Original Article

Prevalence, risk factors and morbidities of gestational diabetes among pregnant women attending a hospital in an urban area of Bhubaneswar, Odisha

Tahziba Hussain, Shritam Das, Firdoush Parveen, Prashanti Samanta, Madhusmita Bal, V. S. Yadav, Sanghamitra Pati

Division of NCDs, ICMR-Regional Medical Research Centre, Chandrasekharpur, Bhubaneswar, Odisha, India

Abstract

Background: Gestational diabetes mellitus (GDM) causes several maternal and neonatal complications. **Aims:** This exploratory study was conducted to estimate the prevalence, determine the risk factors and morbidities among pregnant women. **Methods:** In this prospective study, 1557 pregnant women attending the Gyn. & Obs. clinic of a hospital in an urban area of Bhubaneswar were enrolled. Various socio-demographic factors and clinical profiles were assessed. We used a Glucometer for the diagnosis of GDM. **Results:** More younger pregnant women residing in slums, sedentary and overweight were having diabetes. A large percentage of pregnant women living in rural areas and slums visit the government hospitals as they are benefitted by the State govt.'s scheme, Mamata. Pregnant women residing in the urban areas prefer to go for ante-natal check-ups in private Nursing homes/Clinics owing to the crowd and prolonged waiting hours. In this study, body mass index (BMI) and family history of the pregnant women appeared to be the significant risk factors for the gestational diabetes. Out of 1557 pregnant women, 154 were having diabetes, the prevalence being 9.89%. This is low when compared to the studies reported from other regions of the country. **Conclusions:** Gluco-One is suitable for screening gestational diabetes using the optimal threshold capillary glucose level of 140 mg/dl. As the pregnant women find it difficult to come the next day just to collect the results, this facilitated in getting the test results promptly and appropriate consultation by Doctor the same day. Glucometer can be used for accurate screening of gestational diabetes mellitus. Pregnant women with screening values not normal were identified on the spot and followed up at regular intervals. Screening for diabetes among pregnant women would result in early case detection indirectly resulting in better outcomes of treatment and prevention of complications.

Keywords: Bhubaneswar, gestational diabetes, Odisha, prevalence, risk factors

Introduction

Diabetes is a major public health problem and its prevalence is rising all over the world. The number of people having diabetes is likely to increase from 171 million in 2000 to 366 million in 2030. In India, the cases may rise to about 15.1%, from 31.7 million in 2000 to 79.4 million in 2030.[1,2] Rapid urbanization, aging population, obesity epidemic and less physical activity have contributed to the increased prevalence. The prevalence rates range from 4.6% to 14% in urban areas and 1.7% to 13.2% in rural areas. There are about 62 million people with type 2 diabetes mellitus (DM) and this number is likely to increase up to 79.4 million by 2025 in India.[3,4] The prevalence of gestational diabetes mellitus, i.e., diabetes diagnosed during pregnancy,

Address for correspondence: Dr. Tahziba Hussain, Division of NCDs, ICMR-Regional Medical Research Centre, Chandrasekharpur, Nandankanan Road, Bhubaneswar - 751 023, Odisha, India.
E-mail: tahziba_hussain@hotmail.com

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increases in parallel with the diabetes prevalence. Gestational diabetes mellitus (GDM) is defined as glucose intolerance of varying degrees with onset or first recognition during pregnancy irrespective of the fact that the condition persists after pregnancy or not and whether insulin or only diet modification is used for treatment. The possibility that unrecognized glucose intolerance may have began simultaneously with the pregnancy cannot be excluded.[5,6] It poses a severe threat to the health of both mother and child. Diabetes is not the major complication of pregnancy but it can complicate pregnancy. Several maternal and neonatal complications may be caused by Diabetes in pregnancy. Maternal complications include fasting hyperglycemia, pregnancy-induced hypertension, infections whereas abortion, preterm labor, hydramnios and unexplained fetal deaths are pregnancy complications. Macrosomia, fetal malnutrition, neural tube defects and cardiac anomalies are some of the fetal complications.[7] As it imposes an immense economic burden on the society, effective strategies for management, control of diabetes and its complications are urgently needed.[8,9] This exploratory study was conducted to estimate the prevalence and determine the risk factors and morbidities among pregnant women attending secondary level health care facilities. The socio-demographic and anthropometric profiles were correlated with clinical profile.

