Pravara Med Rev; March 2022, 14 (01), 5 - 14
DOI: 10.36848/PMR/2022/50100.51000

Original article

Study of the risk factors associated with gestational diabetes mellitus at a tertiary level rural hospital, Maharashtra

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ABSTRACT:

Background: Gestational diabetes mellitus (GDM) is a severe and neglected threat to maternal and child health. Many women with GDM experience pregnancy related complications including high blood pressure, large birth weight babies and obstructed labour. Approximately half of women with GDM develop type 2 diabetes within 5 to 10 years after delivery.[2]

Materials & Methods: A case-control study was carried out to find the risk factors for GDM among pregnant women delivering at the Obstetrics & Gynecology department of Pravara Rural Hospital. The study was carried out from October 2018 to November 2020. Total 132 patients were included in the study of whom 44 were cases with GDM & 88 were controls without GDM. Chi-square, Fisher's exact t- test, OR with 95%CI for matched case control study & p-value were calculated.

Results: Family history of DM among first degree relatives, increase in pre-pregnancy BMI, sedentary lifestyle, upper SEC, presence of GDM in last pregnancy, neck circumference>35cms are found to be the risk factors for GDM.
UTI & PIH were found to be some of the health related issues associated with the current pregnancy affected by GDM.
LSCS being mostly the nature of delivery & macrosomic babies were found to be the major pregnancy outcome for mothers with GDM.

Conclusion: GDM affects not only the health status of the mother but also the health status of the newborn. Proper screening of the mothers for GDM is highly recommended.

Key words:- GDM, Macrosomia, PIH, UTI, NCD, case control study.

INTRODUCTION:-

Gestational diabetes mellitus (GDM) is a severe & neglected threat to maternal and child health.[1] Many women with GDM experience pregnancy related complications including high blood pressure, large birth weight babies and obstructed labour.[1] In India, the prevalence of GDM ranges from 6% to 9% in rural and 12%-21% in urban areas with most studies being done in either South or North India.[2] GDM, similar to Impaired Glucose Tolerance, is associated with many risk factors which are modifiable. This study was conducted to focus on the risk factors of GDM so that this modifiable disease which not only affects the mother but also the new born can be prevented from the beginning itself. Not many case control studies on a rural population of Maharashtra were conducted on this topic.

OBJECTIVES:-

1) To study the risk factors associated with gestational diabetes mellitus among pregnant mothers delivering at Pravara Rural Hospital.
2) To study the health related issues with gestational diabetes mellitus.
3) To study the immediate fetal outcome of mothers with gestational diabetes mellitus.

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4) To compare maternal risks & immediate fetal outcome among cases suffering from GDM & their controls not suffering from GDM.

MATERIALS & METHODS:-

An age matched case control study was carried out at the Obstetrics & Gynecology Department of Pravara Rural Hospital, Loni, Maharashtra from the period of October 2018 till November 2020 among pregnant mothers having their deliveries conducted at this hospital & who had given written informed consent. Pregnant mothers with pre-existing diabetes were excluded from the study. The minimum sample size was calculated by the openepi software. For an alpha error of 5%, for a power of 80%, assuming hypothetical proportion of exposure among controls to be 14.3%[6], and the odds ratio, 3.7[6]& taking 2 controls for 1 case , the minimum sample size was estimated to be 44 for cases & 88 for controls. The data collection was done on the basis of the questionnaire prepared for the pregnant mothers coming to the Obstetrics & Gynaecology Department. The data was collected solely by the principal investigator on the basis of the proforma prepared. Confidentiality of the patients was maintained. Data was presented in the form of tables & graphs. Matched OR with 95% CI was calculated. Chi square test & Fisher's exact t-test (only when cells have expected frequencies < 5[24] was performed. p-value was calculated & value ≤0.05 was considered to be statistically significant.[25] Software epi-info version 7.2.2.6 was used for preparation of the schedule & entry of data. Software IBM SPSS version 22.0, Open Epi version 3.01, GraphPad & Microsoft Office Excel version 2007 were used for analysis of data. Cases were pregnant mothers diagnosed with GDM in the present pregnancy. Controls were pregnant mothers without GDM in the present pregnancy with age ±2 years that of the cases.

