

## Original article

## Frequency of gestational diabetes mellitus using DIPSI criteria, a study from Pakistan



Musarrat Riaz<sup>a,\*</sup>, Asmat Nawaz<sup>b</sup>, Shabeen Naz Masood<sup>c</sup>, Asher Fawwad<sup>d,e</sup>, Abdul Basit<sup>a</sup>, A.S. Shera<sup>f</sup>

<sup>a</sup> Department of Medicine, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan

<sup>b</sup> Project management Department, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan

<sup>c</sup> Department of Obstetrics and Gynaecology, Isra University, Karachi-Campus, Pakistan

<sup>d</sup> Department of Biochemistry, Baqai Medical University, Karachi, Pakistan

<sup>e</sup> Research Department, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan

<sup>f</sup> Diabetic Associations of Pakistan and WHO Collaborating Centre, Karachi, Pakistan

## ARTICLE INFO

## Keywords:

Gestational diabetes mellitus

DIPSI

Risk factors

## ABSTRACT

**Background:** Gestational diabetes mellitus [GDM] is associated with adverse maternal and fetal outcome. It is a severe threat to maternal and child health in a resource constraint country like Pakistan.

**Objective:** To find out the frequency of GDM in two metropolitan cities of Pakistan using DIPSI criteria.

**Methodology:** This cross sectional study was conducted between 2013–2016 in various primary, secondary and tertiary care hospitals of two metropolitan cities namely Karachi and Hyderabad in Pakistan. All pregnant women attending the ante natal clinics of recruitment sites during this period were included in the study. After taking consent patients were given 75 g of glucose dissolved in 100 ml of water in non-fasting state using Diabetes in pregnancy Study group of India(DIPSI) criteria. Blood samples were collected after two hours.

**Results:** A total of 11,430 participants were included in the study. Mean gestational age was  $27.12 \pm 6.84$  weeks with 18.8% and 23.1% having positive family history of diabetes and hypertension respectively. Previous history of GDM was present in only 6.8% of participants. About 1349(11.8%) pregnant women were diagnosed with gestational diabetes out of which 6.2%, 39.9% and 51.1% were diagnosed in 1st 2nd and 3rd trimester respectively. No known risk factor regarding GDM was present in 25.6% women.

**Conclusion:** This study shows a high frequency of GDM (11.8%) irrespective of risk factors, and in all trimesters of pregnancy emphasizing the need for universal screening in Pakistan.

## 1. Introduction

Gestational Diabetes Mellitus (GDM) is a worldwide phenomenon with almost 15% of women suffering from hyperglycemia during pregnancy.<sup>1</sup> The onset is associated with a large number of maternal, fetal and neonatal morbidity as well as mortality. GDM is a potential threat to maternal and child health in Pakistan. Women with GDM are becoming an ideal group for primary prevention of diabetes, as women with GDM are at increased risk of developing Type 2 diabetes (T2DM) later in life.<sup>2</sup> GDM represents detection of chronic  $\beta$  cell dysfunction<sup>3</sup> and is a stage in the evolution of Type 2 DM.<sup>4</sup> The diagnosis of GDM offers a unique opportunity in identifying individuals who will be benefited by early therapeutic intervention with diet and exercise to delay or even possibly prevent the onset of diabetes.<sup>5</sup> Globally, fifteen

per cent of pregnant women have GDM. According to an Australian study, Asian women are at increased risk of having GDM compared to their Australian counterparts (11.5% vs 3.7%).<sup>6</sup> The frequency of GDM is significantly high in the South Asian region. In Bangladesh, the frequency has been reported varying from 13.2% to over 40%.<sup>7</sup> A prevalence, as high as 9.9%–17.8% has been reported from Tamil Nadu, India.<sup>8</sup> Large scale studies on GDM have not been conducted in Pakistan. However, smaller hospital based studies have reported a prevalence of 3.3%–8%.<sup>9</sup> Differences in the screening methodology adopted by different investigators makes it difficult to ascertain the current status of GDM in this country. Considering the ethnic commonalities and similarities between Pakistani and Indian populations, it would not be unjustifiable to believe that actual prevalence of GDM in Pakistani women may be much higher than reported. Moreover, Type 2

\* Corresponding author at: Department of Medicine, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan.