Methodology

The detailed protocol of the study was approved by the Institutional Human Ethics Committee.

Study subjects: Pregnant women [gestational age between 24–32 weeks] attending the Gyn. & Obs. clinic of Capital Hospital, Bhubaneswar were enrolled in the study.

Pregnant women suffering from gestational diabetes were defined according to the project algorithm, national and international diabetes guidelines.[10]

Socio-demographic and anthropological data [age, marital status, index of parity (primigravida/multigravida), literacy status, occupation, lifestyle (sedentary/active), familial history (parents/siblings), BMI (height/weight), habits (smoking/alcohol/gutka), reasons for stress, the severity of diabetes (Fasting Blood Glucose (FBG), HbA1c levels), etc., were collected from pregnant women along with the type of treatment (drugs/insulin) using standard questionnaires. The random blood glucose (RBG) levels of the patients were measured with the help of Glucometer, i.e., Gluco-One (Dr. Morepen). The fasting blood glucose screening test at the first prenatal visit has good patient compliance. For this, we used a Glucometer for the diagnosis of GDM. Any other testing methodology such as a semi auto-analyzer or auto-analyzer might lead to delayed results. Gluco-One is suitable for screening gestational diabetes using the optimal threshold capillary glucose level of 140 mg/dl. As the pregnant women find it difficult to come the next day just to collect the results, this facilitated in getting the test results promptly and appropriate consultation by doctor the same day.[11-13] The Glucometer testing procedures and storage of Glucometer test strips were carried out as per the manufacturer's instructions. The diagnosis of GDM at any time during pregnancy was based on one of the following values:

Impaired Fasting Hyperglycemia (IFG): With Fasting plasma glucose = 5.1–6.9 mmol/l (92–125 mg/dl), IFG is a state of fasting blood (or plasma) glucose concentration higher than normal but lower than the diagnostic cut off values for diabetes.

Pre-diabetes and diabetes: With 2-h post 75 g oral glucose load 8.5–11.0 mmol/l (153–199 mg/dl), pre-diabetes and diabetes were classified using FBG levels >126 mg/dl for diabetes or a self-reported history of taking anti-diabetic drugs after diagnosis by a medical professional in accordance with national guidelines.[14]

Post-diagnostic testing: Continued testing for glycemic control and diabetic complications is indicated for the entire period of pregnancy once the diagnosis of diabetes is established in a pregnant woman. Those pregnant women whose blood glucose was higher than 140 mg/dl were tested again for FBG and Post-prandial Glucose (PPG). Their Out patient's Department (OPD) cards were marked with RS denoting "repeat screening." They were followed up at an interval of 3 months and their blood glucose was tested using Glucometer. Prevalence of various socio-demographic risk factors like age, BMI, index of parity, lifestyle, familial history, habits, reasons for stress, bad obstetric history, history of GDM was studied and the results were statistically analyzed.

Statistical analysis

Statistical Package for the Social Sciences (SPSS) version 25 was used for statistical analysis. Prevalence is reported with 95% confidence intervals calculated considering the design effect. All variables were described as proportions, and differences between groups were compared for statistical significance using the Chi-Square (χ^2) test and t-test as applicable. *P* values of <0.05 were considered statistically significant.

Results

In this study, 1557 pregnant women attending the Gyn. & Obs. clinic of Capital hospital in Bhubaneswar were enrolled in the study and screened for Gestational Diabetes using Glucometer by finger prick method. Capital Hospital in Bhubaneswar is the largest peripheral hospital in the State. It caters to the health needs of around 10–12 lakhs of people of Bhubaneswar and nearby districts namely Khurda, Nayagarh, Puri and some bordering areas.