The operational guidelines followed in the present study for detection of GDM was all the pregnant mothers coming for their ante natal check up had to undergo a RBS. RBS ≥200mg/dl is considered as having deranged blood sugar level & had to undergo OGTT. A total of 3 blood samples would be collected. The first taken at fasting stage, the second after 1hour of administration of 75gm of glucose in 300ml of water & the third after 2hours of glucose administration. The third sample if found to have a blood sugar level of ≥140mg/dl was diagnosed of having GDM. Weight was calculated by using a mechanical bathroom weighing scale was used for this purpose by Sknol, model number 747, with an accuracy at 0.5kg. The minimum & maximum weight that could be taken was 5kgs & 150kgs respectively. Weight was measured with the participants standing with almost straight back, without wearing shoes & were told to look straight in front. Standiometer was used for height measurement. The participant was asked to stand upright & was told to look straight at front. The head was kept fixed & the participant was told to take off the shoes on standing on the platform of the standiometer. The measurements were taken in centimeter. Neck circumference was measured in centimeters (cm) using a measuring tape at the level of the upper margin of the thyroid cartilage. BMI[1] was measured using the formula = weight in kgs÷ (height in metre)^2 . BMI classification was adapted from WHO, 2003. Socio-economic status was classified according to modified B.G.Prasad classification 2019. Age was recorded to the nearest completed year after confirmation by asking birth date or by Adhaar card. Occupation was defined as participation in any economically productive activity either physical or intellectual in nature[1]. Life style was assessed based on the occupation of subjects & leisure time activity was not considered[23]. Macrosomia was defined as birth weight greater than 3.45 kg (90th percentile) of neonates[22] . The present study was commenced only after the prior approval from IEC-PIMS.

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RESULTS

Table No:-1 Age distribution of Cases

Age in years	20-25 n(%)	26-31 n(%)	32-37 n(%)	Total
Case	12(27.27)	16 (36.36)	16(36.36)	44

The mean age (in years) of the Controls & Cases were 28.659(±SD=4.82) & 28.795(±SD= 5.097)respectively. Almost 73% of Cases were aged above 25years. The un-paired t-test value was 0.8811 between the age group of cases & controls & the difference was found to be not statistically significant. The present study had found that the prevalence of GDM increases with age.

Table No. 2:- Distribution of Cases & Controls based on the neck circumference

	Neck circumference		Total
	>35cm n(%)	≤35cm n(%)	
Case	19(43.18)	25(56.818)	44
Control	4(4.545)	84(95.45)	88
Total	23	109	132

Fisher's exact 2 tailed p-value= 0.0001
OR= 4.75 & 95%CI= 1.616-13.96

The association of neck circumference with GDM was found to be statistically significant. OR 4 shows that women with neck circumference >35cm are 4 times more exposed of developing GDM compared to women with neck circumference ≤35cm. The increase in neck circumference among cases might also be due to more prevalence of hypothyroidism or high pre-pregnancy BMI among cases as compared to controls.

Table No.3:- Distribution of Cases & Controls on basis of the status of NCD among their first degree relatives.

	Presence of NCD		Total
	Yes n(%)	No n(%)	
Cases	32(72.727)	12(27.27)	44
Controls	26(29.54)	62(70.45)	88
Total	58	74	132

Chi square= 20.487, Df= 1 & p= 0.0001

The association of the presence of NCD among first degree relatives with GDM was found to be statistically significant.

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Table No.4:- Distribution of Cases & Controls on basis of the status of UTI associated with the present pregnancy

	Pregnancy with UTI		Total
	Present n(%)	Absent n(%)	
Case	11(25)	33(75)	44
Control	2(2.27)	86(97.727)	88
Total	13	119	132

Fisher's exact 2 tailed p-value= 0.0001
OR= 5.5 & 95%CI= 1.219-24.81

The association of UTI in pregnancy with GDM was found to be statistically significant. OR almost 5 shows that cases are 5 time more exposed of suffering from UTI in pregnancy compared to controls.

Table No. 5:- Distribution of Cases & Controls on basis of parity

	Parity		Total
	Multipara n(%)	Primipara n(%)	
Cases	25(56.818)	19(43.81)	44
Controls	48(54.545)	40(45.54)	88
Total	73	59	132

Chi square= 0.004 Df= 1 p= 0.095
OR= 0.52 & 95%CI= 0.32-0.84

The association of parity with GDM was found to be statistically not significant. With OR 0.5, cases are less likely to be primipara as compared to the controls.

