Burden, Risk Factors and Outcomes Associated with Gestational Diabetes in A Population-Based Cohort of Pregnant Women from North India

Stuti Bahl

Amrita Institute of Medical Sciences, Kochi, India

Neeta Dhabhai

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Sunita Taneja

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Pratima Mittal

Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India

Rupali Dewan

Vardhman Mahavir Medical College and Safdarjung Hospital, New Delhi, India

Jasmine Kaur

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Ritu Chaudhary

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Nita Bhandari

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Ranadip Chowdhury (✉ ranadip.chowdhury@sas.org.in)

Centre for Health Research and Development, Society for Applied Studies, New Delhi, India

Research Article

Keywords: Gestational Diabetes Mellitus, Stillbirth, Preterm, Caesarean section, Large for gestational age

Posted Date: July 14th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-654299/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at BMC Pregnancy and Childbirth on January 14th, 2022. See the published version at <https://doi.org/10.1186/s12884-022-04389-5>.

Abstract

Background: The burden of gestational diabetes mellitus (GDM) appears to be increasing in India and may be related to the double burden of malnutrition. The population-based incidence and risk factors of GDM, particularly in lower socio-economic populations, are not known. We conducted analyses on data from a population-based cohort of pregnant women in South Delhi, India, to determine the incidence of GDM, its risk factors and association with adverse pregnancy outcomes (stillbirth, preterm birth, large for gestational age babies) and need for caesarean section.

Methods: We analyzed data from the intervention group of the Women and Infants Integrated Interventions for Growth Study (WINGS), an individually randomized factorial design trial. An oral glucose tolerance test (OGTT) was performed at the time of confirmation of pregnancy, and for those who had a normal test (≤ 140 mg), it was repeated at 24-28 and at 34-36 weeks. Logistic regression was performed to ascertain risk factors associated with GDM. Risk ratios (RR) were calculated to find association between GDM and adverse pregnancy outcomes and need for caesarean section.

Results: 19.2% (95% CI: 17.6 to 20.9) pregnant women who had at least one OGTT were diagnosed to have GDM. Women who had prediabetes at the time of confirmation of pregnancy had a significantly higher risk of developing GDM (RR 2.08, 95%CI 1.45 to 2.97). Other risk factors independently associated with GDM were woman's age (adjusted OR (AOR) 1.10, 95% CI 1.06 to 1.15) and BMI (AOR 1.04, 95% CI 1.01 to 1.07). Higher maternal height was found to be protective factor for GDM (AOR 0.98, 95% CI 0.96 to 1.00). Women with GDM, received appropriate treatment did not have an increase in adverse outcomes. However, GDM increased the need for caesarean section (RR 1.17, 95% CI 1.01 to 1.36).

Conclusions: A substantial proportion of pregnant women from a low to mid socio-economic population in Delhi had GDM, with older age, higher BMI and pre-diabetes as important risk factors. These findings highlight the need for interventions for prevention and provision of appropriate management of GDM in antenatal programmes.

Clinical Trial registration: Clinical Trial Registry – India, #CTRI/2017/06/008908
(<http://ctri.nic.in/Clinicaltrials/pmaindet2.php?trialid=19339&EncHid=&userName=society%20for%20applied%20studies>)

Background

Gestational diabetes mellitus (GDM) is glucose intolerance that is first diagnosed during pregnancy most commonly at 24–28 weeks gestation, typically reverting to normal after delivery [1]. The clinical effects of GDM can range from asymptomatic to those of severe hyperglycaemia [2]. GDM poses risks for both the mother and fetus. For women with GDM, elevated glucose levels during pregnancy increases their risk of having a caesarean delivery, and the tendency to develop type 2 diabetes later in life. It also increases the infants' risk of being born too large and developing obesity or diabetes in the future [3]. Women with GDM are also more likely to have recurrent GDM in subsequent pregnancies [4].

The estimated prevalence of GDM, defined as a 2-hour Oral Glucose Tolerance Test [OGTT] ≥ 153 mg/dL as per World Health Organization (WHO) guidelines, varies from < 1 –28% in different countries [5]. Data from high-income countries indicate that GDM complicates up to 12.4 to 25.5% of pregnancies [6]. In India, GDM is defined as 2-hour OGTT > 140 mg/dL by the Diabetes in Pregnancy Study Group, India and in National Guidelines [7]. There is wide variability in reported prevalence estimates for gestational diabetes in India, varying from 7% [8] to nearly 16% [9]. The burden of gestational diabetes appears to be increasing in India and may potentially be related to the double burden of malnutrition. There are limited data on population-based prevalence, risk factors and adverse outcomes of gestational diabetes, particularly in lower socio-economic populations.

