

Assessment of knowledge and attitude of gestational diabetes mellitus among Saudi Women in Al Ahsa

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) defined as a temporarily type of diabetes induced by insulin resistance and pancreatic β -cell dysfunction during pregnancy, GDM can cause major complications, but it can also be avoided and treated. **Methods:** A cross-sectional study was done in Alahsa, Saudi Arabia during the period from March 5 to March 18, 2021, using a validated questionnaire with 17 items concerning GDM awareness and understanding. Participants were categorised into low knowledge (10/17) and fair/good knowledge (11/17) based on their replies. **Results:** The study included 464 adult females aged 24.9-11.6 years from the Alahsa region. According to our survey, nearly one in every five females (22.8 percent) had strong understanding of GDM, which is considered as low percentage. Also our findings shows that more than three-quarters of the study females are aware of the risks of untreated GDM, and two-thirds (69%) are aware that GDM. Furthermore, females' awareness of GDM complication was reasonably good. **Conclusion:** Our study declares that there is a significant frequency of low awareness, knowledge, and awareness about GDM on Alahsa region.

Keywords: Gestational diabetes mellitus, awareness, risk factors, AlAhsa, Saudi Arabia

1. INTRODUCTION

Gestational diabetes mellitus defined as any degree of glucose intolerance that begins or manifests during pregnancy (Metzger et al., 2007). GDM is the most frequent pregnancy complication, and it can have serious maternal and fetal consequences. During pregnancy, women with GDM are at the risk of

developing hypertensive diseases such as gestational hypertension, pre-eclampsia, and eclampsia. In GDM, excessive fetal growth is still a major perinatal issue. Trauma at birth, cesarean section births, shoulder dystocia, and newborn hypoglycemia are all consequences of excessive fetal development (Lowe et al., 2012). The onset of GDM is linked to a number of risk factors. Obesity, maternal age, previous history of GDM, significant family history of diabetes, and membership in a category with a high incidence of diabetes is the most prominent risk factors (Solomon et al., 1997).

Diabetes type 2 is strongly linked to gestational diabetes. Women who have had GDM before have a seven-fold higher chance of having DM2 than women who have had normoglycemic pregnancies (Bellamy et al., 2009). The global prevalence of GDM ranges from 1 to 20%, and it is increasing in lockstep with the rise in increase weight and type 2 diabetes mellitus (Erem et al., 2015). GDM prevalence has risen by 2-3 times in recent years, ranging from 8.9 to 53.4 percent. This is largely due to the implementation of improved screening and diagnostic criteria approved by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) (Moses et al., 2012). Between 2010 and 2014, Alfadhli et al., (2015) conducted a research in Medina, Saudi Arabia, to found out the prevalence of GDM.

According to the findings, almost 22% of 954 pregnant women who completed the early GDM screening had abnormal glucose levels. While GDM was found in 39.4% of 465 women who performed the oral glucose tolerance test (OGTT). GDM founded in roughly 51% of the 573 women who completed the requisite test (early screening + OGTT) in this research. This study found extremely high prevalence of GDM in Saudi Arabia when compared to worldwide prevalence, which may be due to the country's extremely high prevalence of diabetes and obesity (Alfadhli et al., 2015). Despite the fact that GDM is a major problem, there are ways to reduce the chance of having it. These methods include lifestyle changes, physical activity, and dietary changes. There are other pharmacological and non-pharmacological treatments available to assist minimize the risk of GDM (Simmons et al., 2015). In high-risk pregnant women, a moderate customized lifestyle intervention decreased the incidences of GDM by 39% (Koivusalo et al., 2016).

Since there are methods to lower the risk of GDM progression, Controlling GDM is also critical for the mother and her infant to avoid future difficulties. This study will primarily measure knowledge and attitudes about gestational diabetes mellitus in Alahsa, because greater awareness of GDM will lead to the adoption of a healthy lifestyle, improved health-care seeking, and therefore disease prevention and early detection.

2. MATERIAL AND METHODOLOGY

Study design and population

An observational cross-sectional study was done in Alahsa, Saudi Arabia, utilizing a survey instrument to collect responses from adult females aged 18 and up. Because of the current social distancing, a suitable tool that achieved a minimal contact was used to collect the data needed in this study, and it was an online Google form questionnaire distributed through the use of various types of social media apps including what's up, Twitter, and Telegram from the 5th to the 18th of March 2021.