With Chi square (sedentary with heavy)= 7.478 at Df= 1 & p= 0.006 the association of lifestyle with GDM was found to be statistically significant. With OR (moderate with heavy work)=0.33 & 95%CI=0.12-0.917 women who have to undergo heavy physical work are less exposed to having GDM compared to women who undergo moderate physical work.

Table No.6:- Distribution of Cases & Controls on basis of the status of GDM association with the last pregnancy.

	Status of GDM		
	Present n(%)	Absent n(%)	Total
Cases	9(30)	21(70)	30
Controls	0(0)	51(100)	51
Total	9	72	81

Fisher's exact two tailed p-value=0.0001

30% of Cases had their previous pregnancy affected by GDM & this association was found to be statistically significant showing that if the previous pregnancy is affected by GDM there is a high risk of present pregnancy being affected by GDM too. The OR in the present study may be biased as there were no controls with GDM associated with previous pregnancy & it could be due to Berkesonian bias.

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Table No. 7:- Distribution of Cases & Controls on basis of the status of PIH associated with the present pregnancy

	PIH		Total
	Present n(%)	Absent n(%)	
Cases	17(38.636)	27(61.36)	44
Controls	4(4.545)	84(95.45)	88
Total	21	111	132

Fisher's exact 2 tailed p value= 0.0001
OR= 4.25 & 95%CI= 1.43-12.63

The association of PIH with GDM was found to be statistically significant. OR almost 4 shows that mothers with PIH are 4 times more prone for developing GDM compared to mothers without PIH.

Table No.8:- Distribution of Cases & Controls on basis nature of delivery in the present pregnancy

	Nature of Delivery		Total
	LSCS	NVD	
Cases	35(79.545)	9(20.45)	44
Controls	45(51.136)	43(48.86)	88
Total	80	52	132

Chi square= 8.762 Df= 1 p= 0.0031

The association between nature of delivery(LSCS) with GDM was found to be statistically significant which might be because of high prevalence of Macrosomic babies among cases.

Chart No.4 :- Pie-diagram showing distribution of Cases on the basis of the present pregnancy outcome.

