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Research article

Gestational diabetes in rural central India: low prevalence but absence of typical risk factors

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ABSTRACT

Introduction: The reported prevalence of gestational diabetes mellitus (GDM) varies widely across India. Given the short-term, long-term, and multigenerational health impacts of GDM, understanding its frequency and risk factors is important for population screening strategies. We estimated the prevalence of GDM and determined associated risk factors in rural, central India, where data is sparse.

Methods: We conducted a cross-sectional study of a convenience sample of 575 pregnant women attending antenatal care (ANC) clinics at Jan Swasthya Sahyog's (JSS) outreach clinics in rural Chhattisgarh, India. Study participants underwent a non-fasting 75g oral glucose tolerance test (OGTT) between 24-28 weeks gestation. Using Diabetes in Pregnancy Study Group of India (DIPSI) criteria, a 2-hour post-OGTT glucose $\geq$140 mg/dL was used to diagnose GDM.

Results: We found 11 patients (1.9%) who met diagnostic criteria for GDM. Median age, systolic blood pressure, and diastolic blood pressure were higher in those with GDM (26 vs 23 years, $p = 0.02$; 117 vs 106 mmHg, $p = 0.04$, 77 vs 68 mmHg, $p < 0.01$, respectively). Pre-hypertension was associated with increased odds of GDM on multivariate analysis (OR 4.0, 95% CI: 1.1, 14.8). BMI was not associated with GDM. With appropriate management there were no differences in fetal complications between GDM and normal glucose tolerance (NGT) groups.

Conclusions: In rural, central India the prevalence of GDM was 1.9% in the absence of traditional risk factors such as increased BMI. Further research is needed to define the applicability of optimal screening strategies in such settings.

1. Introduction

GDM prevalence varies widely throughout India, from reports of 0.5% in rural Wardha to 42% in urban Lucknow [1, 2, 3]. Though comparison is limited due to variation in diagnostic criteria and screening methodology, it is clear that GDM is a major problem in many areas. Urban prevalence is generally higher than prevalence in rural studies, but some rural studies show a high prevalence as well [4].

The condition has substantial implications for the health of both the mother and fetus. GDM mothers have a 7-fold increase in risk of future type 2 diabetes mellitus (T2DM) [5]. The costs of long-term medications, loss of productivity, and treatment of complications are high, especially in lower socioeconomic strata where the condition is becoming more prevalent [6]. For the fetus, there is an increased risk of birth complications and also of future T2DM and GDM. For female children, increased risk of future T2DM and GDM means the perpetuation of a vicious cycle [7].

Given these implications and the dearth of data to help stratify which populations are most at-risk, current guidelines recommend universal screening for pregnant women in India [8]. However, current practice does not reflect these recommendations, operational questions of how to best do so remain, and more evidence could help increase uptake.

The objectives of this study were to determine the prevalence of GDM in a rural population in Chhattisgarh, India, describe its clinical and demographic profile, and assess risk factors associated with GDM among these patients.

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2. Methods

2.1. Study site and population

We collected data from women attending monthly antenatal clinics (ANC) of Jan Swasthya Sahyog (JSS) from March 2017 to April 2018. JSS is a non-governmental organization which caters to the underserved, primarily tribal population of rural Chhattisgarh. Chhattisgarh is the most impoverished state in India, with 40% of the population living below the poverty line. In rural areas, 49% are below the poverty line [9]. The ANC clinics served 72 villages. All pregnant women in these villages are routinely enrolled in JSS's ANC clinics. A convenience sample of 575 pregnant women who were registered with JSS during the study period and underwent GDM screening as per their standard clinical protocol were included in this study.

2.1.1. Inclusion criteria

Records of all pregnant women between 24-28 weeks who underwent an OGTT during the study period.

2.1.2. Exclusion criteria

None.

2.2. Case definition

Patients who had 2 h post-OGTT glucose of ≥140 mg/dL were diagnosed with GDM according to DIPSI criteria and sent to the main JSS hospital for additional fasting blood glucose (FBS) [10]. Patients with 2 h post-OGTT between 120-139 mg/dL were diagnosed as decreased gestational glucose tolerance (DGGT) and underwent no further management. Other criteria for GDM diagnosis are shown in Table 1 below.

2.3. Data collection

All data were collected from standard forms used for care of pregnant women attending JSS ANC clinics and the electronic medical record where appropriate.