Survey Tool, Instrument, Dissemination and Validation

The survey comprised 17 questions divided into five key areas, which covered the participant's fundamental understanding of GDM (two questions), GDM diagnosis (two questions), GDM risk factors (six questions), complications (five questions), and GDM management (five questions) (two questions). To minimize responders guessing, the questions contained multiple choice answers with one "I don't know" option. Each correct answer received a one, while each wrong or "I don't know" response received a zero. A higher score indicated that the responder was more knowledgeable about GDM. The highest possible score was 17, while the lowest possible score was zero (0).

Sample

According to Google Forms, the sample size was 464 answers, with a margin of error of 5% and a confidence range of 95%. The research needs at least 385 replies.

Validation of study

To validate the questionnaire, it was initially offered to three specialists in the field of research to see if the questions sufficiently measured knowledge and attitude about GDM. Following that, the questionnaire was pretested by distributing it to 20 people who were ultimately eliminated from the research. Cronbach's alpha was used to analyze the data from these surveys. The outcome demonstrated adequate internal consistency (Cronbach's alpha = 0.82).

Data analysis

After data were extracted, it was revised, coded, and fed to statistical software IBM SPSS version 22(SPSS, Inc. Chicago, IL). All statistical analysis was done using two tailed tests. P value less than 0.05 used for statistically significant. For awareness parts, for each correct answer was counted as one point and total summation of the discrete scores of the different items was calculated. A Participant with score less than 60% (10 points) of the maximum score was considered to have poor awareness while good awareness was considered if he had score of 60% (11 points or more) of the maximum or more. Descriptive analysis based on frequency and percent distribution was done for all variables including female’s demographic data, pregnancy, history of gestational diabetes mellitus, and awareness items regarding gestational diabetes. Cross tabulation was performed to evaluate the distribution of female awareness based on bio-demographic data. The Pearson chi-square test used to assess relationships with relation to gestational diabetes

3. RESULTS

464 adult females from the Al-Hasa area participated in the research. Females varied in age from 18 to 59, and with average age of 24.9 11.6 years. 347 (74.8%) of the females were married, with 294 (63.4%) having a university degree in a non-medical field and 28 (6%) having a medical degree. In terms of occupation, 366 (78.9%) were unemployed, 78 (16.8%) worked in the non-healthcare sector, and 20 (4.3%) worked in the medical sector. 269 (74.3%) of the women had previously been pregnant, with 57 (21.2%) of them having gestational diabetes (table 1).

Table 1 Bio-demographic data of study adult females in Al-Hasa, Saudi Arabia

Bio-demographic data	No	%
Age in years		
18-25	212	45.7%
26-35	122	26.3%
36-52	117	25.2%
> 52	13	2.8%
Marital status		
Single	102	22.0%
Married	347	74.8%
Divorced / widow	15	3.2%
Educational level		
Below high school	20	4.3%
High school	122	26.3%
University non-medical speciality	294	63.4%
University medical speciality	28	6.0%
Occupation		
Not working	366	78.9%
Non-medical field	78	16.8%
Medical field	20	4.3%
Chronic health problem		
None	426	91.8%
DM	14	3.0%
HTN	9	1.9%
Thyroid disorder	10	2.2%
Hypercholesterolemia	5	1.1%
Have you ever got pregnant? (n=362)		

No	93	25.7%
Yes	269	74.3%
During your pregnancy have you been diagnosed with gestational diabetes mellitus? (n=269)		
No	212	78.8%
Yes	57	21.2%

Table 2 depicts adult females' general awareness of gestational diabetes in Al-Hassa, Saudi Arabia. GDM was accurately classified as a form of diabetes by 322 (69.4%) of the ladies who were diagnosed for the first time during pregnancy. In addition, 182 (39.2%) properly reported blood glucose levels after one hour after consuming 50 gm of glucose as a GDM diagnostic procedure. 105 (22.6 percent) of females reported diagnosing and the screening for gestational diabetes mellitus between 24-28 weeks of pregnancy, and 396 (85.3 percent) are aware that untreated gestational diabetes mellitus has repercussions for both the mother and the fetus.