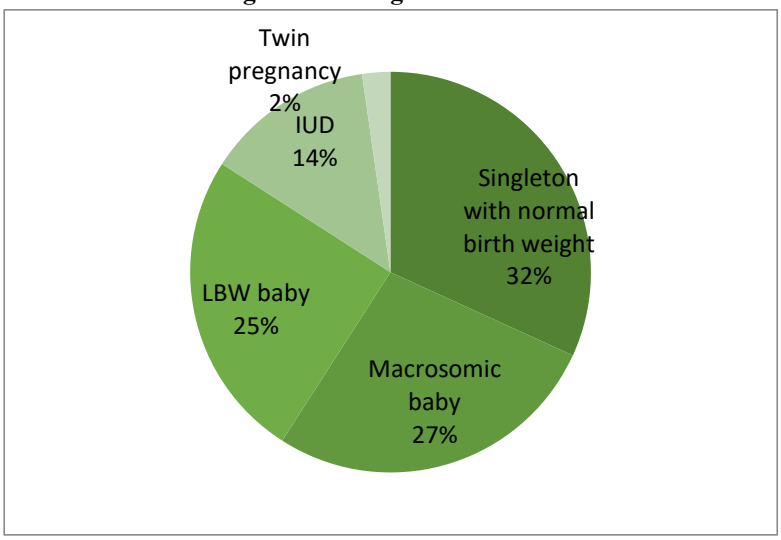

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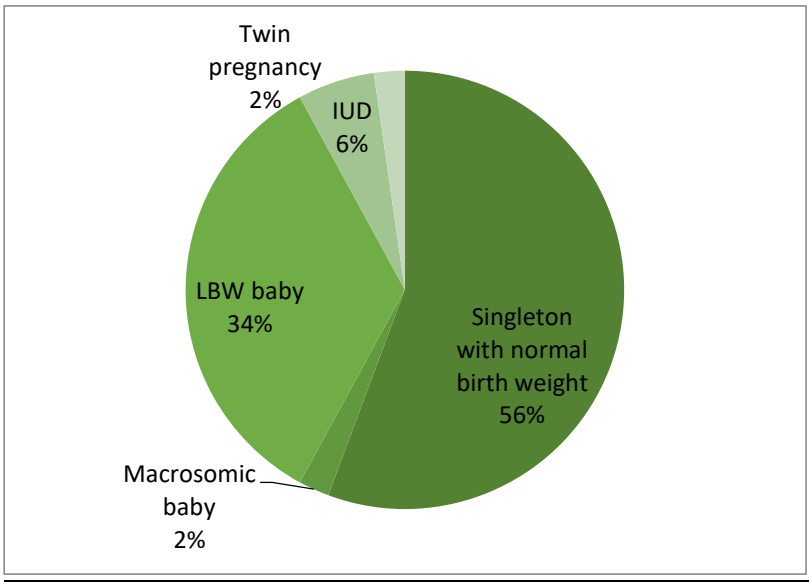
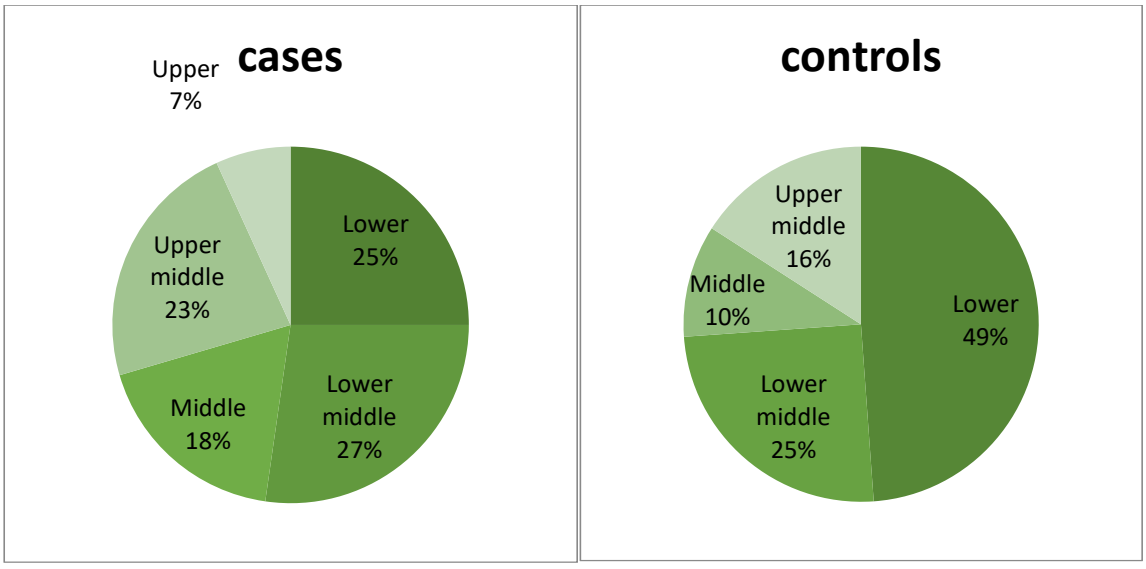
Chart No.4.1 :- Pie-diagram showing distribution of Controls on the basis of the present pregnancy outcome.



Fisher's exact 2 tailed p-value (between Macrosomic baby & singleton with normal birth weight) = 0.0001
OR (Macrosomic baby with normal birth weight)=6 & 95%CI= 1.343-26.81
OR (LBW with normal birth weight)=0.3667 & 95%CI= 0.18-0.73
The association between outcome(Macrosomic baby with normal birth weight bay) of present pregnancy with GDM was found to be statistically significant. OR 6 shows that women with GDM are 6 times more likely to give birth to macrosomic babies compared to women without GDM.

Chart No. 5 :- Pie-diagram showing distribution of cases & controls on basis of their socio economic class



Fisher's exact 2 tailed p-value 0.01 between upper and lower SEC gives a strong statistically significant association between GDM & SEC. Higher SEC → higher level of education → higher prevalence of sitting jobs(sedentary lifestyle & unhealthy eating habits) → higher prevalence of GDM.