The socio-demographic profile of pregnant women is depicted in Table 1. 56% were in the age group 18–25 years, 38% were in the age group 26–33 years whereas 5% were in the age group 34–40 years. This shows that more pregnant women

Table 1: Shows the socio-demographic profile of pregnant women

Parameters		No. of pregnant women screened [*n*=1557 (%)]	No. of GDM cases (*n*=154)	Statistical analysis
Age Group (in years)	18-25	874 (56.13)	89 (57.79)	χ^2=0.520, *P*=0.771
	26-33	605 (38.85)	59 (38.31)	
	>34-40	78 (5)	6 (3.89)	
Life style	Active	670 (43.03)	58 (37.66)	χ^2=2.010, *P*=0.156
	Sedentary	887 (56.96)	96 (62.33)	
Literacy Status	Illiterate	32 (2.05)	1 (0.64)	χ^2=11.186, *P*=0.011
	Primary school	319 (20.48)	46 (29.87)	
	Secondary school	934 (59.98)	79 (51.29)	
	College & above	272 (17.46)	28 (18.18)	
BMI	Underweight	217 (13.93)	5 (3.24)	χ^2=66.601, *P*=<0.0001
	Normal Weight	982 (63.07)	76 (49.35)	
	Overweight	295 (18.94)	64 (41.55)	
	Obese	63 (4.04)	9 (5.84)	
Occupation	House wife	1129 (72.51)	127 (82.46)	χ^2=8.507, *P*=0.014
	Regular Job	123 (7.89)	8 (5.19)	
	Others (daily workers, business)	305 (19.58)	19 (12.33)	
Locality	Urban	187 (12.01)	23 (14.93)	χ^2=2.310, *P*=0.315
	Rural	514 (33.01)	44 (28.57)	
	Slums	856 (54.97)	87 (56.49)	
Familial history	Yes	93 (5.97)	26 (16.88)	χ^2=36.221, *P*=<0.0001
	No	1464 (94.02)	128 (83.11)	

were young. Among the age groups, 57% of pregnant women in the 18–25 years age group and 38% in 26–33 years age group were having diabetes. Whereas 56% were sedentary and 43% were active. A total of 62% of the pregnant women who were sedentary were diagnosed to be having diabetes. About 18% were overweight and 4% were obese. About 41% of overweight women were having diabetes. All were married. About 2% were illiterate, whereas 96% had studied up to college level. A total of 51% of the literate women were having diabetes. About 72% were housewives and very few were having some kind of jobs. Among the housewives, 82% were having hyperglycemia. A total of 33% were from rural areas, 12% were from urban areas and 54% were residing in slums. About 56% of the pregnant women residing in slums were having diabetes. About 6% of the pregnant women had a family history of diabetes, i.e., one of the parents had diabetes. In the family, other members were also having diabetes. Among those having a family history, 16% had diabetes. In this study, BMI and family history of pregnant women are the significant risk factors for gestational diabetes.

The anthropometric and clinical profile of pregnant women are depicted in Table 2. About 75% of the pregnant women had visited the Gyn. & Obs. Clinic during their first pregnancy whereas 22% for their second pregnancy. Among the women who came for the first ante-natal check-up, 69% were diagnosed to be having diabetes. Few women came for an ante-natal check-up for their third and fourth pregnancy. About 37% of the pregnant women were not having any problems at the time of ante-natal check-ups. 35% were having problems related to indigestion, heartburn, acid reflux, etc., These are common problems during the pregnancy and could be due to overeating tendency among pregnant women. About 41% of those having such problems were having diabetes. In this study, we observed that 16% of pregnant women having diabetes were also having thyroid dysfunction. Thyroid dysfunction and diabetes are common endocrine disorders in the adult population which have been shown to mutually influence each other. Out of 1557 pregnant women, only 154 were having diabetes, the prevalence being 9.89%. This is low when compared to the studies reported from other regions of the country.