Table 2 General knowledge regarding gestation diabetes among adult females in Al-Hassa, Saudi Arabia

General knowledge items		No	%
Gestational diabetes mellitus is	Type of diabetes and diagnosed for the first-time during pregnancy	322	69.4%
	Type of diabetes occurs in any time and has no relation to pregnancy	24	5.2%
	Type of diabetes affect women who have abnormal glucose level before pregnancy	19	4.1%
	I don't know	99	21.3%
Gestational diabetes mellitus diagnosed by	Blood glucose level after 1 hour of drinking 50 gm of glucose.	182	39.2%
	Fasting blood glucose	71	15.3%
	HBA1C	58	12.5%
	Random blood glucose	27	5.8%
	I don't know	126	27.2%
Time of diagnosing and screening for gestational diabetes mellitus?	24-28 weeks of pregnancy	105	22.6%
	More than 28 weeks of pregnancy	31	6.7%
	Below 20 weeks of pregnancy	34	7.3%
	Anytime	49	10.6%
	I don't know	245	52.8%
Gestational diabetes mellitus if left untreated there will be consequences affecting.	Mother and foetus	396	85.3%
	Mother only	6	1.3%
	Foetus only	18	3.9%
	I don't know	44	9.5%

Table 3 shows the awareness of adult females in Al-Hassa, Saudi Arabia, on gestation diabetes risk factors. If you have gestational diabetes mellitus, you are at risk acquire diabetes type 2 after birth, according to 190 people (40.9 percent). Furthermore, 377 (81.3%) people are aware that being overweight or obese increases the risk of gestational diabetes mellitus, as do 343 (73.9%) those who have a personal history of having abnormal glucose levels. It is more likely that you may acquire gestational diabetes. 331 (71.3%) females indicated that having a family history of diabetes mellitus increases their risk of developing gestational diabetes mellitus, and 165 (35.6%) knew that having twins increases their risk of developing gestational diabetes mellitus. Furthermore, 249 (53.7%) females reported a past history of gestational diabetes mellitus as a risk factor for developing gestational diabetes mellitus in the following pregnancy.

Table 3 Females’ knowledge regarding gestation diabetes risk factors among adult females in Al-Hassa, Saudi Arabia

GDM risk factors knowledge	No	%	
It’s more likely to develop diabetes mellitus type 2 after delivery if were diagnosed with gestational diabetes mellitus	Yes	190	40.9%
	No	23	5.0%
	I don't know	251	54.1%
Overweight and obesity increase the risk of gestational diabetes mellitus	Yes	377	81.3%
	No	15	3.2%
	I don't know	72	15.5%
If you have previous personal history of having abnormal glucose level. Your likelihood to develop gestational diabetes mellitus?	Increase	343	73.9%
	Decrease	14	3.0%
	I don't know	107	23.1%
If you have family history of diabetes mellitus. Your likelihood to develop gestational diabetes mellitus?	Increase	331	71.3%
	Decrease	8	1.7%
	I don't know	125	26.9%
If you are pregnant with twins, your likelihood to develop gestational diabetes mellitus?	Increase	165	35.6%
	Decrease	15	3.2%
	I don't know	284	61.2%
If you have previous history of gestational diabetes mellitus. Your likelihood to develop gestational diabetes mellitus in the next pregnancy?	Increase	249	53.7%
	Decrease	30	6.5%
	I don't know	185	39.9%

Table 4 shows the knowledge of adult females in Al-Hassa, Saudi Arabia, on gestation diabetes problems and management. High blood pressure and preeclampsia were the most commonly reported complications in GDM (59.3%), followed by macrosomia (51.3%), hypoglycemia, heart disorders, jaundice (43.1%), and stillbirth (43.1%) (24.8%). 385 (83 percent) of participants said that leading a healthy lifestyle and eating a nutritious diet can help prevent and cure gestational diabetes mellitus. 148 (31.9 percent) ladies recognized insulin as a therapy for GDM. In all, 106 (22.8%) adult females exhibited a high degree of awareness on GDM (figure 1).