2.3.1. Demographic data

Baseline demographic variables such as age, weight, height, BMI, parity, comorbidities, and previous pregnancy complications were collected.

2.3.2. Laboratory data

Available laboratory data including hemoglobin level and non-fasting OGTT results were also collected. All reported hemoglobin and blood glucose measurements were from venous blood samples.

2.3.3. Clinical data

Maternal and neonatal outcomes data including pregnancy complications, fetal complications, fetal birthweight, blood pressure, and treatment were recorded from ANC and postnatal care (PNC) forms. Blood pressure is measured in the ANC clinics following the WHO STEPS protocol.

2.3.4. Sample size

Convenience sampling was conducted without a pre-defined sample size, but included all women enrolled in the ANC clinics during the defined time period.

2.4. Data analysis

We summarized the characteristics of the study population using descriptive statistics. Continuous variables were compared using the Mann-Whitney U test, and categorical variables were analysed using the Chi-squared test or ANOVA where appropriate. Univariate logistic regression analyses were then done to determine the association of risk factors with GDM. Clinically and statistically significant variables were included in a multivariable model. Missing data were excluded from analysis. Statistical analysis was conducted with STATA version 15.1.

2.5. Patient involvement

We intend to disseminate the main results of this study to the community in which this study was conducted and will seek patient and public involvement in the development of an appropriate method of dissemination.

2.6. Ethics

The study was a retrospective review of de-identified, routine clinical data. The study was approved by the Research Advisory Board of JSS and exempted after review by the Weill Cornell Medicine Institutional Review Board (IRB).

3. Results

Of 1106 pregnant women in the study area, 575 (52.0%) women were between 24-28 weeks gestation during the study period and underwent testing for GDM. JSS ANC clinics cover all pregnant women in the study area. The median glucose 2 h post OGTT was 90 mg/dl (IQR 82–99). Overall, the prevalence of GDM was 1.9% (n = 11) and prevalence of DGGT was an additional 3.0% (n = 17). (Table 2).

In the total cohort, median age was 23 years (IQR 21–26), and median 2nd trimester BMI was 20.7 kg/m^2 (IQR 19.2–22.7). Median parity was 1 (IQR 0–2). Comparing GDM vs NGT groups, age was significantly higher in the GDM group (26 vs 23 yrs, p = 0.02). Systolic and diastolic BP were also higher in the GDM group (117 mmHg (IQR 107–121) vs 106 (IQR 99–113), p = 0.04) and (77 mmHg (IQR 72–82 vs 68 (IQR 63–74), p < 0.01). Median BMI was 22.5 (IQR 19.6–23.5) in the GDM group but was not significantly higher than the NGT group. There were no missing data. (Table 3).

There was no difference in rate of C-sections or institutional delivery, and pregnancy complications did not occur in the GDM group with the exception of one patient with lower extremity swelling. (Table 4).

One GDM participant was treated with metformin (9.1%), and the remainder were treated with diet-control alone (91.9%) (Table 2).

A multivariable model assessing age, BMI, parity, and HTN/pre-HTN was analyzed. Pre-HTN was associated with GDM (OR 4.0 [95% CI 1.1, 14.8], p = 0.04). (Table 5)

4. Discussion

We describe a population in rural, central India with a prevalence of GDM of 1.9%. This is a lean population, with median 2nd trimester BMI only 20.7 kg/m^2. The traditional risk factors of age and BMI were not different between GDM and NGT groups on regression analysis, but age

Table 1. Diagnostic criteria for GDM.

Diagnostic criteria	Method	Fasting (mg/dl)	1 h (mg/dl)	2 h (mg/dl)
WHO 1999	Fasting; 75g glucose	-	-	≥140
IADPSG	Fasting; 75g glucose	≥92	≥180	≥153
DIPSI	Non-fasting; 75g glucose	-	-	≥140

WHO, World Health Organization; IADPSG, International Association of Diabetes in Pregnancy Study Group, DIPSI, Diabetes in Pregnancy Study Group of India.

Table 2. OGTT results.