We conducted analyses on data from a population-based cohort of urban and peri-urban low-to-mid-socioeconomic neighborhoods of South Delhi, India, to determine the incidence of gestational diabetes mellitus, its risk factors and association with adverse pregnancy outcomes (stillbirth, preterm birth, large for gestational age babies) and need for caesarean section.

Methods

Methods

Study design, setting and participants

We conducted this secondary analysis on data being collected as part of the Women and Infants Integrated Growth Study (WINGS). The study was conducted in urban and peri-urban low-to-mid-socioeconomic neighborhoods of South Delhi, India. A summary of the WINGS is provided below, details of methods have been previously published [10].

Briefly, eligible women aged between 18 and 30 years were identified through a door-to-door survey. Women who provided written consent to participate in the study were enrolled (first randomization; to receive pre-and peri-conception interventions or routine care and followed up until their pregnancies were confirmed, or for 18 months after enrollment. Once pregnancy was confirmed by ultrasonography, written consent was obtained (second randomization; to receive enhanced antenatal, postnatal, and early childhood care or routine antenatal, postnatal, and early childhood care) from women for further participation in the study. For the current analysis, we included pregnant women from the intervention group.

Pregnant women in the intervention group received at least 8 antenatal care visits. Body mass index (BMI) and HbA1c assessments were done at the time of confirmation of pregnancy. A one step oral glucose tolerance test was performed at the time of confirmation of pregnancy, 75mg of anhydrous glucose was dissolved in 300ml of water and given orally to the participant (fasting or non fasting) and 2 hours later a venous blood sample was taken, and blood sugar tested. In woman who had a blood sugar level ≤ 140 mg/dl defined as normal, OGTT was repeated at 24–28 weeks and at 34–36 weeks of

gestation. Women who had 2 hour blood sugar value of $> 140\text{mg/dl}$ were identified to have GDM using national criteria [7]. They were initially managed with dietary counseling. Thereafter, a fasting (FBS) and post prandial blood sugar (PPBS) was done after 2 weeks. Women with PPBS of $< 120\text{mg/dl}$ were continued on dietary management and tests were repeated monthly in second trimester and fortnightly in third trimester. In women with PPBS of $\geq 120\text{mg/dl}$ medical management was initiated with Metformin or Insulin. Referral to the diabetic clinic of our collaborating tertiary care hospital was done for uncontrolled cases.

Definitions

GDM was defined as blood sugar $> 140\text{ mg/dL}$ two hours after ingesting 75 grams glucose orally at any time during pregnancy using Government of India guidelines [7]. Prediabetes was defined if HbA1c values ranged between 5.7–6.4% [11]. Stillbirth was defined if a baby was born with no signs of life at or after 28 weeks of gestation [12]. Preterm birth was defined as babies born alive before 37 completed weeks of pregnancy. Large for gestational age (LGA) was defined as infant's birth weight above the 90th percentile for gestational age using Intergrowth – 21st Standards [13].

Statistical analysis

Sociodemographic characteristics were reported as mean (SD), or proportions as appropriate. We calculated incidence (95% confidence interval: CI) of GDM occurring at any time during the pregnancy. Univariable and multivariable logistic regressions were performed to ascertain risk factors associated with GDM. The candidate variables were maternal age, height, years of schooling, religion (Hindu and others), type of family (extended or joint, and nuclear), family wealth quintiles, early pregnancy (gestational age ≤ 20 weeks) BMI, HbA1c. The family wealth index was calculated for each participant by performing a principal component analysis based on all 33 assets owned by the household as done in national surveys [14]. The total scores were used to divide the population into five equal wealth quintiles: the poorest, very poor, poor, less poor, and least poor. We also calculated risk ratios (RR) and their 95% CI for the association between GDM and adverse pregnancy outcomes (stillbirth, preterm birth, baby large for gestational age) and need for caesarean section. All statistical analyses were performed using STATA version 16 (StataCorp, College Station, TX, USA).