E-mail addresses: [musarratriaz@bide.edu.pk](mailto:musarratriaz@bide.edu.pk) (M. Riaz), [anawaz@bide.edu.pk](mailto:anawaz@bide.edu.pk) (A. Nawaz), [shabeen.naz@isra.edu.pk](mailto:shabeen.naz@isra.edu.pk) (S.N. Masood), [asherfawwad@bide.edu.pk](mailto:asherfawwad@bide.edu.pk) (A. Fawwad), [abdulbasit@bide.edu.pk](mailto:abdulbasit@bide.edu.pk) (A. Basit), [dapkh@cyber.net.pk](mailto:dapkh@cyber.net.pk) (A.S. Shera).

<https://doi.org/10.1016/j.cegh.2018.06.003>

Received 24 February 2018; Accepted 3 June 2018

Available online 04 June 2018

2213-3984/ © 2018 Published by Elsevier, a division of RELX India, Pvt. Ltd on behalf of INDIACLEN.

**Table 1**  
Baseline characteristics.

Variables	Group-A (BSL < 140 mg/dl)	Group-B (BSL ≥ 140 mg/dl)	OR (95% CI)	P-value	Overall
n	10081	1349	–	–	11,430
Age (years)	27.0 ± 5.8	28.8 ± 5.9	1.07(1.06-1.08)	< 0.0001	27.2 ± 5.9
Gestation (weeks)	27.2 ± 6.8	26.4 ± 7.1	0.98(0.97-0.99)	< 0.0001	27.1 ± 6.8
Gravida					
Single	2962 (29.4%)	360 (26.7%)	1		3322 (29.1%)
Multiple	7028 (69.7%)	969 (71.8%)	1.13(0.99-1.28)	0.056	7997 (70%)
Trimester					
First	380 (3.8%)	83 (6.2%)	1		463 (4.1%)
Second	3814 (37.8%)	530 (39.3%)	0.63(0.49-0.81)	< 0.0001	4344 (38%)
Third	5548 (55%)	690 (51.1%)	0.56(0.44-0.73)	< 0.0001	6238 (54.6%)
Ethnicity					
Urdu speak/Muhajir	7087 (70.3%)	947 (70.2%)	1		8034 (70.3%)
Punjabi	376 (3.7%)	53 (3.9%)	1.03(0.76-1.39)	0.835	429 (3.8%)
Sindhi	1034 (10.3%)	143 (10.6%)	1.03(0.85-1.24)	0.719	1177 (10.3%)
Pathan	1197 (11.9%)	161 (11.9%)	1.00(0.84-1.20)	0.942	1358 (11.9%)
Balochi	194 (1.9%)	20 (1.5%)	0.77(0.48-1.22)	0.274	214 (1.8%)
Others	193 (1.9%)	25 (1.9%)	0.96(0.63-1.47)	0.885	218 (1.9%)

Data presented as mean ± s.d or n (%); OR: Odd ratio.  
Here, BSL denotes blood sugar level.

diabetes is now occurring at much younger age, in our population which also indicates towards a higher prevalence of GDM.

As there are no uniform international standards for the ascertainment and diagnosis of GDM<sup>10</sup> which creates more confusion. Various existing diagnostic criteria are country specific such as those recommended by American Diabetes Association, Canadian Diabetes in Pregnancy Study Group (CANDIPS), National Diabetes Data Group (NDDG) (USA & Europe), Australasian Criteria, Japan Diabetes Association, German Diabetes Association and Diabetes, UK (NICE Guidelines). All the diagnostic criteria require women to be in fasting. However, attending the first prenatal visit in the fasting state is impractical in many settings therefore, the dropout rate is very high when a pregnant woman is asked to come again for the glucose tolerance test.<sup>11</sup> Hence, there is need for an easy to perform, simple test which is economical and evidence based.<sup>12</sup> Diabetes in pregnancy study group of India (DIPSI), has recommended to perform 75 g m OGTT in non-fasting state<sup>8</sup> and a single 2 h value of > 140 mg/dl is taken as diagnostic of GDM. It is believed that a woman with normal glucose tolerance will respond with adequate insulin response to have normal glucose values, whereas a woman with impaired insulin response will behave abnormally with the ingestion of 75 g m glucose. This method has been adequately reported in the literature<sup>12</sup> and being a one-step procedure it looks suitable in the health settings of Pakistan where compliance is a major issue.

The aim of the present study was to find out the prevalence of GDM in two metropolitan cities of Pakistan using DIPSI criteria.

## 2. Methodology

This cross sectional study was conducted between 2013–2016 in three major hospitals namely Countess of Dufferin Fund Hospital (CDF Hospital) in Hyderabad, Fatima Bai Hospital- and Fatima Hospital, Baqai Medical University- in Karachi as well as different primary care clinics named GDM Centers in the rural cum urban settings of two metropolitan cities namely Karachi and Hyderabad in Pakistan.