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DISCUSSION

The present study had found that almost 73% of Cases were aged above 25years & prevalence of GDM increases with age. In a study conducted by Bhat M et al [6] 60.7% (n = 182) of the Cases were ≥ 25 years. Bhatt AA et al[4] did not find any significant association with increasing maternal age & prevalence of GDM. Seshiah V et al[18] that the prevalence of proportion of GDM increased with age. Verma AK et al[17] had not found increased in age to be a risk factor for GDM. Rajput R et al[20] had found that the prevalence rate for GDM was higher in women aged >25years. The present study had found 77% of cases & 50% of controls to be homemakers leading a sedentary lifestyle but only 11% of Cases had to do heavy work whereas almost 33% of Controls were involved in some type of heavy work. Bhat M et al [6] had found that the prevalence of homemakers among GDM Cases & Controls were 95% & 99% respectively & the association between the occupation was found to be statistically significant. Verma AK et al[17] had found that the occupation was the only variable which had the significant statistical influence on the diabetic state of the mother. Anand SS et al[15], had found no differences between the GDM & non-GDM groups in physical activity in pregnancy. Swami SR et al[14] had found a non-significant trend of increased GDM in patients with decreased physical activity. The present study had found that 25% of Cases & 49% of Controls belonged to the lower socioeconomic class whereas 7% of Cases belonged to the upper socioeconomic class. Bhat M et al [6] had found no difference in monthly family income among GDM Cases & Controls. Anand SS et al[15], had found no difference in socioeconomic status among women with & without GDM. Rajput R et al[20], had found odds ratio was found to be highest for GDM Cases in socio-economic status >upper middle class (5.48). Verma AK et al(2008)[17] had found no statistical significant relationship between socioeconomic status & GDM. The present study had found that 4% of Cases & 31% of Controls had low BMI. 32% of Cases & 56% of Controls had normal BMI. Prakash GT et al[12], had observed that the average body mass index (BMI) was 28.8kg/m^2 for GDM mothers when compared to 25kg/m^2 in the Controls. Anand SS et al[15], had observed that when compared to the participants without gestational diabetes, those with gestational diabetes were more likely to have a higher pre-pregnancy body mass index (BMI) {mean 24.9 (SD 4.6) v. 23.2 (SD 4.3), p < 0.001}. Mahalakshmi MM et al[7], had found that women with GDM had higher mean body mass index at first booking (26.4 ± 5.2 kg/m^2 vs. 25.2 ± 5.1 kg/m^2; *P* < 0.001). Bhat M et al[6], had observed that body mass index ≥ 25 was significantly higher in Cases than Controls (37.9 vs. 14.3%). Swami SR et al[14], had observed that prevalence of GDM was more in patients with body mass index (BMI) >23 compared to BMI<23{GDM: 11.4% versus 8.3% (p=0.0374)}. Puttaraju CM et al[21] had observed that mean BMI of GDM patients was 20.87±6.61 kg/ m^2 & BMI >25 kg/m^2 was observed in 43.39% (23/53) of the GDM patients; of which 9.4 %(5/53) were obese and 34%(18/53) were overweight. Neelakandan R et al[9], had observed that among the women with GDM, 38 (14.7%) women had a BMI of <23, 96 (37.2%) had a BMI of 24-30 and 124 (48.0%) had BMI >30. The prevalence of GDM increased from 14.7% for BMI <23 to 48% for BMI > 30. Rajput R et al(2013)[20], had found that Women having BMI >25 kg/m^2 had GDM 11/50 (22%) compared to 11/232 (4.7%) in women with BMI 18.5 kg/m^2. The present study had found that 84% of Cases & 38% of Controls had a family history of diabetes among first degree relatives. Both Anand SS et al(2017)[15] & Bhat M et al2010[6] had observed family history of diabetes among first degree relatives to be a risk factor for GDM. The present study had found that 30% of Cases had the previous pregnancy affected by GDM. Prakash GT et al[12], had observed that 23% of GDM mothers had a history of GDM. The present study had found that 25% of Cases & only almost 2% of Controls had UTI associated with the present pregnancy. Bhat M et al[6],had observed UTI(OR = 4.8), to be significantly associated with GDM. Mohan MA et al[10], had seen that the percentage of pregnant women affected by vaginal candidiasis was 25% in GDM group contrasting with 6.5% in non-GDM group. McMahon MJ et al[11] had observed that urinary tract infection occurred more frequently in women with GDM than in those without GDM. The present study had found that 32% of Cases & 56% of Controls had babies with normal birth weight, 27% of Cases & only 2 % of Controls had Macrosomic babies & 25% of Cases & 34% of Controls had LBW babies. Mahalakshmi MM et al[7], had found that women with GDM had higher rates of macrosomia (13.9% vs. 10.8%; *P* = 0.02). Mithal A et al[3], had wrote that