Discussion

In this study, 1557 pregnant women attending the Gyn. & Obs. Clinic of Capital Hospital, Bhubaneswar were enrolled and screened for type 2 DM. About 57% of pregnant women in the 18–25 years age group and 38% in 26-33 years age group were having diabetes. About 62% of the pregnant women who were sedentary were diagnosed to be having diabetes. Being sedentary is a risk factor for obesity and diabetes. About 41% of overweight women were having diabetes. About 51% of the literate women were having diabetes. Among the housewives, 82% were having hyperglycemia. About 56% of the pregnant women residing in slums were having diabetes. This shows that a large percentage of pregnant women living in rural areas and slums visit the government hospitals as the ante-natal check-up, medicines and other benefits are provided free of cost. The cost and stay during delivery are borne by the hospital. The family member accompanying the pregnant women is also provided accommodation, food and stay. In some hard to reach areas, the pregnant women are picked up and dropped by an ambulance, free of cost. The pregnant women also get incentives after delivery under the State govt.'s scheme namely Mamata. The pregnant women are entitled to receive a cash incentive of

Table 2: Shows the anthropometric and clinical profile of the pregnant women

Parameters		No. of pregnant women screened [*n*=1557 (%)]	No. of GDM cases (*n*=154)	Statistical analysis
Index of parity	I Pregnancy	1172 (75.27%)	107 (69.48)	χ^2=4.202, *P*=0.240
	II Pregnancy	349 (22.41%)	44 (28.57)	
	III Pregnancy	31 (1.99%)	3 (1.94)	
	IV Pregnancy	5 (0.32%)	0	
Complications	Bleeding Problem	254 (16.31%)	42 (27.27)	χ^2=20.518, *P*=<0.0001
	Leg swelling	171 (10.98%)	14 (9.09)	
	Chest pain, vomiting	365 (23.44%)	29 (18.83)	
	Indigestion, acid reflux, etc.	554 (35.58%)	64 (41.55)	
	Not having any other problem	585 (37.57%)	43 (27.92)	
Any other morbidities	Thyroid dysfunction	121 (7.77%)	26 (16.88)	χ^2=8.765, *P*=0.012
	Eosinophilia	63 (4.04%)	3 (1.94)	
	Gastritis	868 (55.74%)	136 (88.31)	

Rs. 6,000/- which is paid in three installments to: i) at the stages of early registration of pregnancy, ii) at the time of institutional delivery and iii) 3 months after delivery, if the childbirth is registered and is given BCG vaccination, OPV and DPT-1 & 2. The ASHA (Accredited Social Health Activist) are provided incentives based on performance to promote institutional delivery among pregnant women.[15]

