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Prevalence of gestational diabetes mellitus and associated risk factors among rural pregnant women attending antenatal care

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Abstract
Background: The prevalence of Gestational Diabetes Mellitus (GDM) is increasing continuously worldwide and in recent years it is emerging as a major public health challenge in India. GDM is a common complication during pregnancy that can fatally affect the outcome of pregnancy, hence early diagnosis and appropriate measures are essential. The present study was conducted to estimate the prevalence and associated risk factors affecting GDM in rural, Uttar Pradesh, India.
Methods: A cross-sectional community based study was conducted among 605 pregnant women registered at Primary Health Center (PHC) of Harhua block of Varanasi district Uttar Pradesh. Following DIPSI Guideline, One step OGTT with two hours after taking 75 gm oral glucose irrespective of last meal was used and screen by Glucometer. The plasma glucose level of ≥140 mg/dL was taken as cutoff for confirm the GDM in pregnant women. Statistical analysis was performed using SPSS version 20 Software.
Results: The mean age of pregnant women was found to be 24.39 ± 3.17, ranging between 17 and 36 years. 46 out of 605 pregnant women (7.6%) were diagnosed as having GDM. The age (X^2=42.42; P<.01), educational status (X^2=16.72; P<.01) and BMI (X^2= 53.58; p<.01) of pregnant women were significantly associated with prevalence of GDM. Moreover higher age (AOR= 9.33, 95% CI: 3.20-27.19; p<.01) and obesity (AOR= 17.96, 95% CI: 4.30-74.98; p<.01) were seen as significant and strong predictor of GDM.
Conclusions: This study has shown the prevalence of GDM in all socio-demographic categories, especially in pregnant women with high age and high BMI. GDM can lead to type-2 diabetes in pregnant women later on after delivery. Proper awareness about antenatal care and use of mobile medical units in the screening and diagnosis of GDM can play an important role in ensuring better maternal and fetal health.

Keywords: Gestational diabetes mellitus (GDM), pregnant women, high-risk pregnancy

Introduction
In a global perspective, gestational diabetes mellitus is one of the commonest metabolic complications of pregnancy and increasing day by day. Gestational Diabetes Mellitus (GDM) is a state of Impaired Glucose Tolerance (IGT) with onset or first recognition during pregnancy. It shows like a common medical disorder but can adversely affect the health of mother and fetus and can cause significant maternal and fetal complications if not diagnosed and treated in time. Moreover, mothers with GDM and their fetus are at increased risk of developing type-2 diabetes later in life [1-5]. Therefore, early diagnosis of GDM is essential to reduce maternal and fetal morbidity and to help to prevent from type 2 diabetes. The global prevalence of GDM ranges widely, from 1% to 28%, depending on study participants characteristics (e.g., maternal age, socioeconomic status, race/ethnicity, environment, body composition, lifestyle disparities; dietary habits), screening methods, and diagnostic criteria [6-10]. Several studies and meta-analysis have reported approximately one in every ten pregnant women in Eastern and Southeastern Asia had GDM [3, 7]. On the other hand, western countries including Europe (5.4%), America (9.2%) and Australia (5.7%) have also been found to be affected by the prevalence of GDM [7].
The prevalence of gestational diabetes mellitus (GDM) has been increased significantly over the past two decades, especially in developing countries like India [2, 7, 11]. Indian women have an estimated 11 times higher risk of developing GDM than women in other parts of the world [4, 11]. Several studies and meta-analysis reported the prevalence of gestational diabetes mellitus has ranged up to 41.9% (Uttar Pradesh) in different parts of India. More interestingly these studies showed low prevalence rate in rural area and comparatively higher prevalence rate in urban areas [1, 2, 4, 8-10, 12, 13].

Earlier studies suggested that the increasing occurrence of GDM was related to factors such as maternal age ≥ 25 years, overweight or obese, smoking, previous history of GDM, macrosomia, spontaneous abortions or stillbirths, multiparity and premature delivery significantly increased the risk of GDM whereas, history of congenital anomaly, HIV status, and history of abortion showed no impact on the risk of GDM [10, 14-18].