Results

In this study 2294 women were followed up from preconception period till delivery. Socioeconomic and clinical characteristics of enrolled women before pregnancy are shown in Table 1. The study population was relatively young, with a mean (SD) age of 23.8 (3.1) years, about half of whom had higher than secondary school education, and with a monthly family income of about 20,000 INR (about 300 USD). Just over a third (34.9%) had height less than 150 cm. The mean (SD) BMI was 22.2 (4) kg/m^2 and there was dual burden of malnutrition, with 18% women underweight and 22.8% women overweight or obese (Table 1).

Table 1
Sociodemographic characteristics of pregnant women

Characteristics of pregnant women	n = 2294
Age (years), mean (SD)	23.8 (3.1)
Height (cm), mean (SD)	152.3 (5.7)
Height < 150 cm	800 (34.9)
Years of schooling	107 (4.7)
None (0)	204 (8.9)
Primary (1–5)	835 (36.4)
Secondary (6–12)	1,148 (50.0)
Higher than secondary (> 12)	
Working outside home	110 (4.8)
Early pregnancy BMI, mean (SD)	22.2 (4.0)
Underweight (< 18.5 kg/m ²)	412 (18.0)
Overweight or obesity ($\geq$ 25 kg/m ²)	522 (22.8)
Hindu	1893 (82.5)
Wealth quintiles	393 (17.1)
Poorest	381 (16.6)
Very Poor	458 (20.0)
Poor	486 (21.2)
Less Poor	576 (25.1)
Least Poor	
Nuclear family	769 (33.5)
All values are numbers (percentages) unless stated otherwise	

Table 2 shows the proportion of enrolled women who developed GDM and those who had prediabetes before pregnancy. 19.2% (95% CI: 17.6 to 20.9) pregnant had GDM using national guidelines (2-hour OGTT value of > 140 mg/dL). About 0.2% women had diabetes and 2.7% had prediabetes before pregnancy.

Table 2
Proportion of women with gestational diabetes and with prediabetes before pregnancy

Glycemic status	n (%)	95% CI
Gestational diabetes anytime during pregnancy	n = 2244*	17.6 to 20.9
Defined as OGTT > 140 mg/dL ¹	430 (19.2)	9.2 to 11.7
Defined as OGTT > 152.9 mg/dL ²	233 (10.4)	96.2 to 97.8
HbA1c status at the time of identification of pregnancy	n = 1854**	2.0 to 3.5
< 5.7	1,800 (97.1)	0.06 to 0.5
5.7 to 6.4	50 (2.7)	
> 6.4	4 (0.2)	
¹ definition based on national guidelines; ² definition based on WHO guidelines.		
* 50 women did not have an OGTT during pregnancy: ** 440 missing values for HbA1c.		

Table 3 shows the association between baseline characteristics of women with gestational diabetes (2-hour OGTT > 140 mg/dL anytime during pregnancy). Higher age (adjusted odds ratio (AOR) 1.10, 95% CI 1.06 to 1.15 for each year), higher pre-pregnancy BMI (AOR 1.04, 95% CI 1.01 to 1.07 for each unit) and higher HbA1c (AOR 1.73, 95% 1.23 to 2.44 for each unit) were identified as risk factors for GDM. Woman's height was a protective factor (AOR 0.98, 95% CI 0.96 to 1.00, p = 0.027 for each cm) for GDM.

Table 3

Potential risk factors for developing gestational diabetes (2-hour OGTT > 140 mg/dL anytime during pregnancy) in enrolled women

Risk factors for GDM	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Age in years	1.13 (1.09 to 1.17); p < 0.001	1.10 (1.06 to 1.15); p < 0.001
Height in cm	0.99 (0.97 to 1.00); p = 0.137	0.98 (0.96 to 1.00); p = 0.027
Years of schooling	1.01 (0.98 to 1.03); p = 0.658	0.99 (0.96 to 1.02); p = 0.569
Working outside home	0.84 (0.50 to 1.40); p = 0.500	0.99 (0.57 to 1.72); p = 0.964
Nuclear family	1.01 (0.81 to 1.26); p = 0.953	0.97 (0.74 to 1.28); p = 0.837
Wealth quintile	Reference	Reference
Poorest	1.21 (0.83 to 1.78); p = 0.323	1.16 (0.76 to 1.80); p = 0.491
Very Poor	1.39 (0.97 to 1.99); p = 0.074	1.31 (0.86 to 2.01); p = 0.204
Poor	1.36 (0.95 to 1.94); p = 0.093	1.17 (0.75 to 1.81); p = 0.490
Less Poor	1.47 (1.04 to 2.07); p = 0.029	1.34 (0.87 to 2.07); p = 0.187
Least Poor		
Non-Hindu religion	0.92 (0.69 to 1.21); p = 0.543	0.90 (0.65 to 1.24); p = 0.519
Pre-pregnancy BMI (kg/m ²)	1.07 (1.05 to 1.10); p < 0.001	1.04 (1.01 to 1.07); p = 0.013
HbA1c at pregnancy confirmation (%)	2.05 (1.47 to 2.87); p < 0.001	1.73 (1.23 to 2.44); p = 0.002