	Median (IQR) or N (%)
Median 2hr post OGTT glucose, mg/dL	90 (82–99)
Number meeting criteria for GDM	11 (1.9%)
Treated with metformin	1 (9.1%)
Treated with diet control alone	10 (91.9%)
Number meeting criteria for DGGT	17 (3.0%)

IQR, interquartile range; OGTT, oral glucose tolerance test; GDM, gestational diabetes; DGGT, decreased gestational glucose tolerance.

displayed a trend toward significance with higher age noted in the GDM group.

Notably, pre-HTN was associated with an OR of GDM of 4.0 on adjusted analysis. Pre-HTN and HTN have been reported to be associated with increased risk of GDM in previous literature, including in one study in India conducted in a population with very low GDM prevalence [11, 12]. Given the strength of the association of pre-HTN with GDM that we found in our population, pre-HTN should be further studied as a potential basis for selective GDM screening in otherwise low-risk populations.

Other studies in the literature had a comparably low prevalence. One in rural Wardha reported a prevalence of 0.5%, though they used the O'Sullivan criteria which has lower sensitivity [13]. Studies from Delhi and Manipur reported prevalences of 1.5% and 1% [12, 14], respectively, using the 100g ADA criteria, but prevalence of abnormality on the initial step of the screening test, which is most similar to the DIPSI used in our study, was close to 10%. Rural studies in Kashmir had a prevalence of 2.4%, in Jaipur 3.3%, in Mysuru 3.7%, and in Coimbatore 2.1% [15, 16, 17, 18]. However, the last three studies may have had an artificially low prevalence because of the inclusion of women in 1st trimester. Our setting had a low prevalence despite using a lower glucose cutoff and including only women in 2nd and 3rd trimester.

Low prevalence may have been attributable to several factors. In Western studies, age >30 and BMI >25 kg/m^2 are generally considered risk factors, but our population is very young (median age was only 23 years despite median gravida of 2) and lean (median BMI was only 20.7 kg/m^2) and likely undernourished, with high prevalence of anemia, which all likely contributed to a lower prevalence. Prior work in India indicates that gestational weight gain is low [19]. This information was not available in our cohort, but low gestational weight gain could have contributed to lower prevalence as well. Occupation and physical activity information was not collected in this study, but our population does primarily agricultural work for which physical activity is very high. A study by Mishra et al highlights the significant protective effect of physical activity against GDM by showing a 10 fold lower prevalence of GDM among people who carry out >3000 METs of activity per week [20]. Similarly, ambient outdoor air pollution has been shown to increase risk for GDM but is likely very low in our remote population [21].

Table 4. Pregnancy complications by GDM status.

	GDM (n = 11) N (%)	NGT (n = 564) N (%)
Pre-term delivery	0 (0%)	2 (0.4%)
Pre-eclampsia, Hypertension	0 (0%)	11 (2.0%)
Lower extremity swelling	1 (9.1%)	7 (1.2%)
Anemia, including sickle cell	0 (0%)	10 (1.8%)
IUGR or oligohydramnios	0 (0%)	2 (0.4%)
Fetal demise	0 (0%)	8 (1.4%)
History of stillbirth or abortion	0 (0%)	5 (0.9%)

GDM, gestational diabetes; NGT, normal glucose tolerance.

Nutritional factors may have contributed as well to protection against a high prevalence of GDM and deserve further study. We do not know whether our population has a high consumption of millets, antioxidants and probiotics, but anecdotally we believe they do. If so, these may contribute to protection against GDM and the oxidative stress associated with it. Diet should be studied further in this population and compared to other populations that have similar physical activity levels but a more westernized diet.

DIPSI criteria for the diagnosis of GDM may have low sensitivity as it does not account for fasting hyperglycemia [22, 23, 24, 25]. A study in North India by Arora et al observed that most GDM diagnoses were made based on fasting glucose [26]. Therefore, our prevalence could be an underestimate of GDM in this sample. However, this is unlikely given that 2 h post-OGTT glucose was only 119 at 95th percentile in our cohort. In contrast, it is also possible that, given the low pre-test probability of GDM in this sample and the fact that most women were treated with diet control alone, many GDM diagnoses could have been false positives.

GDM screening is resource-intensive, and though universally recommended in India, rarely practiced even in urban centers. This may be due to multiple reasons. A study in the public health centers of Bangalore reported that only 12% of doctors knew how to diagnose and manage

Table 3. Baseline demographics by GDM status.