Table 4 Females’ knowledge regarding gestation diabetes complications and management among adult females in Al-Hassa, Saudi Arabia

GDM complications and management items	No	%
Complications of GDM		
<i>Macrosomia</i>	238	51.3%
<i>High blood pressure and preeclampsia</i>	275	59.3%
<i>Polyhydramnios</i>	53	11.4%
<i>Still birth</i>	115	24.8%
<i>Neonatal problems such as hypoglycemia, cardiac diseases, jaundice</i>	200	43.1%
<i>I don't know</i>	35	7.5%
Prevention & treatment methods		
Following healthy lifestyle and eating healthy diet help in preventing and treating gestational diabetes mellitus		
<i>Yes</i>	385	83.0%
<i>No</i>	7	1.5%
<i>I don't know</i>	72	15.5%
Gestational diabetes mellitus is treated by		

<i>Insulin</i>	148	31.9%
<i>Anti-diabetic medications</i>	118	25.4%
<i>I don't know</i>	198	42.7%

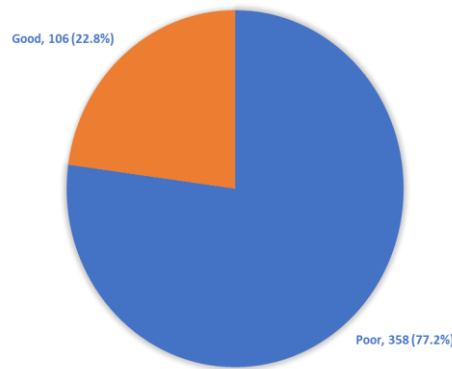


Figure 1 Overall adult’s female knowledge level regarding gestational diabetes, Al-Hasa, Saudi Arabia

Table 5 demonstrates the range of adult females' awareness of GDM based on their bio-demographic information. With statistical significance ($P=.013$), 46.4 percent of female university graduates in medical specialties had high knowledge levels compared to 30 percent of those who graduated from primary schools. In addition, 55 percent of females working in the medical sector had a high degree of expertise, compared to 21.3 percent of those not working ($P=.002$). 50 percent of people with DM had a good knowledge level, compared to 21.6 percent of those without health issues ($P=.048$). Other characteristics such as age, marital status, and GDM history were shown to have no effect on knowledge level.

Table 5 Distribution of adult female’s knowledge level regarding GDM by their bio-demographic data.

Bio-demographic data	Overall knowledge level				P-value
	Poor		Good		
	No	%	No	%	
Age in years					.348
<i>18-25</i>	169	79.7%	43	20.3%	
<i>26-35</i>	87	71.3%	35	28.7%	
<i>36-52</i>	92	78.6%	25	21.4%	
<i>> 52</i>	10	76.9%	3	23.1%	
Marital status					.953
<i>Single</i>	78	76.5%	24	23.5%	
<i>Married</i>	268	77.2%	79	22.8%	
<i>Divorced / widow</i>	12	80.0%	3	20.0%	
Educational level					.013*
<i>Below high school</i>	14	70.0%	6	30.0%	
<i>High school</i>	94	77.0%	28	23.0%	
<i>University non-medical speciality</i>	235	79.9%	59	20.1%	
<i>University medical speciality</i>	15	53.6%	13	46.4%	
Occupation					.002*
<i>Not working</i>	288	78.7%	78	21.3%	
<i>Non-medical field</i>	61	78.2%	17	21.8%	
<i>Medical field</i>	9	45.0%	11	55.0%	

Chronic health problem					
<i>None</i>	334	78.4%	92	21.6%	.048*
<i>DM</i>	7	50.0%	7	50.0%	
<i>HTN</i>	8	88.9%	1	11.1%	
<i>Thyroid disorder</i>	6	60.0%	4	40.0%	
<i>Hypercholesterolemia</i>	3	60.0%	2	40.0%	
Have you ever got pregnant?					
<i>No</i>	77	82.8%	16	17.2%	.145
<i>Yes</i>	203	75.5%	66	24.5%	
During your pregnancy have you been diagnosed with gestational diabetes mellitus?					
<i>No</i>	162	76.4%	50	23.6%	.485
<i>Yes</i>	41	71.9%	16	28.1%	

P: Pearson X2 test

*P < 0.05 (significant)

4. DISCUSSION

The purpose of this study was to find out how many adult females knew about gestational diabetes mellitus (GDM) and the conditions that cause it. Pregestational diabetes mellitus (PGDM) and gestational diabetes mellitus (GDM) impact 1 to 20% of all pregnancies across the world (Seshiah et al., 2004). A range of factors, including ethnicity, impact the occurrence of GDM. Type 2 diabetes and gestational diabetes are more frequent in South Asians (Chowdhury et al., 2003; Makgoba et al., 2012). GDM was detected in 17.8% of urban women, 13.8 percent of semi-urban women, and 9.9% of rural women in a study conducted by Seshiah et al., (2004) in South India, based on a two-hour 75 g post glucose test of 140 mg/dL. Alfadhli et al., (2015) conducted early tests in 211 of 954 women in Saudi Arabia (22.1 percent). GDM was discovered in 39.4 percent of females. The percentage of GDM patients diagnosed by OGTT and early screening climbed to 51 percent (292 women).