Overall, it can be concluded that the prevalence of GDM varies from region to region. Uttar Pradesh is the largest population holding and demographically diverse state. For the development and successful operation of any health program or policy, it becomes necessary to estimate the prevalence of GDM in different parts of the state. Considering all these facts, the present study was conducted to study the prevalence of GDM and associated risk factors among rural pregnant women of Varanasi, Uttar Pradesh, India.

Materials and Methods

Study Population: The population of the present study included all pregnant women who registered in all sub-centres of the Primary Health Center (PHC) of Harhua block, Varanasi district Uttar Pradesh during the data collection period.

Study Design: The present study was primarily conducted to explore the prevalence of GDM and associated risk factors among rural pregnant women. To achieve these goals, the researcher used a community-based cross-sectional study design and face-to-face interview technique to collect required data**.**

Sample Size:

Based on the prevalence of GDM in previous studies, a mean value of 10% was taken for the prevalence of GDM for the sample size estimation. The following formula was used to draw sample size with design effect (Multistage sampling) = 1.5

$Z^2_{\alpha/2}P\ (1\text{-}P)/d^2$

Although the estimated study sample size was 600, but actually 605 study subjects were finally taken as these study subjects who met the required criteria for the study.

Data Collection Tools and Procedure

The data collection process began by selecting six sub-centres randomly from all sub centres of the selected Primary Health Center of Community Development Block (Harhua) Varanasi district. The investigator met the pregnant women one by one who are registered for antenatal checkup in the selected sub centres. After explaining the purpose of the present study and taking the consent of the pregnant women, the data collection process started. The questions were asked in the local language to facilitate the understanding of the respondents. Investigator herself asked the questions which were stated in the schedule and filled the responses given by the pregnant women. The Socio Demographic Profile Schedule was used to collect the background information and socioeconomic status of the study participants. The modified BG Prasad's socioeconomic status scale was used to assess the socio-economic status of the study participants. Medical and obstetric data was recorded from MCP (Mother and Child Protection) card. Anthropometric measurements were recorded by using Glucometer, Weighing machine, and Measuring tape. Following DIPSI Guideline, One step OGTT with two hours after taking 75 gm oral glucose irrespective of last meal was used and screen by Glucometer. The plasma glucose level of ≥140 mg/dL was taken as cutoff for confirm the GDM in pregnant women.

Data Processing and Analysis

The collected data were cheeked, cleared and entered into MS-Excel data sheet software and analysis was done by using SPSS version (20.0). The descriptive analysis such as proportions, percentages, and frequency distribution were used for categorical variables and the chi square test was used to determine the association among variables. The logistic regression model was used on significantly associated variables. All statistical analyses were considered significant at value of $p<0.05$.

Ethical Issues

This study was approved by ethical committee of the Institute of Medical Sciences, Banaras Hindu University, Varanasi Uttar Pradesh. Written consent was taken from all the study participants after explaining the nature of the study, its potential benefits and the expected duration of the study. The confidentiality of the participants was maintained throughout the study and they were also ensured that their participation was voluntary and that they could leave the study at any time.

Results

Socio demographic characteristics of the pregnant women:

A total of 605 pregnant women participated in the study. The mean age of pregnant women was found to be 24.39 ± 3.17, ranging between 17 and 36 years. Majority of the study participants (62.48%) were in the age group of 20-25 years. Most of the pregnant women belonged to OBC category (51.24%), while 35.54% belonged to SC/ST and 13.22% belonged to general category. As regard of religion, most of the pregnant women belonged to Hindu religion (91.90%) as compared to Muslim religion (8.10%). Nearly two-thirds of the pregnant women (78.68%) were from joint family. The educational status of pregnant women shows that 10.74% of study participants were illiterate while only 21.65% of pregnant women were graduated. Nearly all pregnant women were housewife (97.36%). The modified BG Prasad scale was used to classify participants into socioeconomic groups. Most of the pregnant women were from lower middle class (44.30%) and middle class (27.60%), only 3.47% pregnant women belonged to upper class.