While pregnant women residing in urban areas prefer to go for ante-natal check-ups in private Nursing homes/Clinics/ Corporate hospitals owing to the crowd and prolonged waiting hours. Among those having a family history, 16% had diabetes. In this study, BMI and family history of the pregnant women appeared to be the significant risk factors for the gestational diabetes. Among the women who came for the first ante-natal check-up, 69% were diagnosed to be having diabetes. Few women came for ante-natal check-up for their third and fourth pregnancy. This shows that more women were aware of the family planning concept. 37% of the pregnant women were not having any problems at the time of ante-natal check-ups. About 41% of those having problems related to indigestion, heartburn, acid reflux, etc., were having diabetes. In this study, we observed that 16% of pregnant women having diabetes were also having thyroid dysfunction. The prevalence of thyroid disease in diabetes is estimated to be 10.8%, hypothyroidism (~30%) and sub-clinical hypothyroidism (~50%) are the predominant cases. About 12% of the cases are of hyperthyroidism whereas 11% of cases are postpartum thyroiditis. Thyroid dysfunction can lead to significant metabolic disturbances and is common among diabetic patients. Screening for thyroid abnormalities at regular intervals in all diabetic patients is recommended for the treatment of subclinical thyroid dysfunction. In patients with diabetes, a Thyroid Stimulating Hormone (TSH) assay needs to be done at the time of diagnosis and then repeated at an interval of 5 years. The screening test of choice is the sensitive serum TSH assay.[16,17] Out of 1557 pregnant women, only 154 were having diabetes, the prevalence of Gestational diabetes in our study was found to be 9.89%. This is low when compared to the studies reported from other regions of the country. In India, around 4 million women are having GDM, at any particular time slot. GDM has associations beyond the index pregnancy, putting two generations at the risk of future diabetes. It poses serious health consequences, in the short and long-term for the mother and the child. Treatment of maternal hyperglycemia will reduce this risk almost to the level seen among women without GDM.[18,19] Complications such as high blood pressure, large birth weight babies and obstructed labor may be the consequences of GDM. Pregnant women diagnosed with GDM are likely to develop overt diabetes throughout postpartum and are at risk of developing diabetes 5 to 10 years after delivery.

Hyperglycemia in pregnancy is highest in women over the age of 45 and rises rapidly with age. There were around 23 million women (20–79 years) living with diabetes in 2019 and this is likely to rise to 343 million in 2045. Hyperglycemia was observed in 20 million or 16% of live births, 84% of which were due to gestational diabetes. Healthcare providers can support women with GDM in carefully controlling and monitoring their blood glucose levels to reduce the adverse outcomes of pregnancy.[20] Pre-pregnancy counseling and multidisciplinary team management is the key to achieving good pregnancy outcomes. The abnormal metabolic environment due to hyperglycemia has a profound impact on maternal and fetal outcomes. Among Indians, the prevalence of diabetes is alarmingly high. In South Asian countries, among the ethnic groups, women of southern Indian regions have the highest number of GDM. Hyperglycemia becomes more relevant during pregnancy because Indian women are 11-times at risk of developing GDM in contrast to other regions.[21] The prevalence of GDM varies widely with screening and diagnostic criteria. There are several screening criteria for the diagnosis of GDM but in this study, we used the point of care Glucometer.[11,22-25] Selfmonitoring of blood glucose using reagent impregnated strips is a simple and integral component of diabetes care and management. The precision and accuracy of glucometers have improved over the years. Though the estimates vary widely throughout India, the prevalence of GDM appears to be increasing. Several authors have carried out studies to determine the prevalence of GDM in pregnant women of different regions of India. Whereas some have focused on prevalence and risk factors, others have focused on outcomes in the various states of India.[26-40] The differences in age and/or socio-economic status

of pregnant women lead to regional differences in prevalence. Some others have focused on the awareness programs, screening strategies and management. The essential approaches to prevent the progression of GDM are awareness of risk factors, early identification, quick referral and a healthy lifestyle.[41-44]

In our study, it was found to be 9.89%. This might be due to the fact that all complicated cases were excluded right in the beginning, along with strict follow up and awareness programs running in parallel. It is important for primary care physicians to refer the pregnant women for routine screening of FBG and RBG by Glucometer as they observe the pregnant women in the Gyn. & Obs. Clinic in different hospitals or Clinics.

Universal screening of all pregnant women for GDM in all three trimesters has been made mandatory by the Government of India (GoI), to ensure that no woman is left either undiagnosed or untreated and prevent complications such as overt DM. It is better than selective screening [based on risk factors] and plays a role in early diagnosis, for detection of more cases and treatment as antenatal women with no symptoms of GDM have an adverse prognosis.[45,46] The World Health Organization (WHO) criteria are simple, in terms of cost efficiency and convenience for the pregnant women of developing countries and need to be included in the routine antenatal care of each and every pregnant women. The one-step procedure of WHO is dually useful in the screening as well as diagnosis but WHO criteria of 2nd-hour plasma sugar levels ≥140 mg is useful in identifying a number of cases and has the potential for prevention.[47]

Strengths and Limitations

This study has several strengths and few limitations as well as challenges. A large number of pregnant women were registered consecutively in a robust manner and screened. An electronic database was used for recording and reporting. Screening was implemented along with the routine health system.