Participants' weight at booking was recorded from the patient record cards, while current weight of subjects was measured in kilogram on a digital weighing scale.

### 2.1. Screening

All pregnant females coming for their routine checkup at the

recruiting sites were included in our study. Informed consent was obtained from each patient. The principle of “Universal Screening” has been adopted and the pregnant women undergo blood glucose test on the first prenatal visit, irrespective of the risk factors. If a woman was screened negative for GDM, she was re-screened at 26th-28th weeks of gestation. If still screened negative she undergoes the test for GDM again at 34th-36th weeks of gestation. The “Diabetes in Pregnancy Study Group of India (DIPSI)” method was adopted. The DIPSI method is a one-step procedure. It serves the dual purpose of screening and diagnosis and predicts adverse pregnancy outcome.<sup>8</sup>

All pregnant women attending the antenatal clinics were counseled and informed consent was taken for 75 g m glucose dissolved in 250 ml of water. Venous plasma glucose was estimated after 2 h of glucose ingestion (WHO 1999 criteria for diagnosis of GDM). A2-hours plasma glucose with a cut off of ≥ 140 mg/dl was taken as diagnostic of GDM. A plasma glucose value between 120-139 mg/dl was considered as Gestational Impaired Glucose Tolerance (GIGT) while values ≥ 200 was labeled as overt Diabetes.

### 2.2. Exclusion criteria for screening

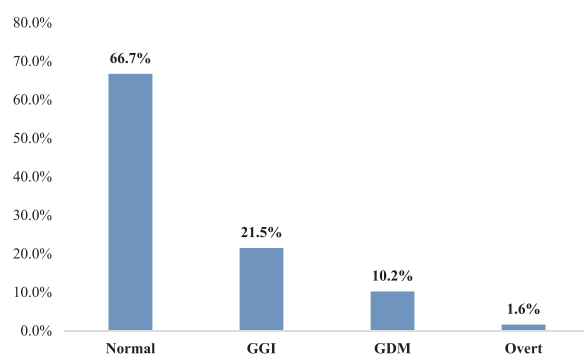
All women with known type 1 or type 2 diabetes and the known cases of “Hyperglycemia in Pregnancy” were excluded.

### 2.3. Statistical analysis

Data was analyzed by SPSS version 16. The data was presented as frequency (%) or mean ± SD. Student's *t*-test and Chi square test were used to check the significance.

## 3. Results

A total of 11,430 were screened for GDM using the DIPSI criteria. The mean age of the patients was 27.2 ± 5.9 years and average week of gestation was 27.1 ± 6.8 weeks. A total of 3322 (29.1%) women were primigravida, while 7997 (70%) were multigravida. As per weeks of gestation 463 (4.1%) patients were in first trimester, 4344 (38%) patients were in second trimester and 6238 (54.6%) patients were in third trimester. Regarding ethnicity in the GDM group, 947 (70.2%) participants were Urdu speaking, 161 (11.9%) Pathan, 143 (10.6%) Sindhi, 53 (3.9%) Punjabi and 20 (1.5%) were Balochi speaking. Estimated odds ratio show that GDM was significantly associated with



**Fig. 1.** Prevalence of GDM by DIPSI Criteria.  
GGI: Gestational Glucose Intolerance.  
GDM: Gestational Diabetes Mellitus.

increasing age, low gestational age. It was also observed that women in second and third trimester were significantly less likely to have gestation than women in first trimester (Table 1).

Out of 11430 pregnant women, 2463 (21.5%) were GGI while 1167 (10.2%) and 181 (1.6%) study participants were diagnosed as GDM and Overt diabetes respectively (Fig. 1 and 2).

The age distribution as per different categories of DIPSI is given in Table 2.

Majority of patients in GDM group were  $\geq 30$  years' age. Increased incidence was noted in first trimester and in multigravida women.

Known risk factors of GDM included family history of diabetes, hypertension and Previous history of GDM which was present in 18.8%, 23.1% and 6.8% respectively. Previous history of GDM was present in 23% women, however in 20.6% women blood glucose testing for GDM was not done in previous pregnancies. Additionally 25.6% pregnant women diagnosed with GDM have no known risk factor regarding GDM (Table 3).