According to the current survey, roughly one in every five females (22.8 percent) had strong understanding of GDM, which is a rather low rate. In general, more than three-quarters of the study females are aware of the risks of untreated GDM, and two-thirds (69%) are aware that GDM is a kind of DM that arises during pregnancy. Only one-third of females properly recognized GDM diagnostic techniques, whereas one-fifth (22.6 percent) correctly identified GDM diagnosis time. Female respondents were more aware of GDM risk factors, including obesity (more than 80%), a history of having abnormal glucose levels (three quarters), and a family history of DM (three quarters), but just one-third were aware of pregnancy with GDM.

Furthermore, females' awareness of GDM consequences was reasonably excellent, with high blood pressure and preeclampsia being the most commonly diagnosed, followed by having a baby with macrosomia. More than three-quarters of females are aware that leading a healthy lifestyle and eating a healthy food can help prevent and treat gestational diabetes mellitus, but only one-third are aware that insulin is a therapy for GDM. The study also found that more knowledge was found among highly educated females in the medical field and those with chronic health conditions, particularly diabetes. Seshiah et al., (2008), discovered a greater degree of awareness among Indian women, reporting that around 17.5 percent of women had strong knowledge, 56.7 percent had fair knowledge, and 25.8 percent had low knowledge. Furthermore, Thomas et al., (2020) discovered that 67 percent of females polled had little awareness of GDM. Out of these twenty-two individuals, the majority (n = 16; 48.48 percent) require greater managerial expertise.

Elmekresh et al., (2017), investigated Gestational diabetes awareness among Sharjah women of reproductive age. According to the authors, 73.5 percent of females were aware of the GDM. When compared to non-married women, married women exhibited a higher level of awareness. In Dhahran, Saudi Arabia, Alnaeem et al., (2019) discovered that 75% of them were aware that consuming unhealthy foods, obesity, and depression put them at risk of GDM, and that they needed to engage in physical activity to avoid GDM. However, only 25.4% were aware that GDM was associated with hypertension. Furthermore, 37% of those polled were aware that GDM might result in cases of low neonate birth weight, 62.7 percent were aware that GDM could result in concealed DM, and 24.9 percent were aware of the possibility of an elevated risk of congenital abnormalities, particularly if DM is not identified. Only 21.7 percent of expecting women respondents was aware that untreated DM posed a risk to the unborn child's health, requiring the termination of the pregnancy, while 45.7 percent were doubtful and 32.6 percent were unaware of such risks

(Alnaeem, 2019). Also, according to Alharthi et al., (2018) 54 percent of Saudi female participants were aware of GDM risk factors but had little understanding of GDM diagnosis (15.9 %). The two risk variables about which participants were most aware were multigravida and a past history of GDM (67.7 %).

5. CONCLUSION

These findings highlight the need of large-scale diabetes information and education programs aimed at women of reproductive age and their partners for the prevention and control of GDM.

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Author contribution

All authors of this study were equally involved in the design of the study, data collection, analysis, drafting and correction of the final draft, and the author was responsible for the proper implementation of the study at all stages. There is no author whose name is not listed in the authors list.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval

The study was approved by the King Faisal University (Ethical approval code 2021-17-72).