The early identification of the newly diagnosed cases resulted in linking these patients to appropriate care, which in turn, lead to improved diabetes treatment outcomes.

One limitation of this study was that it was difficult to ascertain whether symptoms of hyperglycemia were present in pregnant women. The periodic screening at intervals of 3 months was a bit challenging as some did not come for regular ante-natal check-ups. It is required to investigate how the increasing incidence of GDM impacts diabetes control efforts in this State. Similarly, the investigations for estimation of HbA1C and lipid profile could not be done for patients which were costly. Some of the challenges, such as the value of repeated screening and the use of point-of-care T2DM diagnostics at each subsequent clinic visit need to be looked into. This study shows the significance of repeated screening of pregnant women to distinguish those at risk of developing GDM.

Conclusions

Out of 1557 pregnant women, 154 were having diabetes. Thus, in our study, the prevalence of Gestational diabetes was found to be 9.89%. The data from our study suggest that a Glucometer can be used for outpatient screening of pregnant women for GDM **accurately**. Glucometer is suitable for screening GDM using the optimal threshold capillary glucose level of 140 mg/dl. The benefit of capillary blood glucose screening is simplicity to use, in terms of cost and convenience. Pregnant women with screening values other than normal can be identified on the spot and registered for regular follow-up tests.

Screening for diabetes among pregnant women in ANC clinics would lead to earlier detection of diabetes leading to better diabetes-specific treatment outcomes and prevention of complications.

We, therefore, feel that screening pregnant women, irrespective of their complaints and symptoms, at regular intervals, for signs and symptoms of hyperglycemia would go a long way in early detection of gestational diabetes.

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Conflicts of interest

There are no conflicts of interest.

References

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes-estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27:104753.
2. IDF Diabetes Atlas. 9th ed. 2019. p. 1-176. Available from: https://www.diabetesatlas.org/en/. pdf.
3. Mohan V, Sandeep S, Deepa R. Epidemiology of type 2 diabetes: Indian scenario. Ind J Med Res 2007;125:217-30.
4. Ramachandran A, Snehalatha C, Kapur A, Vijay V, Mohan V, Das AK, *et al.* High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetol 2001;44:1094-101.
5. Kapoor N, Sankaran S, Hyer S, Shehata H. Diabetes in pregnancy: A review of current evidence. Curr Opin Obs Gynecol 2007;19:586-90.
6. Seshiah V, Balaji V, Balaji MS. Paneerselvam A, Kapur A. Pregnancy and diabetes scenario around the world: India. Int J Gynaecol Obstet 2009;104:S358.
7. Spellacy WN, Miller S, Winegar A, Peterson PQ.

Macrosomia-Maternal characteristics and infant complications. Obstet Gynecol 1985;66:158-61.