Table 1: Socio-demographic characteristics of study participants (N=605)

Socio-demographic characteristics		Study participants (N=605)		95% Confidence Interval	
		No.	%	Lower	Upper
Age	Below 20	20	3.31	2.0	4.8
	20-25	378	62.48	58.7	66.4
	26-30	187	30.91	27.3	34.7
	Above 30	20	3.31	2.0	4.8
Category	General	80	13.22	10.6	16.0
	OBC	310	51.24	47.3	55.0
	SC/ST	215	35.54	31.6	39.3

Religion	Hindu	556	91.90	89.6	94.0
	Muslim	49	8.10	6.0	10.4
Types of family	Joint	476	78.68	75.4	82.0
	Nuclear	129	21.32	18.0	24.6
Educational status	Illiterate	65	10.74	8.1	13.4
	Primary	53	8.76	6.6	11.1
	Secondary	189	31.24	27.8	35.0
	Higher secondary	167	27.60	24.3	31.1
	Graduate	131	21.65	18.5	25.1
Occupational status	House wife	589	97.36	96.0	98.7
	Working women	16	2.64	1.3	4.0
Socioeconomic status	Upper class	21	3.47	2.1	5.1
	Upper middle class	72	11.90	9.4	14.7
	Middle class	167	27.60	24.0	30.9
	Lower middle class	268	44.30	40.3	48.3
	Lower class	77	12.73	10.1	15.5

Socio demographic risk factors associated with GDM:

Out of 605, 46 pregnant women (7.6%) were diagnosed as GDM using DIPSI recommended 75 gm OGTT (Seen in Figure 1). The finding of the study revealed significant association between age of pregnant women and prevalence of GDM (X^2=42.42; P<.01). The presence of GDM was associated with increasing age. The highest prevalence rate of GDM was diagnosed in those pregnant women who belonged above 30 years age group (45%) followed by 26-30 years age group (7.0%), and 20-25 year age group (6.6%). In below 20 years age group, none of the pregnant women were diagnosed with GDM. Similarly, the educational status of pregnant women was found to be significantly associated with the prevalence of gestational diabetes (X^2=16.72; P<.01). The prevalence of gestational diabetes was found to be highest among illiterate pregnant women (16.9%) and the corresponding prevalence was found to be lowest among secondary educated pregnant women (2.6%). However, a clear picture of the relationship between the prevalence of GDM and the educational status of pregnant women was not found. Moreover, category (X^2=.77; P>.05), religion (X^2=.51; P>.05), type of family (X^2=.005; P>.05), occupational status (X^2=1.35; P>.05), and socio-economic status (X^2=6.35; P>.05) of pregnant women were not found to be significantly associated with prevalence of GDM. However among all socioeconomic class the highest proportion of prevalence of GDM was found in those pregnant women who belonged upper socioeconomic class (14.3%). Moreover finding revealed that only 16 working pregnant women were participated in this study and GDM was not diagnosed in any of them.

Table 2: Socio demographic risk factors associated with GDM among the study participants (N=605)

Socio-demographic characteristics		Not GDM		GDM		Chi (X^2)	P-value
		No.	%	No.	%		
Age	Below 20	20	100.0%	0	0.0%	42.42	0.00
	20-25	354	93.7%	24	6.3%		
	26-30	174	93.0%	13	7.0%		
	Above 30	11	55.0%	9	45.0%		
Category	General	72	90.0%	8	10.0%	0.78	0.68
	OBC	288	92.9%	22	7.1%		
	SC/ST	199	92.6%	16	7.4%		
Religion	Hindu	515	92.6%	41	7.4%	0.51	0.47
	Muslim	44	89.8%	5	10.2%		
Family Type	Joint	440	92.4%	36	7.6%	0.01	0.94
	Nuclear	119	92.2%	10	7.8%		
Educational status	Illiterate	54	83.1%	11	16.9%	16.72	0.00
	Primary	50	94.3%	3	5.7%		
	Secondary	184	97.4%	5	2.6%		
	H. Secondary	154	92.2%	13	7.8%		
	Graduate	117	89.3%	14	10.7%		
Occupational Status	House Wife	543	92.2%	46	7.8%	1.35	0.25
	Working	16	100.0%	0	0.0%		
Socioeconomic Status	Upper class	18	85.7%	3	14.3%	6.35	0.17
	Upper Middle Class	66	91.7%	6	8.3%		
	Middle class	161	96.4%	6	3.6%		
	Lower Middle Class	243	90.7%	25	9.3%		
	Lower Class	71	92.2%	6	7.8%		