	Total Median (IQR) or N (%)	GDM (n = 11) Median (IQR) or N (%)	NGT* (n = 564) Median (IQR) or N (%)	P value
Age, yrs	23 (21–26)	26 (23–30)	23 (21–26)	0.02*
Gravida	2 (1–3)	2 (2–3)	1 (1–3)	0.80
Parity	1 (0–2)	1 (1–2)	1 (0–2)	0.54
BMI, kg/m^2	20.7 (19.2–22.7)	22.5 (19.6–23.5)	20.7 (19.2–22.7)	0.47
Weight, kg	47.2 (43.1–52.5)	50 (43.6–55.1)	47.2 (43.1–52.5)	0.73
Height, cm	151 (147.5–154.6)	149 (146–153)	151 (147.5–155)	0.24
Hemoglobin, mg/dL	10.2 (9.5–11)	10.2 (9.5–11)	10.2 (9.5–11)	0.88
Blood pressure category				
Hypertension (BP > 140/90 mmHg)	12 (2.1%)	0 (0%)	12 (2.1%)	0.07
Pre-Hypertension (BP > 120/80)	77 (13.4%)	4 (36.4%)	73 (12.9%)	-
Systolic BP, mmHg	106 (99.5–113)	117 (107–121)	106 (99–113)	0.04*
Diastolic BP, mmHg	68 (63–74)	77 (72–82)	68 (63–74)	<0.01*
Institutional delivery	386 (67.1%)	8 (72.7%)	378 (67.0%)	0.69
C sections	36 (6.3%)	1 (9.1%)	35 (6.2%)	0.84
Fetal birthweight (kg)	2.7 (2.5–3)	2.8 (2.3–3)	2.7 (2.5–3)	0.93

GDM, gestational diabetes; NGT, normal glucose tolerance; BMI, body-mass index; BP, blood pressure.
* NGT includes DGGT.

Table 5. Association of risk factors with GDM.

	OR (95% CI)	P value	aOR (95% CI)	P value
Age, yrs	1.09 (0.99, 1.21)	0.08	1.13 (0.99, 1.30)	0.08
Gravida	1.07 (0.72, 1.59)	0.73		
Parity	1.17 (0.79, 1.75)	0.44	0.85 (0.49, 1.45)	0.54
BMI, kg/m^2	1.05 (0.85, 1.30)	0.65	0.99 (0.80, 1.23)	0.96
Hemoglobin, mg/dL	1.08 (0.64, 1.82)	0.77		
HTN	-		-	
Pre-HTN	3.75 (1.07, 13.13)	0.04*	4.00 (1.09, 14.76)	0.04*

BMI, body-mass index; HTN, hypertension.

GDM, so education may be a barrier [27]. Fasting OGTT requires patient preparation and multiple blood draws in facilities where lab services are not consistently available. Treatment with insulin requires access to an expensive medication, appropriate storage, and monitoring devices [28]. There is a strong initiative in the National Health Mission to improve screening and treatment for GDM across India [29]. Along with improving screening and treatment for this condition, focusing on the wider need of more available phlebotomy and lab services, access to medications, training for doctors, and healthcare infrastructure as a whole remains important.

Our study had several strengths and limitations. Our population is unique and has not been previously systematically studied. We were unable to collect extensive data on risk factors, including socioeconomic status, psychosocial factors, nutrition, physical activity, and traditional risk factors such as gestational weight gain and family history of diabetes. However, the ANC program covered nearly every pregnant woman in the study area and therefore we have a true sample for determination of GDM prevalence in this population. We used DIPSI criteria to diagnose GDM, which as discussed above has unclear true sensitivity. Use of DIPSI also limits comparison to many other studies, but it allows for comparison to current clinical practice in much of India. Finally, given that it was a cross-sectional study, we do not have follow-up information for post-postpartum OGTT in GDM patients, but postpartum diabetes risk will need to be assessed in future research.

5. Conclusions

In this rural population in central India, prevalence of GDM by Indian diagnostic criteria was 1.9% in the absence of traditional risk factors such as increased BMI. Pre-HTN was associated with increased risk. Universal screening may be required but further understanding of cost-effective and operationally feasible strategies to do so are needed.

Declarations

Author contribution statement

Ravi Kurbude and Manju Thakur: Conceived and designed the experiments; Performed the experiments.

Rachna Jain: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Puja Chebrolu and Naman Shah: Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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