8. Gabbe SG, Graves CR. Management of diabetes mellitus complicating pregnancy. Obstet Gynecol 2003;102:85768.
9. Gavhane SP, Aher KH, Bangal VB, Bhavsar DK, Verma P. Study of prevalence, maternal and perinatal outcome in gestational diabetes in rural population. Pravara Med Rev 2017;9:4-9.
10. Seshiah V, Das AK, Balaji V, Joshi SR, Parikh MN, Gupta S. Gestational diabetes mellitus-guidelines. J Assoc Phys India 2006;54:622-8.
11. Klonoff DC. Point-of-care blood glucose meter accuracy in the hospital setting. Diab Spectr 2014;27:174-9.
12. Ullal A, Parmar GM, Chauhan PH. Comparison of glucometers used in hospitals and in outpatient settings with the laboratory reference method in a tertiary care hospital in Mumbai. Ind J Endocr Metab 2013;17:S688-93.
13. Food and Drug Administration*:* Blood glucose monitoring test systems for prescription point-of-care use. Available from: http://www.fda.gov/downloads/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/UCM380325.pdf.
14. Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy. WHO/NMH/MND/13.2. World Health Organization. 2013:1-62.
15. Revised MAMATA Guidelines. Government of Odisha. Department of Women & Child Development and Mission Shakti. 2017:1-31. Available from: http://wcdodisha.gov.in/Application//uploadDocuments/content/REVISED_MAMATA_GUIDELINE_IN_ENGLISH.pdf.
16. Hage M, Zantout MS, Azar ST. Thyroid Disorders and Diabetes Mellitus (Review Article). J Thyroid Res 2011;Article ID 439463:7.
17. Muller AF, Drexhage HA, Berghout A. Postpartum thyroiditis and autoimmune thyroiditis in women of childbearing age: Recent insights and consequences for antenatal and post natal care. Endocr Rev 2001;22:605-30.
18. India State-Level Disease Burden Initiative Diabetes Collaborators. The increasing burden of diabetes and variations among the states of India: The global burden of disease study 1990-2016. Lancet Glob Health 2018;6:e135262.
19. Anjana RM, Ali MK, Pradeepa R, Deepa M, Datta M, Unnikrishnan R, *et al*. The need for obtaining accurate nationwide estimates of diabetes prevalence in India-rationale for a national study on diabetes. Ind J Med Res 2011;133:369-80.
20. Diagnosis & Management of Gestational Diabetes Mellitus. Technical and Operational Guidelines. Maternal Health Division Ministry of Health and Family Welfare. Government of India December 2018:1-100.
21. Chu SY, Callaghan WM, Kim SY, Schmid CH, Lau J, England LJ, *et al*. Maternal obesity and risk of gestational diabetes mellitus. Diab Care 2007;30:2070-6.
22. Agarwal MM, Dhatt GS. Fasting plasma glucose as a screening test for gestational diabetes mellitus. Arch Gynecol Obstet 2006;275:81-7.
23. Li KT, Naik S, Alexander M, Mathad JS. Screening and diagnosis of gestational diabetes in India: A systematic review and meta-analysis. Acta Diabetol 2018;55:613-25.
24. Metzger BE, Gabbe SG, Persson B. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diab Care 2010;33:676-82.
25. Polur H, Prasad K, Bandela P, Hindumathi, Saheb S. Diabetes in pregnancy study group in India (DIPSI)-A novel criterion to diagnose GDM. Int J Biochem Res Rev 2016;10:1-6.
26. Agarwal S, Das V, Agarwal A, Pandey A, Namrata. Prevalence of gestational glucose intolerance and gestational diabetes in a Tertiary Care Centre in Northern India. J Clin Diagnos Res 2018;12:QC04-6.
27. Arora GP, Thaman RG, Prasad RB, Almgren P, Røns CB, Groop LC, *et al*. Prevalence and risk factors of gestational diabetes in Punjab, North India: Results from a population screening program. Europ J Endocrinol 2015;173:257-67.
28. Balaji V, Balaji M, Anjalakshi C, Cynthia A, Arthi T, Seshiah V. Diagnosis of gestational diabetes mellitus in Asian-Indian women. Ind J Endocrinol Metab 2011;15:187-90.
29. Bhavadharini B, Mahalakshmi MM, Anjana RM, Maheswari K, Uma R, Deepa M, *et al*. Prevalence of gestational diabetes mellitus in urban and rural Tamil Nadu using IADPSG and WHO 1999 criteria (WINGS 6). Clin Diabetes Endocrinol 2016;2:8.
30. Chanda S, Dogra V, Hazarika N, Sudke A, Vig A, Bamrah HS, *et al*. Determining the Prevalence and Risk factors of Gestational Diabetes Mellitus through Mobile Medical units in a low-resource setting in Assam, India: A Community-based Study. The Lancet Pub. Health 2018. Available from: http://dx.doi.org/10.2139/ ssrn.3514773. [Last accessed on 2020 Jan 01].
31. Jali MV, Desai BR, Gowda S, Kambar S, Jali SM. A hospital based study of prevalence of gestational diabetes mellitus in an urban population of India. Eur Rev Med Pharmacol Sci 2011;15:1306-10.
32. Kalra P, Kachhwaha C, Singh H. Prevalence of gestational diabetes mellitus and its outcome in western Rajasthan. Ind J Endocrinol Metab 2013;17:677-80.
33. Murugaraj V, Nagalingam S. Prevalence and commonest predictors of gestational diabetes mellitus: A cross-sectional study. Int J Adv Med 2019;6:96-100.
34. Panigrahi A, Mallicka, Panda, J. Gestational diabetes mellitus, its associated factors, and the pregnancy outcomes among pregnant women attending tertiary care hospitals of Bhubaneswar, India. Int J Diabetes Dev Ctries 2020;1-8. doi: 10.1007/s13410-020-00798-4.
35. Rajput R, Yadav Y, Nanda S, Rajput M. Prevalence of gestational diabetes mellitus & associated risk factors at a tertiary care hospital in Haryana. Ind J Med Res 2013;137:728-33.
36. Seshiah V, Balaji V, Balaji MS, Paneerselvam A, Arthi T, Thamizharasi M, *et al*. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu)-A community based study. J Assoc Phys India 2008;56:329-33.
37. Siddiqui S, Waghdhare S, Panda M, Sinha S, Singh P, Dubey S, *et al*. Regional prevalence of gestational diabetes mellitus in North India. J Diabetol 2019;10:25-8.
38. Shridevi AS, Prabhudev P, Bhovi MR. A clinical study of prevalence of gestational diabetes mellitus and associated risk factors at a tertiary care centre in Karnataka, India. Int J Reprod Contracept Obstet Gynecol 2015;4:1840-5.
39. Sreekanthan K, Belicita A, Rajendran K, Vijayakumar A. Prevalence of gestational diabetes mellitus in a medical college in South India: A pilot study. Ind J Clin Prac 2014;25:342-7.