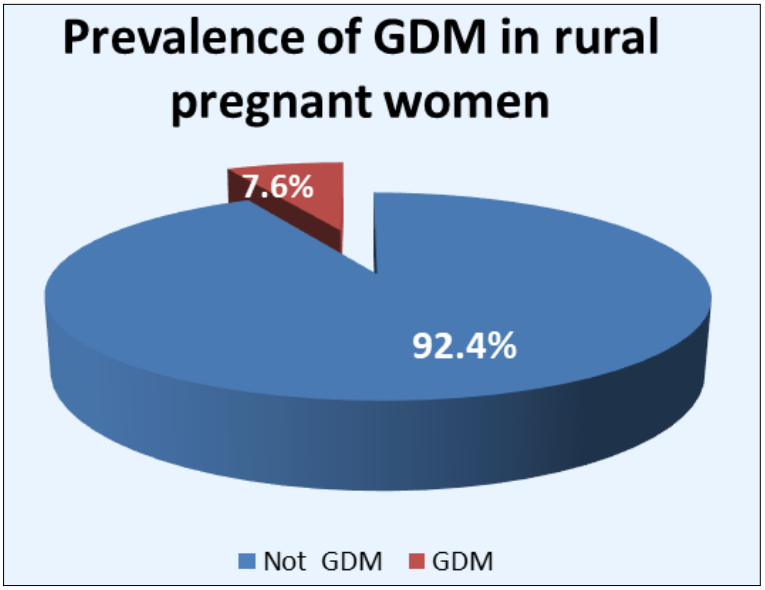

Fig 1: Showing prevalence of GDM in rural pregnant women

Clinical risk factors associated with GDM

The finding of the study revealed that clinical factors such as gestational age (X^2= 0.79; p>.05), multiparous pregnancy (X^2= 0.10; p>.05), and weight gain (X^2= 0.73; p>.05) were not found to be significantly associated with prevalence of GDM. The BMI of Pregnant women was found to be strongly and significantly associated with prevalence of GDM (X^2= 53.58; p<.01). The prevalence of GDM was found to be high with increasing level of BMI. The highest prevalence rate of GDM was diagnosed in obese pregnant women (41.2%) followed by over-weight pregnant women (18.6%), and Normal weight pregnant women (4.5%) while lowest prevalence rate of GDM was diagnosed in underweight pregnant women (3.1%).

Table 3: Clinical risk factors associated with GDM among the study participants (N=605)

Risk Pregnancy Factors		Not GDM		GDM		Chi (X^2)	P-value
		No.	%	No.	%		
Gestational Age	Second Trimester	218	91.2%	21	8.8%	0.79	0.38
	Third Trimester	341	93.2%	25	6.8%		
BMI	Under-weight (<18.5)	124	96.9%	4	3.1%	53.58	0.00
	Normal-weight (18.5-22.9)	342	95.5%	16	4.5%		
	Over-weight (23.0-27.5)	83	81.4%	19	18.6%		
	Obese (>27.5)	10	58.8%	7	41.2%		
Multiparous pregnancy (≥ 4 births)	No	506	92.5%	41	7.5%	0.10	0.76
	Yes	53	91.4%	5	8.6%		
Weight Gain	Up to 8Kg.	443	92.9%	34	7.1%	0.73	0.39
	Above 8 Kg	116	90.6%	12	9.4%		