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Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Alfadhli EM, Osman EN, Basri TH, Mansuri NS, Youssef MH, Assaaedi SA, Aljohani BA. Gestational diabetes among Saudi women: prevalence, risk factors and pregnancy outcomes. *Ann Saudi Med* 2015; 35(3):222-30. doi: 10.5144/0256-4947.2015.222.
2. Alharthi Ahmad S, Khalid A Althobaiti, Khaled A Alswat. Gestational diabetes mellitus knowledge assessment among Saudi women. *Open Access Maced J Med Sci* 2018; 1522. doi:10.3889/oamjms.2018.284
3. Alnaeem, Latteefah Saleh. Awareness of Gestational Diabetes among Antenatal Women at the King Fahd Military Medical Complex Hospital in Dhahran, Saudi Arabia. *Egypt J Hosp Med* 2019; 2784-2793. doi: 10.21608/ejhm.2019.32977
4. Bellamy L, Casas JP, Hingorani AD, Williams D. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. *Lancet* 2009; 373(9677):1773-9. doi: 10.1016/S0140-6736
5. Chowdhury, Tahseen A, Clare Grace, Peter G Kopelman. Preventing diabetes in south Asians. *BMJ* 2003; 1059-1060. doi:10.1136/bmj.327.7423.1059
6. Elmekresh A, AbuHalimeh B, Abukhater R, Bakro A, Nahab S. Gestational diabetes awareness in women of childbearing

- age in Sharjah. *Glob j obes diabetes metab syndr* 2017; 4(2):051-3..DOI:10.17352/2455-8583.000023
7. Erem C, Kuzu UB, Deger O, Can G. Prevalence of gestational diabetes mellitus and associated risk factors in Turkish women: the Trabzon GDM Study. *Archives med sci* 2015; 11(4):724. doi:10.5114/aoms.2015.53291
 8. Koivusalo SB, Rönö K, Klemetti MM, Roine RP, Lindström J, Erkkola M, Kaaja RJ, Pöyhönen-Alho M, Tiitinen A, Huvinen E, Andersson S. Gestational diabetes mellitus can be prevented by lifestyle intervention: the Finnish Gestational Diabetes Prevention Study (RADIEL) a randomized controlled trial. *Diabetes care* 2016; 39(1):24-30. doi:10.2337/dc15-0511
 9. Lowe LP, Metzger BE, Dyer AR, Lowe J, McCance DR, Lappin TR, Trimble ER, Coustan DR, Hadden DR, Hod M, Oats JJ. Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study: associations of maternal A1C and glucose with pregnancy outcomes. *Diabetes care* 2012; 35(3):574-80.doi: 10.2337/dc11-1687
 10. Makgoba M, Savvidou MD, Steer PJ. An analysis of the interrelationship between maternal age, body mass index and racial origin in the development of gestational diabetes mellitus. *Int J Obstet Gynaecol* 2012; 276-282. doi:10.1111/j.1471-0528.2011.03156.x
 11. Metzger BE, Buchanan TA, Coustan DR, de Leiva A, Dunger DB, Hadden DR, Hod M, Kitzmiller JL, Kjos SL, Oats JN, Pettitt DJ, Sacks DA, Zoupas C. Summary and recommendations of the Fifth International Workshop-Conference on Gestational Diabetes Mellitus. *Diabetes Care* 2007; 30 Suppl2:S251-60. doi: 10.2337/dc07-s225
 12. Moses RG. Gestational diabetes mellitus: implications of an increased frequency with IADPSG criteria. *Diabetes Care* 2012; 35(3):461-2. doi: 10.2337/dc11-2237.
 13. Seshiah V, Balaji V, Balaji MS, Paneerselvam A, Arthi T, Thamizharasi M, Datta M. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu)--a community based study. *J Assoc Physicians India* 2008; 56:329-33
 14. Seshiah V, Balaji V, Balaji MS, Sanjeevi CB, Green A. Gestational diabetes mellitus in India. *Japi* 2004; 52(9):707
 15. Simmons, David. Prevention of gestational diabetes mellitus: where are we now?. *Diab Obes Metabol* 2015; 824-834. doi: 10.1111/dom.12495
 16. Solomon CG, Willett WC, Carey VJ, Rich-Edwards J, Hunter DJ, Colditz GA, Stampfer MJ, Speizer FE, Spiegelman D, Manson JE. A prospective study of pregravid determinants of gestational diabetes mellitus. *JAMA* 1997; 278(13): 9315766. doi:10.1001/jama.1997.03550130052036
 17. Thomas S, Pienyu R, Rajan SK. Awareness and knowledge about gestational diabetes mellitus among antenatal women. *Psychol Community Health* 2020; 8(1):237-48. doi: 10.5964/pch.v8i1.287