Women who had prediabetes before pregnancy were at a higher risk for gestational diabetes (RR 2.08, 95% CI 1.45 to 2.97, p < 0.001; not shown in table).

Univariable and multivariable logistic regression was also performed to ascertain risk factors associated with GDM using WHO criteria (2-hour OGTT > 153 mg/dL anytime during pregnancy) and baseline characteristics of women (Supplementary Table 1). The findings were similar to those obtained using national criteria (Supplementary Table 1).

Table 4 shows the association of GDM with adverse pregnancy outcomes in the context where management of GDM was supported by the research team. In this study, there was no significant association of GDM with stillbirth, preterm birth or LGA. Women with GDM were more likely to give birth by caesarean section (RR 1.17, 95% 1.01 to 1.36) when we used OGTT > 140 mg/dL to define GDM. However, we did not find an increased risk of caesarean section in pregnant women with GDM defined by WHO criteria (Supplementary table 2).

Table 4
Association between gestational diabetes mellitus (2-hour OGTT > 140 mg/dL) and adverse pregnancy outcomes

Outcome	No GDM n (%)	GDM n (%)	RR (95% CI)
Stillbirth	N = 1782 24 (1.3)	N = 430 3 (0.7)	0.52 (0.16 to 1.71)
Preterm birth	N = 1782 230 (12.9)	N = 430 48 (11.2)	0.86 (0.65 to 1.16)
Large for gestational age	N = 1627 21 (1.3)	N = 406 8 (2.0)	1.53 (0.68 to 3.42)
Caesarean section	N = 1757 519 (29.5)	N = 427 148 (34.7)	1.17 (1.01 to 1.36)

Discussion

The main findings of this study are that 19.2% of a population-based cohort of pregnant women from urban and peri-urban low-to-mid-socioeconomic neighborhoods in South Delhi, India were diagnosed to have GDM at one or more antenatal visits. In this population there is a dual burden of malnutrition, with 18% women being underweight and 22.8% women being overweight or obese. Older age, higher pre-pregnancy BMI and higher HbA1c level at confirmation of pregnancy were identified as risk factors for GDM and higher height was a protective factor. Women with GDM, received appropriate treatment in this study and did not have an increase in adverse outcomes such as stillbirths, preterm births and large for gestational age babies but were more likely to give birth by caesarean section than women without GDM.

Previous studies have shown a wide variation in the prevalence of GDM from different states in India [8, 15–17]. The geographical differences in prevalence of gestational diabetes have been attributed to differences in mean age, BMI and socioeconomic status of pregnant women from different regions of the country [18]. Using the same cut-off (WHO, 2-hour blood sugar > 153 mg/dL) for defining GDM, the prevalence of GDM in our study was almost similar (10.4%) as that in developed countries (12.5–25.5%) [6]. Our findings related to adverse pregnancy outcomes are similar to previous studies which have shown that treatment of GDM reduces the incidence of fetal macrosomia, mortality, birth trauma, and caesarean section deliveries [19, 20].

A major strength of our study is that it is a population-based assessment of GDM in women belonging to the low to mid socioeconomic strata, which is more representative of the average Indian population. In addition to providing the burden and risk factors of GDM, we also studied the association of this condition, when it was identified early and managed appropriately, with adverse pregnancy outcomes.

The study also examined the risk associated with pre-diabetes at the time of pregnancy identification with GDM, and with adverse pregnancy outcomes. We used a single 2-hour OGTT value at any time during pregnancy to detect GDM, which is feasible in a setting like India, where the pregnant women may not return after the first visit due to financial constraints, lack of accessibility of a health care centre and other reasons.