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GDM influences Macrosomia. Balaji V et al[22], had observed Macrosomia in 9.9% of GDM women with intervention and 9.8% of the NGT women. Bhat M et al[6], had observed that macrosomia (OR = 4.4), was significantly associated with the presence of GDM. Shefali AK et al[13], had found that the prevalence of 'low birth weight' babies in the study groups were:- 14.3% in non-diabetic mothers, and 8.2% in GDM & the prevalence of 'large babies' was higher in GDM (27.6%)group compared to non-diabetic Controls (7.1%) & the differences was statistically significant [p = 0.04]. The present study had found that almost 79% of Cases & 51% of Controls had delivered by caesarean section in the index pregnancy. Mohan MA et al[10],had observed more women in GDM group underwent caesarean section (81.3% in GDM vs 30.2% in non-GDM) in comparison to non GDM group, where spontaneous vaginal delivery was more prevalent (15.6% in GDM vs 69.2% in non-GDM). Pandey U et al[16], had observed LSCS rate to be 69.23 % in the GDM group. The present study had found that almost 39% of Cases & only 4% of Controls had PIH associated with the current pregnancy. Mohan MA et al[10],had observed that the gestational hypertension to be higher in GDM group (28.1%) than in non GDM group (13.0%). Bhatt AA et al[4], had found that gestational hypertension does not have a significant association with prevalence of GDM. Saxena P et al[19] had found that the incidence of pregnancy induced hypertension (PIH), to be more in diabetic pregnancies. The present study had found that almost 43% of Cases & 4% of Controls had neck circumference >35cm. Bakht K et al [8]had found after analysis of the receiver operating curve that the cut-off value of the neck circumference for predicting gestational diabetes was 35.70 cm with a sensitivity of 0.514 and specificity of 0.812.

RECOMMENDATIONS

National guidelines for management of GDM[5] should be followed at all levels of health care delivery system.

Primary prevention

"Individual high risk strategy" should be followed in case of preventing GDM. Women with a positive family history of DM among first degree relatives, overweight individuals, elderly women & mothers with previous history of GDM should be given more priority.

Secondary prevention

Screening by OGTT for all the pregnant women should be made mandatory according to the national guidelines[5]. Delay in receiving proper treatment should be avoided. As soon as a mother is detected with GDM medical nutrition therapy(MNT) with physical exercise should be started.

Tertiary prevention

All neonates of GDM mothers should receive immediately essential newborn care with emphasis on early breastfeeding to prevent hypoglycemia. 75 gm OGTT (fasting and 2 hr PP) at 6 weeks postpartum to evaluate glycemic status of GDM women should be made mandatory.

STUDY LIMITATIONS

Findings cannot be extrapolated to the general population as it is a hospital based study. Not every mother was screened for GDM by OGTT. Although the minimal sample size was taken, but each & every woman who was diagnosed as GDM during the study period was considered in the present study. Temporal association is not proven since direction of reasoning here was retrospective. Only OR could be calculated from the present study, but neither incidence nor prevalence of GDM could be calculated.

ACKNOWLEDGEMENT

To the HoD of the Obstetrics & Gynaecology Department of Pravara Rural Hospital for his cooperation in completion of the present study without any hindrance.

REFERENCES

1.Park K. Epidemiology of Chronic Non communicable diseases and Conditions. Park's Textbook of Preventive & Social Medicine.24th edition Bhanot Publishers; 2017.p.391-5, 410-1, 415-9, 726 & 561.