40. Wahi P, Dogra V, Jandial K, Bhagat R, Gupta R, Gupta S. Prevalence of gestational diabetes mellitus and its outcomes in Jammu region. J Assoc Phys India 2011;59:227-30.
41. Mishra S, Rao CR, Bhadoria AS, Mohanty S, Kishore S, Chaudhary AS. Life-cycle approach for prevention of gestational diabetes mellitus. Clin Epidemiol Glob Health 2019;7:418-23.
42. Shriraam V, Rani SM, Sathiyasekaran BWC, Mahadevan S. Awareness of gestational diabetes mellitus among antenatal women in a primary health center in South India. Ind J Endocrinol Metab 2013;17:146-8.
43. Tieu J, McPhee AJ, Crowther CA, Middleton P. Screening and subsequent management for gestational diabetes for improving maternal and infant health. Cochrane Database Syst Rev 2014;2:CD007222.
44. Wahabi HA, Fayed AA, Alzeidan RA, Mandil AA. The independent effects of maternal obesity and gestational diabetes on the pregnancy outcomes. BMC Endocr Disord 2014;13:47.
45. Farrar D, Fairley L, Wright J, Tuffnell D, Whitelaw D, Lawlor DA. Evaluation of the impact of universal testing for gestational diabetes mellitus on maternal and neonatal health outcomes: A retrospective analysis. BMC Preg Childbirth 2014;14:317.
46. Moses RG, Cheung NW. Point: Universal screening for gestational diabetes mellitus. Diab Care 2009;32:134951.
47. WHO recommendation on the diagnosis of gestational diabetes in Pregnancy. 08 March 2018.