This study has important programmatic implications. First, the high burden of GDM even in low socio-economic populations highlights the need to focus on its prevention, early detection and management in antenatal care programmes. Secondly, preventive interventions should target key risk factors including lowering the prevalence of obesity and overweight in women of reproductive age and detecting and managing pre-diabetes. Finally, early detection and appropriate management is likely to be effective in lowering the adverse pregnancy outcomes associated with GDM.

Conclusions

A substantial proportion of pregnant women from urban and peri-urban low-to-mid-socioeconomic neighborhoods in Delhi had GDM, with older age, higher BMI and pre-diabetes as important risk factors and taller woman as a protective factor. These findings highlight the need for interventions for prevention and provision of appropriate management of GDM in antenatal programmes.

Abbreviations

95% CI: 95% Confidence Interval

AOR: Adjusted Odds Ratio

BMI: Body mass index

GDM: Gestational diabetes mellitus

LGA: Large for gestational age

OGTT: Oral glucose tolerance test

WINGS: Women and Infants Integrated Interventions for Growth Study

WHO: World Health Organisation

Declarations

Ethics statement

The Ethics Review Committees of the Society for Applied Studies, Vardhman Mahavir Medical College and Safdarjung Hospital, and the World Health Organization, Geneva have approved the study. Written

consent was obtained from the study participants.

Consent for publication

Not Applicable

Availability of data and materials

The Society for Applied Studies, India is a collaborator in the Healthy Birth, Growth, and Development Knowledge Integration (HBGDKi) initiative launched by the Bill & Melinda Gates Foundation. The data generated from the study will be shared with the HBGDKi repository (<https://github.com/HBGDKi>). However, individual requests can be considered on a case-by-case basis. The request for data along with the detailed proposal describing the intended scientific question(s) to be addressed, should be submitted to Dr. Sunita Taneja (sunita.taneja@sas.org.in).

Funding

The main trial (WINGS) is funded by the Biotechnology Industry Research Assistance Council (BIRAC), Department of Biotechnology, Government of India under the Grand Challenges India - All Children Thriving Initiative (GCI-ACT Ref No: BIRAC/GCI/0085/03/14-ACT) and the Bill & Melinda Gates Foundation, USA (Grant ID #OPP1191052). The funding agencies did not play any role in study design and are neither involved in nor have any influence over the collection, analyses or interpretation of data.

Author's contributions

RC, SB, ND, ST, RB were involved in conceptualizing research questions, preparation of data file, statistical analysis, data interpretation, manuscript writing, editing and finalization. PM, RD, JK, RC, NB were involved in revising the manuscript critically for important intellectual content. All authors have read and approved the final manuscript.

Acknowledgements

The Society for Applied Studies acknowledges the core support provided by the Department of Maternal, Newborn, Child and Adolescent Health, World Health Organization, Geneva (WHO Collaborating Centre IND-158). We acknowledge the contribution and support of the mothers and families and others in the community.

References

1. Metzger BE, Coustan DR: **Summary and recommendations of the Fourth International Workshop-Conference on Gestational Diabetes Mellitus. The Organizing Committee.** *Diabetes care* 1998, **21 Suppl 2**:B161-167.