#### 4. Discussion

In the present study frequency of GDM was found to be 11.9% using DIPSI criteria. The occurrence of GDM was associated with parity advancing age, and history of diabetes in first-degree relatives. Our findings are in accordance with the findings of various other studies reporting that obesity and family history of diabetes are the high risk factors for gestational diabetes, along with advancing age, parity and previous history of gestational diabetes.<sup>13,14</sup>

GDM prevalence has been reported variably from 1.4 to 14% worldwide and differently among racial and ethnic groups. Prevalence is higher in Asian women than in Caucasian women.<sup>13</sup> Compared to European women, the prevalence of gestational diabetes has increased 11-fold in women from the Indian subcontinent.<sup>15</sup> In Pakistan, prevalence of GDM has been reported to be from 4.2% to 26%. Conflicting results are available from within Pakistan showing a varied prevalence ranging from as high as 26% in Peshawar, 4.2% and 8% in Karachi, <

1% in primigravida females from Lahore, 22% in Balochistan, 14% in Bahawalpur and 14.8% in Hyderabad.<sup>16–22</sup> This wide variation resulted from the selection of patients and criteria used for diagnosing GDM which resulted in further confusion.

Compared with non-GDM subjects, GDM patients were older, with the mean ages of the two groups being  $24.7 \pm 3.11$  years and  $27.1 \pm 2.44$  years, respectively. A study from South India showed age  $> 25$  years as a risk factor for GDM.<sup>8</sup> Bibi et al reported a mean age of  $33 \pm 22.8$  years in women diagnosed with GDM,<sup>16</sup> which is in contrast to our study findings as majority of our patients were in 20–25 years age group. According to Royal College of Gynecology and Obstetrics guidelines the age less than 25 years is less prone to develop GDM. However, younger ages were not exempted from GDM in our study participants.

Obesity as a significant risk factor for GDM is supported by several studies stating that overweight or obesity at the start of pregnancy predisposes to GDM. The obesity was the risk factor for the development of GDM in studies from Karachi, Peshawar and Bahawalpur demonstrating that overweight and obese women are more prone to develop GDM. In Bahawalpur study large number of patients with GDM were obese.<sup>21</sup> Out of these factors, pre-pregnancy maternal obesity and excessive weight gain during pregnancy are potentially modifiable, independent risk factors that often occur in conjunction with GDM or hyperglycemia in pregnancy.

Lifestyle has changed over the years leading to an increase in the incidence of obesity. Women of this region have increased tendency for more visceral or central fat, which is a known risk factor for insulin resistance and cardiovascular disease.<sup>23</sup> The education level is low which leads to lack of health awareness and adoption of an unhealthy lifestyle, eventually causing an increase in the incidence of obesity.

The family history of type 2 Diabetes mellitus is a known risk factor associated with the development of GDM as reported in various studies. A study done in Baqai medical university reported more than half of the patients having family history of Diabetes Mellitus. In this study, majority of patients with GDM also had previous history of GDM.<sup>24</sup> However, in our study, large number of women were never tested for GDM in the previous pregnancies and had no knowledge regarding GDM.

When stratified according to ethnicities, 70.2% women in the GDM group were Urdu speaking; 3.9% Punjabi, 1.6% Balochi, 11.9% Pukhtoon and 10.6% were Sindhi speaking. No association with GDM with the different ethnicities was found in our study. Therefore, we suggest that irrespective of ethnic background, all Pakistani women are at risk of GDM and should be timely screened.

One of the limitations of the current study was that we did not follow up these females to record various obstetric complications like preterm birth, macrosomia and caesarean section. We also did not repeat OGTT after delivery.

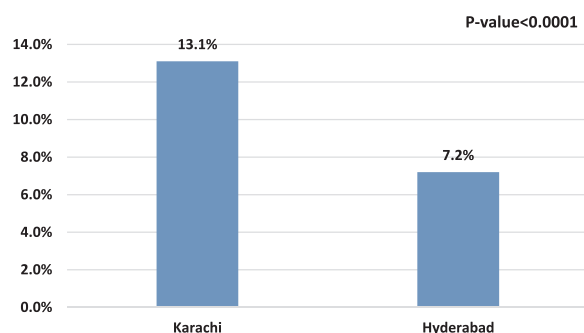
Despite of these limitations, the study was the first multi central survey carried out in the region that reports a GDM frequency of 11.9%; this alone makes a strong case of screening and early detection of GDM by OGTT in all pregnant women irrespective of age, BMI, ethnicity and risk factors in our population.

Awareness at community level regarding use of healthy food and physical activity to maintain normal weight will help in controlling the rising trend of GDM in pregnant women. Also, screening and early detection of GDM by OGTT in all pregnant women and frequent monitoring is recommended for the prevention of various maternal and neonatal complications.