Logistic regression analysis for predicting prevalence of gestational diabetes mellitus:

After bivariate analysis, only significantly associated variables were fed into the logistic regression model such as age and BMI. Educational status of pregnant women was not entered in logistic regression model because it did not showed linear association with GDM. Finding revealed increased likelihood of GDM with increasing age. Pregnant women aged over 30 years were 9.33 times more likelihood of developing GDM (AOR= 9.33, 95% CI: 3.20-27.19; p<.01) as compared to pregnant women under 26 years age. Similarly, obese pregnant women were 17.96 times more likelihood to develop GDM (AOR= 17.96, 95% CI: 4.30-74.98; p<.01) and over-weight pregnant women were 5.92 times more likelihood to develop GDM (AOR= 5.92, 95% CI: 1.90-18.49 p<.01) as compared to underweight pregnant women.

Table 4: Logistic regression analysis for predicting prevalence of gestational diabetes mellitus

Variables in the Equation		β	S.E.	P value	AOR	95% C.I.	
						Lower	Upper
Age	26-30	0.00	0.37	0.996	1.00	0.48	2.08
	Above 30	2.23	0.55	0.000	9.33	3.20	27.19
	Below 26 (Ref.)	---	---	---	---	---	---
BMI	Normal-weight	0.26	0.58	0.653	1.30	0.42	4.01
	Over-weight	1.78	0.58	0.002	5.92	1.90	18.49
	Obese	2.89	0.73	0.000	17.96	4.30	74.98
	Under-weight (Ref.)	---	---	---	---	---	---

Discussion

GDM is a common metabolic problem in pregnancy with variable prevalence of gestational diabetes mellitus worldwide and also in different regions of a country. The prevalence of GDM in the Indian population is high compared with other Asian countries [7, 16, 19, 20]. This evidence indicates that the prevalence of GDM might also be affected not only by different screening methods and diagnostic criteria but also by the characteristics of the population [6-10, 14]. In the present study, 7.6% pregnant women (46) were diagnosed as GDM using DIPSI recommended 75 gm OGTT.

Earlier studies conducted across India reported different rate of GDM prevalence such as 6.6% in Rajasthan [21] 6.94% in Jammu [22], 35% in Punjab [23], 8.5% in Bangalore [9], 10% in North India [11], 11.8% in Tamil Nadu [6], 3.33% in Bihar [4], 9.5% Maharashtra [2], 4.8% in Karnataka [24], 16.67% in rural Assam [19], 1.9% in rural Chhattisgarh [13], 20.4% in Gujarat [8]. The diversity of prevalence of GDM was not only found in different states of the country, but this diversity can also be seen in different parts of Uttar Pradesh. The prevalence of GDM was seen in 26% in eastern Uttar Pradesh [12], 13.45 in Kanpur Nagar [25], 13.9% in Lucknow [1], 9.7% in Saifai [26], 6.72% in western Uttar Pradesh [27]. Moreover, the prevalence has been shown to be higher in urban India as compared to the rural parts. This variation in the prevalence of GDM could be attributed to the difference in geographical conditions, cultural context, and sample drawn from urban or rural part, dietary habits and socio-economic status of study participants. It is also largely influenced by the criteria used for screening and diagnosis the GDM such as ADA, IADPSG, DIPSI, and some others.

Evidence from studies around the world suggested the likelihood of GDM among pregnant women increases with increasing maternal age [6, 11, 18, 20, 28-30]. The present study also expressed the increasing prevalence of GDM with increasing age of pregnant women. Most of the pregnant women (45%) diagnosed with gestational diabetes were above the 30 years of age group, on the other hand none of the pregnant women under 20 years of age were diagnosed with GDM. In the same order, the logistic regression model also revealed that likelihood of GDM increases with increasing age. Pregnant women aged over 30 years were 9.33 times more likelihood of developing GDM as compared to pregnant women under 26 years age. However, some degree of similarity can be seen in the findings of Thathagari *et al*. [28] who reported the likelihood of a pregnant woman >25 years of age developing GDM was 3.55 times that of a pregnant woman <25 years of age, and Gracelyn and Saranya [6] reported an odds ratio of 3.92 for pregnant women >25 years of age than comparatively younger age pregnant women.

