WHO criteria

Results	No. of patients	
	ADA criteria	WHO criteria
Positive	14 (4%)	68 (19.4%)
DGGT/IGT*	37 (10.6%)	63 (18%)
Negative	299 (85.4%)	219 (62.6%)

*DGGT in WHO criteria and IGT in ADA criteria

ADA = American Diabetes Association; WHO = World Health Organization; IGT = impaired glucose tolerance; DGGT = decreased gestational glucose tolerance

No statistically significant differences between these two groups were observed regarding frequencies of antenatal complications. Polyhydramnios and preeclampsia were the most common antenatal complications. Polyhydramnios was seen in 36% of the GDM cases diagnosed by ADA criteria compared with 22% of GDM cases by WHO criteria and preeclampsia was seen in 7% of GDM cases by ADA criteria and 8% of GDM cases diagnosed by WHO criteria.

Out of 19 cases of polyhydramnios in the study group 14 cases had GDM. All 14 cases were found by WHO criteria whereas only five cases would have been identified by ADA criteria (OR = 0.62, 95% CI 0.16–2.45, P value: 0.516). Out of nine cases of preeclampsia in the study group, five had GDM. All five cases were diagnosed by WHO criteria whereas only one case would have been identified by ADA criteria (OR = 1.03, 95% CI 0.01–25.3, P value = 1.00). Thus compared to the ADA criteria more cases with polyhydramnios/preeclampsia were identified using WHO criteria.

No other significant antenatal complications were noted in those diagnosed as GDM by either ADA or WHO criteria.

In the study group, 88% cases had spontaneous vaginal delivery and 10% cases had lower segment caesarean section (LSCS). Most of those diagnosed as GDM had spontaneous vaginal delivery. In those cases diagnosed as GDM by WHO criteria, 4% had instrumental delivery. LSCS was done in 7% (ADA) versus 12% (WHO) GDM cases versus 8% in normal pregnant women. The most common indication for LSCS was previous caesarean section with GDM. The 4.4% of GDM cases diagnosed by WHO criteria had instrumental delivery versus 2% in normal pregnant women.

In the study group, macrosomia was found to be the most common neonatal complication (11%).

The positive association between GDM (diagnosed by ADA criteria or WHO criteria) and neonatal complications was statistically significant. (P value <0.001 for both ADA and WHO criteria).

Seventy-nine percent of GDM cases diagnosed by ADA and 41% of GDM cases diagnosed by WHO had neonatal complications (macrosomia, prematurity, respiratory distress, still-birth, IUGR, congenital anomalies, neonatal death) (Table 5).

Thus, neonatal complications were higher in those diagnosed as GDM by ADA criteria when compared with those diagnosed by WHO criteria.

The positive association between macrosomia and GDM diagnosed by both criteria was statistically significant (P < 0.001).

In total, 71% and 43% of those diagnosed as GDM by ADA and WHO, respectively, had babies with birth weight ≥3.5 kg (macrosomia).

Out of 38 babies with birth weight ≥3.5 kg in the study group, 29 babies were born to mothers identified as having GDM. All 29 (74%) GDM mothers with macrosomic babies were identified by WHO criteria versus only 10 (26%) by ADA criteria (OR = 3.36, CI 0.85–14.32, P value: 0.09).

Thus, in comparison to the ADA criteria, more mothers with macrosomic babies were identified by WHO criteria.

DISCUSSION

In the Indian context, screening for GDM is essential in all pregnant women as Indian women have an 11-fold increased risk of developing GDM compared with Caucasian women. But due

Table 4 Antenatal complications in women with GDM diagnosed by ADA and WHO criteria

Antenatal complications	Positive		DGGT/IGT		Negative	
	ADA	WHO	ADA	WHO	ADA	WHO
Present	6 (42.9%)	20 (29.4%)	13 (35.1%)	15 (23.8%)	76 (25.4%)	60 (27.4%)
Absent	8 (57.1%)	48 (70.6%)	24 (64.9%)	48 (76.2%)	223 (74.6%)	159 (72.6%)
Total	14	68	37	63	299	219