2. International Diabetes Federation. IDF Diabetes Atlas, 9thedn. Brussels, Belgium: International Diabetes Federation,2019https://www.idf.org/our-activities/care-prevention/gdm(data accessed on July 27,2020).
3. Mithal A, Bansal B, Kalra S. Gestational diabetes in India:science and society. Indian J EndocrinolMetab. 2015 Nov-Dec; 19(6):701-4
4. Bhatt AA, Dhore PB, Purandare VB, Syyad MG, Mandal MK, UnnikrishnanAG.Gestational diabetes mellitus in rural population of Western India.Results of a community survey. Indian J EndocrinolMetab. 2015 Jul-Aug; 19(4): 507-10.
5. Diagnosis & Management of Gestational Diabetes Mellitus. Technical and Operational Guidelines. Maternal Health Division, Ministry of Health and Family Welfare, Government of India, February 2018.www.nhm.gov.in/nrhm-components/rmnch-a/maternal-health/guidelines.html (data accessed on September15,2018).
6. Bhat M,Ramesha KN, Sankara PS, Menon S, Sowmini CV, Kumar SG.Determinants of gestational diabetes mellitus: A case control study in a district tertiary care hospital in south India.Int J Diabetes DevCtries. 2010 Apr-Jun; 30(2): 91–6.
7. Mahalakshmi MM, Bhavadharini B, Maheswar K, Kalaiyarasi G, Anjana RM,Ranjit U, et al.Comparison of maternal and fetal outcomes among Asian Indian pregnant women with or without gestational diabetes mellitus: A situational analysis study (WINGS-3). Indian J EndocrinolMetab. 2016 Jul-Aug; 20(4): 491–6.
8. Bakht K, Mazhar S,Bhalli A, Rashid A, Khan K and Jahanzaib U. Correlation Between Neck Circumference and Gestational Diabetes Mellitus and Associated Risk Factors During Pregnancy. Cureus. 2018 May; 10(5): e2699.
9. Neelakandan R, Sethu PS. Early Universal Screening for Gestational Diabetes Mellitus.J ClinDiagn Res. 2014 Apr; 8(4): OC12–OC14.Published online 2014.
10. Mohan MA, Chandrakumar A. Evaluation of prevalence and risk factors of gestational diabetes in a tertiary care hospital in Kerala. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. Volume 10, Issue 2, April–June 2016, Pages 68-71.
11. McMahon MJ, Ananth CV, Liston RM.Gestational diabetes mellitus.Risk factors, obstetric complications and infant outcomes. J Reprod Med. 1998 Apr;43(4):372-8.
12. Prakash GT, Das AK, Habeebullah S,Bhat V, Shamanna SB. Maternal and Neonatal Outcome in Mothers with Gestational Diabetes Mellitus. Indian J EndocrinolMetab. 2017 Nov-Dec; 21(6): 854–58.
13. Shefali AK, Kavitha M, Deepa R, Mohan V. Pregnancy outcomes in pre-gestational and gestational diabetic women in comparison to non-diabetic women--A prospective study in Asian Indian mothers (CURES-35). J Assoc Physicians India. 2006 Aug;54:613-8.
14. 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.J Indian Med Assoc. 2008 Nov;106(11):712-4, 735.
15. Anand SS,Gupta M ,Teo KK, SchulzeKM, Desai D,AbdallaN, et al. Causes and consequences of gestational diabetes in South Asians living in Canada: results from a prospective cohort study. CMAJ Open 2017 Jul-Sep; 5(3): E604-11.
16. Pandey U, Kumar AN, Agrawal S, Batra S. Outcome of Diabetic Pregnancies in a Tertiary Referral Centre, Varanasi. The Journal of Obstetrics and Gynecology of India.J ObstetGynaecol India. 2016 Aug;66(4):226-32.
17. VermaAK , Singh B, Mengi V. Gestational Diabetes In Rural Women of Jammu. Indian J Community Med. 2008 Jan; 33(1): 54–5.
18. Seshiah V, Balaji V, Balaji MS, Sanjeevi CB, Green A. Gestational Diabetes Mellitus in India. J Assoc Physicians India.Vol.52. September 2004.707-11.
19. Saxena P, Tyagi S, Prakash A, Nigam A, Trivedi SS. Pregnancy outcome of women with gestational diabetes in a tertiary level hospital of north India. IJCM, Year 2011, Vol 36; issue 2; Page 120-3.
20. Rajput R, Yadav Y, Nanda S, Rajput M. Prevalence of gestational diabetes mellitus & associated risk factors at a tertiary care hospital in Haryana. Indian J Med Res 137, April 2013, pp 728-33.
21. Puttaraju CM, Shankaregowda MM. Prevalence of Gestational Diabetes Mellitus and Associated Risk Factors at a Tertiary Care Hospital in Karnataka. Indian Journal of Obstetrics and Gynecology Volume 4 Number 1, January - April 2016.

22. Balaji V,Balaji M, Anjalakshi C, Cynthia A, Arthi T, Seshiah V. Diagnosis of gestational diabetes mellitus in Asian-Indian women. Indian J EndocrinolMetab. 2011 Jul-Sep; 15(3): 187–90.
23. Kulkarni AP, Baride JP, Doke PP, Mulay PY. Textbook of community medicine. 4th edition Mumbai: Vora publication; 2013.p.26-269.
24.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426219/#:~:text=The%20chi%2Dsquared%20test%20applies,especially%20for%20small%2Dsized%20samples(data accessed on September 15,2018).
25. https://www.cdc.gov/training/SIC_CaseStudy/Interpreting_Odds_ptversion.pdf(data accessed on September 15,2018).

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