Although maternal age is an established risk factor for gestational diabetes, the exact cause of the association between maternal age and GDM is not clearly understood. The association of advanced maternal age with higher parity, obesity, and increased insulin resistance due to parity, higher levels of circulating adipokines and inflammatory markers, as well as oxidative stress may partially clarify this association [3, 13, 14, 20, 29].

Similarly, the educational status of pregnant women was found to be significantly associated with the prevalence of gestational diabetes. The prevalence of gestational diabetes was found to be highest among illiterate pregnant women (16.9%) and lowest among secondary educated pregnant women (2.6%) and more than 10% among undergraduate pregnant women. On the other hand, the socio-economic status of pregnant women was not found to be associated with the prevalence of GDM although the highest proportion of the prevalence of GDM was found among pregnant women who belonged higher socioeconomic class (14.3%). This result is inconsistent with other studies where low socioeconomic status has been expressed as a significant risk factor for the development of GDM [19, 31]. However, this study did not provide a clear picture of the relationship between the prevalence of GDM and the educational and socio-economic status of pregnant women. Earlier studies also show somewhat mixed opinions about this relationship. Some previous studies have shown that the prevalence of GDM rate increases with increasing educational level and moving towards higher socioeconomic status [8, 9, 11, 26, 29, 32]. Meanwhile, some studies showed no association between education and socioeconomic status on GDM [18, 19, 22, 31]. Overall it can be said that every pregnant woman should be cautioned about GDM and take it seriously, whether she is highly educated and living in upper class level or lower educated and living in lower-class level.

Evidence from studies across the world as well as in different parts of India has demonstrated an association between GDM and high BMI or obesity [2, 6, 9, 10, 21, 23, 27, 28, 30, 33]. Similarly a high degree of association between occurring of GDM and high BMI was also observed in the present study. The highest prevalence rate of GDM was diagnosed in obese pregnant women (41.2%) as compared to normal-weight pregnant women (4.5%). Logistic regression revealed that obese pregnant women were 17.96 times more likely to develop as compared to underweight pregnant women.

This adverse effect of high BMI may be due to increased pressures on maternal metabolism from being overweight or excess weight during pregnancy, resulting in imbalances in hormonal carbohydrate regulation process, and increased blood glucose levels as a result of insulin sensitivity [21, 34, 35]. Furthermore, no significant association of multiparity and weight gain during pregnancy with GDM was found in the present study. However some earlier studies have reported multiparity and excessive weight gain in pregnancy as significant risk factors for development of GDM [9, 10, 15, 28, 30]. Such association may be due to the fact that higher parity is associated with advanced maternal higher age and obesity which mutually influenced the development of GDM. A good lifestyle, regular exercise, weight control and nutritional diets would be highly beneficial for the prevention of maternal/fetal complications associated with gestational diabetes mellitus.

Conclusion and Recommendation

The prevalence of GDM in pregnant women was found to be 7.60% and it was noted that together high maternal age and high BMI are very strong risk factors for the development of GDM. Research data suggests that India has become the capital of GDM globally, in such a situation, early diagnosis and appropriate intervention are necessary to ensure maternal and fetal health. In women of reproductive age, the development of GDM can be prevented to a great extent by encouraging antenatal screening, promoting healthy lifestyle habits, and maintaining a balanced weight.

Limitations

The present study has some limitations as the study design was cross-sectional so the results should be interpreted with caution. This study does not provide an opportunity to evaluate the causal relationship and no follow-up was available. The findings of the study can only be inferred about rural pregnant women attending antenatal care services. This study was based on self-report of the participants, the information obtained might had

less validity and there might be chance for recall bias. We did not simultaneously perform and compare different diagnostic criteria for screening of GDM therefore there is a possibility of error in assessing prevalence due to method of using DIPSI criteria.

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Conflicts of Interest
There are no conflicts of interest.

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