ADA = American Diabetes Association; WHO = World Health Organization; IGT = impaired glucose tolerance; DGGT = decreased gestational glucose tolerance

Table 5 Neonatal complications and birth weight in babies of mothers with GDM diagnosed by ADA and WHO criteria

Neonatal complications	Positive		DGGT/IGT		Negative	
	ADA	WHO	ADA	WHO	ADA	WHO
Present	11 (78.6%)	28 (41.2%)	12 (32.4%)	7 (11.1%)	33 (11%)	21 (9.6%)
Absent	3 (21.4%)	40 (58.8%)	25 (67.6%)	56 (88.9%)	266 (89%)	198 (90.4%)
Total	14	68	37	63	299	219
Birth weight (kg)						
<3.5	4 (28.6%)	39 (57.4%)	24 (64.9%)	60 (95.2%)	284 (95%)	213 (97.3%)
3.5–3.9	10 (71.4%)	27 (39.7%)	11 (29.7%)	3 (4.8%)	14 (4.7%)	5 (2.3%)
≥4	0	2 (2.9%)	2 (5.4%)	0	1 (0.3%)	1 (0.5%)
Total	14	68	37	63	299	219

ADA = American Diabetes Association; WHO = World Health Organization; IGT = impaired glucose tolerance; DGGT = decreased gestational glucose tolerance; GDM = gestational diabetes mellitus

to limited resources, universal screening is not possible. Screening in high-risk patients is essential to decrease the maternal and perinatal morbidities and mortalities. In our hospital the outpatient department antenatal attendance is 200–300 cases per day and there are 50–70 deliveries per day. However, it is practically impossible to do universal screening for DM in all antenatal women due to limited resources and manpower. So, we have taken cases with any one risk factor in our study, though other studies have done universal screening.

The prevalence of GDM (WHO criteria) in each age group found in this study was similar to the observation by Seshiah *et al.*² in which 1251 pregnant women were screened.

In the present study, the prevalence of GDM increased with age from 18.5% in the age group of <20 years to 26% in the age group ≥30 years by WHO criteria.

In the study by Seshiah *et al.*² the prevalence of GDM increased with age from 14.5% in the 15–19-year-old age group to 25% ≥30-year-old group.

All studies confirm that advanced age is associated with an increased incidence of GDM.

The prevalence of GDM (WHO criteria) in our study increased with gravidity as well, from 18% in the primigravidae to 20% in the multigravidae, which was similar to the observation by Seshiah *et al.*² (16.3% in primigravidae and 25.8% in multigravidae).

Prevalence of GDM

In the present study, the diagnostic pick-up rate was approximately five times more with WHO criteria than with ADA criteria (19.4% versus 4%), similar to other studies.

In the study by Schmidt *et al.*⁹ the diagnostic pick-up rate was approximately three times greater with WHO criteria than with ADA criteria (7.2% versus 2.4%).

In the study by Seshiah *et al.*² the diagnostic pick-up rate was approximately four times greater with WHO criteria than with ADA criteria (16.2% vs. 3.93%).

Antenatal complications

Preeclampsia is more common in women with diabetes than in non-diabetic women (10% versus 4%).¹⁰

In a study by Schmidt *et al.*⁹ 5% of GDM cases diagnosed by ADA criteria or WHO criteria had preeclampsia. They observed that GDM was associated with a two to three times' greater risk of preeclampsia. In their study after adjustment for centre, ethnicity, maternal height, parity educational level, age prepregnancy BMI, and weight gain at enrolment, statistically significant relative ratios (RRs) of 2.28 for ADA and 1.94 for WHO criteria were present. With that adjustment, ~5% of the preeclampsia observed could be attributed to GDM as defined by ADA and ~8% to the more prevalent GDM by WHO criteria.