Further large-scale studies are needed in order to have a clear perception of the occurrence of GDM in Pakistan.

#### Conflict of interest

Author has no conflict of interest.



**Fig. 2.** Prevalence of GDM.

**Table 2**

Age, gestational age and gravidity of study participants.

Variables	DIPSI Criteria				
	Normal	GGI	GDM	Overt	Overall
<b>Age (years)</b>					
< 19	100(76.3%)	22(16.8%)	9(6.9%)	0(0%)	131
20–25	2808(71.7%)	804(20.5%)	284(7.3%)	18(0.5%)	3914
26–30	2707(65.6%)	904(21.9%)	451(10.9%)	67(1.6%)	4129
≥ 30	1870(61.1%)	691(22.6%)	404(13.2%)	94(3.1%)	3059
<b>Trimester</b>					
First Trimester	277(59.8%)	103(22.2%)	70(15.1%)	13(2.8%)	463
Second Trimester	2895(66.6%)	920(21.2%)	458(10.5%)	71(1.6%)	4344
Third Trimester	4193(67.2%)	1355(21.7%)	596(9.6%)	94(1.5%)	6238
<b>Gravidity</b>					
Primigravida	2279(68.6%)	683(20.6%)	327(9.8%)	33(1.0%)	3322
Multigravida	5280(66%)	1749(21.9%)	822(10.3%)	146(1.8%)	7997

Data presented as n (%).

**Table 3**

Risk factors for GDM.

Family history of Diabetes Present	18.8%
Family history of Diabetes not known	28.6%
Family history of Hypertension	23.1%
Family history of hypertension not known	14.9%
Previous history of GDM in multigravida	6.8%
Previous history of GDM not known (not checked)	20.6%
No known risk factors regarding GDM	25.6%

**Author contribution**

**M Riaz:** literature search, interpretation of data, wrote and reviewed the manuscript.

**A Nawaz:** Supervised the study, wrote and reviewed the manuscript.

**S N Masood:** Wrote and reviewed the manuscript.

**A Fawwad:** Wrote and reviewed the manuscript.

**A Basit:** Concept and design, edit and reviewed the manuscript.

**AS Shera:** Concept and design, edit and reviewed the manuscript.

**Acknowledgments**

The authors acknowledge the support and cooperation of the various organizations and participants who agreed to participate in their program. The hard work and dedicated commitment of the members of the Gestational Diabetes Prevention and Control Programme and participants, who made this study possible and the WDF contribution for financing.