2. Kjos SL, Buchanan TA: **Gestational diabetes mellitus.** *The New England journal of medicine* 1999, **341**(23):1749–1756.
3. Zhu Y, Zhang C: **Prevalence of Gestational Diabetes and Risk of Progression to Type 2 Diabetes: a Global Perspective.** *Current diabetes reports* 2016, **16**(1):7.
4. MacNeill S, Dodds L, Hamilton DC, Armson BA, VandenHof M: **Rates and risk factors for recurrence of gestational diabetes.** *Diabetes care* 2001, **24**(4):659–662.
5. Jiwani A, Marseille E, Lohse N, Damm P, Hod M, Kahn JG: **Gestational diabetes mellitus: results from a survey of country prevalence and practices.** *The journal of maternal-fetal & neonatal medicine: the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet* 2012, **25**(6):600–610.
6. Sacks DA, Hadden DR, Maresh M, Deerochanawong C, Dyer AR, Metzger BE, Lowe LP, Coustan DR, Hod M, Oats JJ *et al*: **Frequency of gestational diabetes mellitus at collaborating centers based on IADPSG consensus panel-recommended criteria: the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study.** *Diabetes care* 2012, **35**(3):526–528.
7. India. MHDMoHaFWGo: **Diagnosis & Management of Gestational Diabetes Mellitus. Technical and Operational Guidelines.** In.; 2018.
8. Swami SR, Mehetre R, Shivane V, Bandgar TR, Menon PS, Shah NS: **Prevalence of carbohydrate intolerance of varying degrees in pregnant females in western India (Maharashtra)–a hospital-based study.** *Journal of the Indian Medical Association* 2008, **106**(11):712–714, 735.
9. Seshiah V, Balaji V, Balaji MS, Sanjeevi CB, Green A: **Gestational diabetes mellitus in India.** *The Journal of the Association of Physicians of India* 2004, **52**:707–711.
10. Taneja S, Chowdhury R, Dhabhai N, Mazumder S, Upadhyay RP, Sharma S, Dewan R, Mittal P, Chellani H, Bahl R *et al*: **Impact of an integrated nutrition, health, water sanitation and hygiene, psychosocial care and support intervention package delivered during the pre- and peri-conception period and/or during pregnancy and early childhood on linear growth of infants in the first two years of life, birth outcomes and nutritional status of mothers: study protocol of a factorial, individually randomized controlled trial in India.** *Trials* 2020, **21**(1):127.
11. Rudan I, O'Brien KL, Nair H, Liu L, Theodoratou E, Qazi S, Luksic I, Fischer Walker CL, Black RE, Campbell H: **Epidemiology and etiology of childhood pneumonia in 2010: estimates of incidence, severe morbidity, mortality, underlying risk factors and causative pathogens for 192 countries.** *Journal of global health* 2013, **3**(1):010401.
12. Taneja S, Strand TA, Kumar T, Mahesh M, Mohan S, Manger MS, Refsum H, Yajnik CS, Bhandari N: **Folic acid and vitamin B-12 supplementation and common infections in 6-30-mo-old children in India: a randomized placebo-controlled trial.** *The American journal of clinical nutrition* 2013, **98**(3):731–737.
13. Villar J, Cheikh Ismail L, Victora CG, Ohuma EO, Bertino E, Altman DG, Lambert A, Papageorgiou AT, Carvalho M, Jaffer YA *et al*: **International standards for newborn weight, length, and head**

- circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. *Lancet (London, England)* 2014, **384**(9946):857–868.
14. Balram Paswan SKS, Hemkothang Lhungdim, Chander Shekhar, Fred Arnold, Sunita Kishor, Abhishek Singh, Dhananjay W. Bansod, Manoj Alagarajan, Laxmi Kant Dwivedi, Sarang Pedgaonkar, Manas R. Pradhan: **International Institute for Population Sciences (IIPS) and Macro International. National Family Health Survey (NFHS-4)**. In.; DECEMBER 2017
 15. Bhatt AA, Dhore PB, Purandare VB, Sayyad MG, Mandal MK, Unnikrishnan AG: **Gestational diabetes mellitus in rural population of Western India - Results of a community survey**. *Indian journal of endocrinology and metabolism* 2015, **19**(4):507–510.
 16. Gopalakrishnan V, Singh R, Pradeep Y, Kapoor D, Rani AK, Pradhan S, Bhatia E, Yadav SB: **Evaluation of the prevalence of gestational diabetes mellitus in North Indians using the International Association of Diabetes and Pregnancy Study groups (IADPSG) criteria**. *Journal of postgraduate medicine* 2015, **61**(3):155–158.
 17. Arora GP, Thaman RG, Prasad RB, Almgren P, Brøns C, Groop LC, Vaag AA: **Prevalence and risk factors of gestational diabetes in Punjab, North India: results from a population screening program**. *European journal of endocrinology* 2015, **173**(2):257–267.
 18. Mithal A, Bansal B, Kalra S: **Gestational diabetes in India: Science and society**. *Indian journal of endocrinology and metabolism* 2015, **19**(6):701–704.
 19. Crowther CA, Hiller JE, Moss JR, McPhee AJ, Jeffries WS, Robinson JS: **Effect of treatment of gestational diabetes mellitus on pregnancy outcomes**. *The New England journal of medicine* 2005, **352**(24):2477–2486.
 20. Landon MB, Spong CY, Thom E, Carpenter MW, Ramin SM, Casey B, Wapner RJ, Varner MW, Rouse DJ, Thorp JM, Jr. *et al*: **A multicenter, randomized trial of treatment for mild gestational diabetes**. *The New England journal of medicine* 2009, **361**(14):1339–1348.

Supplementary

Supplementary Tables are not available with this version