Deerochanawong *et al.*¹¹ observed that 50% of GDM diagnosed by National Diabetes Data Group (NDDG) criteria and 12% of GDM diagnosed by WHO criteria had preeclampsia.

In the present study, antenatal complications of GDM (mainly polyhydramnios) were more commonly associated with those diagnosed by ADA criteria than those diagnosed by WHO criteria. It was comparable to other studies.

Mode of delivery

There is a high incidence of operative delivery rate in women with GDM. Deerochanawong *et al.*¹¹ in their study of 709 women, found that 32% and 70% of those diagnosed as GDM by WHO criteria and NDDG criteria respectively had LSCS.

Emmanuel Odar *et al.*¹² in a study of 90 women observed that mothers with GDM (WHO criteria) were twice as likely to have a caesarean section because of big babies and obstructed labour than the controls without GDM.

As observed in other studies, LSCS and instrumental delivery rates increased in those diagnosed as GDM by WHO criteria, but the association was not statistically significant.

NEONATAL OUTCOMES

Deerochanawong *et al.*¹¹ observed that GDM cases diagnosed by WHO criteria had significantly worse neonatal outcomes including macrosomia, large for gestational age infants, hypoglycaemia and hyperbilirubinaemia with RR of 2.84, 2.95, 3.99 and 0.95, respectively than GDM cases diagnosed by NDDG criteria. Emmanuel Odar *et al.*¹² observed that the babies of mothers with GDM (WHO criteria) were more likely to be macrosomic (36.7%), stillborn (16.7%) and have shoulder dystocia (23.3%) than those of normal mothers. Schmidt *et al.*⁹ in a study of 4997 women observed that GDM cases diagnosed by WHO have an increased risk of delivering a macrosomic infant, and suffering a perinatal death. Women having GDM based on the ADA criteria had a three times greater risk of perinatal death. Forsbach-Sanchez *et al.*¹³ observed that prevalence of macrosomia in GDM (WHO criteria) was almost double when compared with normal pregnant women. De Sereday *et al.*¹⁴ observed in 473 women that the WHO criteria were optimal for predicting macrosomia.

In the present study, 79% and 41% of GDM cases diagnosed by ADA and WHO criteria respectively had neonatal complications. Stillbirth occurred in only one case diagnosed as GDM by both ADA and WHO criteria. As such, there is no difference in stillbirth rate in those diagnosed as GDM by ADA criteria and WHO criteria. There were no NICU admissions or neonatal deaths in babies born to those diagnosed as GDM by either ADA or WHO criteria in the present study.

There was a greater detection rate of GDM and macrosomia using WHO criteria versus ADA criteria.

In the present study, more cases (68 versus 14) of GDM were detected using WHO criteria versus ADA criteria. Three times more cases (29 versus 10) with GDM who delivered macrosomic infants were detected with WHO criteria.

ADA criteria are more stringent and thus logically define a more severe condition. ADA criteria require three blood samples, as opposed to only one with the WHO criteria. The drawback of the ADA criteria is that they permit both 100 g and 75 g GTT. Though the glucose loads are different, the cut-off values are the same. Further, the 3-hour value for OGTT is not given in the ADA criteria. The WHO criteria have the simplicity of applying the same criteria for diabetes used in non-pregnant women.

By identifying a large number of DM women, the WHO criteria have a greater potential for prevention of maternal and perinatal morbidity and mortality.

CONCLUSION

ADA criteria identify more severe cases of GDM but mild cases diagnosed by WHO are missed. The WHO test for glucose tolerance – 2-hour post-plasma glucose ≥ 140 mg/dL after 75 g glucose load – was abnormal in a greater percentage of women with adverse outcomes especially macrosomia than

GTT using the ADA criteria. This method, recommended by WHO, which serves both as a screening and diagnostic procedure is easy to perform and is economical. The WHO criteria help to identify a large number of GDM cases, thus having a greater potential for prevention of maternal and neonatal complications.

CONFLICTS OF INTEREST

No conflicts exist.

CONTRIBUTORSHIP

All authors have (1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published.

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