**References**

- [1]. ADA. Standards of medical care in diabetes-2015 abridged for primary care providers. *Clin Diabetes*. 2015;33:97–111. <http://dx.doi.org/10.2337/diaclin.33.2.97>.
- [2]. Girling J, Dornhorst A. Pregnancy and diabetes mellitus. In: Pick Up John C, Williams Gareth, eds. *Textbook of diabetes*. 3rd ed. Blackwell Publishing Company; 2003:65–66.
- [3]. Buchanan TA, Xiang A, Kjos SL, Watanabe R. What is gestational diabetes. *Fifth International Workshop Conference on Gestational Diabetes Mellitus Diabetes Care*. 2007;30(2):S105–S111. <http://dx.doi.org/10.2337/dc07-s201>.
- [4]. Carpenter MW. Gestational diabetes, pregnancy hypertension, and late vascular disease. *Diabetes Care*. 2007;30(2):S246–S250. <http://dx.doi.org/10.2337/dc07-s224>.
- [5]. Tuomilehto J. A paradigm shift is needed in the primary prevention of type 2 diabetes. *Prevention Type*. 2005;2:153–165.
- [6]. Carolan M, Davey MA, Biro MA, Kealy M. Maternal age, ethnicity and gestational diabetes mellitus. *Midwifery*. 2012;28(6):778–783. <http://dx.doi.org/10.1016/j.midw.2011.08.014>.
- [7]. Sandesh-Panthi MAhasanat, Mashfiqul-Hasan YA, Nusrat-Sultana SJ, Atiqur-Rahman M, Fariduddin M, et al. Frequency of gestational diabetes mellitus in Bangladesh impact of WHO 2013 screening criteria: efficiency of DIPSI and WHO 1999 criteria. *JCD*. 2015;2(2).
- [8]. Seshiah V, Balaji V, Balaji MS, et al. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu) - a community based study. *J Assoc Phys India*. 2008;56:329–333.
- [9]. Ahkter J, Qureshi R, Rahim F, et al. Diabetes in pregnancy in Pakistani women: prevalence and complications in an indigenous south Asian community. *Diabet Med*. 1996;13(2):189–191. [http://dx.doi.org/10.1002/\(SICI\)1096-9136\(199602.2008;56:329-333](http://dx.doi.org/10.1002/(SICI)1096-9136(199602.2008;56:329-333)
- [10]. International Association of Diabetes & Pregnancy Study Groups. (IADPSG) recommendations on the diagnosis and classification of hyperglycemia in pregnancy. IADPSG Consensus Panel. *Diabetes Care*. 2010;33(3)<http://dx.doi.org/10.2337/dc09-1848>.
- [11]. McIntyre HD, Oats JJ, Zeck W, Seshiah V, Hod M. Matching diagnosis and management of diabetes in pregnancy to local priorities and resources: an international approach. *Int J Gynecol Obstet*. 2011;115:S26–S29. [http://dx.doi.org/10.1016/S0020-7292\(11\)60008-8](http://dx.doi.org/10.1016/S0020-7292(11)60008-8).
- [12]. Polur Prasad KD, Bandela PV, Hindumathi Saheb SH. Diabetes in pregnancy study group in India (DIPSI) – a novel criterion to diagnose. *GDM*. 2016;10(1):1–6. <http://dx.doi.org/10.9734/IJBCRR/2016/22624>.
- [13]. Yuen L, Wong VW. Gestational diabetes mellitus: challenges for different ethnic groups. *World J Diabetes*. 2015;6(8):1024–1032. <http://dx.doi.org/10.4239/wjcd.v6.i8.1024>.
- [14]. Rahman AS, Jaffri MSA, Raza SB, Sattar FA. The prevalence of gestational diabetes in patients attending diabetic clinic at SirSyed Hospital. *Pak J Pharmacol*. 2007;24:37–42.
- [15]. Jawa A, Raza F, Qamar K, Jawad A, Akram J. Gestational diabetes mellitus is rare in primigravida Pakistani women. *Indian J Endocrinol Metabol*. 2011;15:191–193. <http://dx.doi.org/10.4103/2230-8210.83404>.
- [16]. Bibi S, Saleem U, Mahsood N. The frequency of gestational diabetes mellitus and associated risk factors at Khyber teaching hospital Peshawar. *J Postgrad Med Inst (Peshawar-Pakistan)*. 2015;29(1).
- [17]. Iqbal R, Rafique G, Badruddin S, Qureshi R, Cue R, Gray-Donald K. Increased body fat percentage and physical inactivity are independent predictors of gestational diabetes mellitus in South Asian women. *Eur J Clin Nutr*. 2007;61:736–742. <http://dx.doi.org/10.1038/sj.ejcn.1602574>.
- [18]. Rahman AS, Jaffri MSA, Raza SB, Sattar FA. The prevalence of gestational diabetes in patients attending diabetic clinic at Sir Syed Hospital. *Pak J Pharmacol*. 2007;24:37–42.
- [19]. Jawa A, Raza F, Qamar K, Jawad A, Akram J. Gestational diabetes mellitus is rare in primigravida Pakistani women. *Indian J Endocrinol Metabol*. 2011;15:191–193.
- [20]. Razaq S, Masood Z, Malik A, Hameed-Ur-Rehman NR, Jamil N. An investigation on the prevalence of gestational diabetes mellitus in the pregnant women of Province Balochistan. *World J Med Sci*. 2015;12(2):198–203. <http://dx.doi.org/10.5829/idosi.wjms.2015.12.2.93229>.
- [21]. Zaman N, Taj N, Nazir S, Ullah E, Fatima N. Gestational diabetes mellitus and obesity: an experience at a teaching hospital in Bahawalpur, Pakistan. *Rawal Med J*. 2013;38:165–168.
- [22]. Qazi A, Fahim A, Qureshi A. Gestational diabetes mellitus; still a great problem. *Prof Med J*. 2016;23(1).
- [23]. Pi-Sunyer FX. The epidemiology of central fat distribution in relation to disease. *Nutr Rev*. 2004;62(July (Suppl. 2):S120–S122. <http://dx.doi.org/10.1111/j.1753-4887.2004.tb00081.x>.
- [24]. Naheed F, Kammeruddin K, Hashmi HA, Narijo S. Frequency of impaired oral glucose tolerance test in high risk pregnancies for gestational diabetes mellitus. *J Coll Phys Surg Pak*. 2008;18:82–85.