Original Research Paper

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Diabetology

HBA1C IN GESTATIONAL DIABETES MELLITUS AND ITS ASSOCIATION WITH BODY MASS INDEX IN NORTH INDIAN POPULATION

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ABSTRACT

Background: Diabetes during pregnancy a worldwide health problem is more challenging in Asian population which affects both mother and baby. The probability of developing type 2 diabetes increases in future by several folds in mother and perinatal morbidity is also high among babies of Gestational diabetes mellitus (GDM) mothers. The risk of developing gestational diabetes mellitus is greater even at low Body Mass Index (BMI) among Asian women, reason of which is still not clearly understood. **Material and Methods:** 198 pregnant women were enrolled in this case-control study and categorized as GDM and non-GDM on the basis of “Diabetes in Pregnancy Study Group in India” (DIPSI) criteria for screening gestational diabetes. All the pregnant women were further categorized on the basis of trimester into 3 groups and period of gestation (PoG) into 4 groups respectively. Body mass index (BMI) and glycated hemoglobin (HbA1c) were estimated in all the groups. **Results:** No significant association was observed in BMI among GDM and non-GDM women when categorized on the basis of trimester as well as PoG. HbA1c level were significantly lower in 2nd trimester and in 2nd PoG among GDM women. Also positive correlation was observed between BMI and HbA1c in early 2nd trimester (>12 weeks to <19 weeks) among GDM women. **Conclusion:** Women with higher BMI have the risk of developing diabetes during pregnancy but this does not rule out the risk of GDM in women with lower BMI. Also, HbA1c may not be used as a good diagnostic marker in GDM however it is helpful in differentiating pre-pregnancy diabetes from true gestational diabetes.

KEYWORDS : Gestational diabetes mellitus (GDM), Body Mass Index (BMI), Glycated hemoglobin (HbA1c), Period of Gestation (PoG), Trimester.

INTRODUCTION

Maternal obesity before pregnancy and weight gain during pregnancy is associated with increased risk of developing gestational diabetes and its complications (Haugen, et. al., 2014). Obese pregnant women are at four time higher risk of developing gestational diabetes as compared to women with normal body weight (Chu, et. al., 2007). As the prevalence of diabetes and cardiovascular diseases is high in Asian population, WHO in the year 2000 proposed a lower BMI cut-off for Asian population. Despite lowering the BMI cut-off to define overweight and obese in Asian population, the reason of high risk of diabetes as compared to Non-Asians still remain non-concurring. The aim of this study was to find out the correlation between maternal weight and GDM at the time of its diagnosis when compared with pregnant women without GDM. Also, to determine whether maternal weight shows any association with plasma blood glucose and HbA1c (glycated hemoglobin)?

MATERIALAND METHOD

This case-control was conducted in the Department of Biochemistry, King George's Medical University, Lucknow, Uttar Pradesh in collaboration with Department of Obstetrics and Gynaecology, King George's Medical University, Lucknow Uttar Pradesh over a period of one year (2018 – 2019). The ethical clearance was taken from Institutional Ethics Committee (Reference Code: 83rd ECM IIA/P5 dated 04/02/2017). After obtaining written informed consent apparently healthy pregnant women were enrolled in this study from antenatal clinic (ANC) of Obstetrics and Gynaecology Department.

Selection Of Pregnant Women For Study

A proforma of standardized questionnaire was used to obtain obstetric history, personal history and family history of diabetes and gestational diabetes in previous pregnancy. Women with previous history of gestational diabetes, pre-GDM or any other chronic illness were excluded from the study. Height was measured in meter square (mt^2) in all the selected women by stadiometer and weight was measured in kilogram (kg) by Bioelectric Impedance Analyzer (Omron Healthcare, USA). Body mass index (BMI) was calculated by the formula weight (kg)/ height (mt^2). A total of 560 pregnant women attending ANC were enrolled in the study, 270 were excluded on the basis of previous history of GDM or diabetes, hypertension, dyslipidemia, thyroid disorder and chronic illness like tuberculosis, asthma etc (Flowchart shown in figure 1).

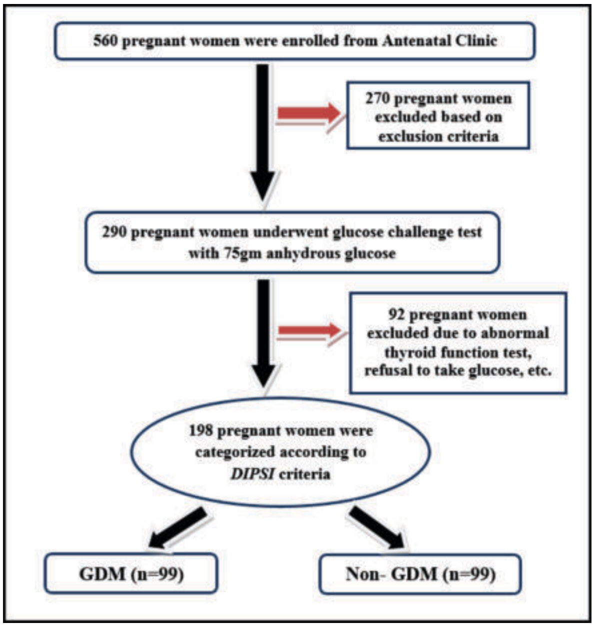

Figure 1: Flowchart Showing The Enrolment Of Pregnant Women In The Study GDM (n=99)

Procedure Of Oral Glucose Load Test

290 pregnant women were subjected to glucose tolerance test according to DIPSI (Diabetes in Pregnancy Study Group India) irrespective of time and their last meal. 75 gm anhydrous glucose was dissolved in 300 ml water and administered orally within five minutes. Blood sample collection

After two hour of glucose administration, 3.5 ml venous blood sample was collected under aseptic precautions in fluoride vial and EDTA vial for estimation of post glucose load plasma glucose (PGPG) and HbA1c level.

Categorization of enrolled pregnant women into two groups (GDM and non-GDM)

198 pregnant women were categorized into two groups: group1 (GDM; n=99) and group2 (non-GDM; n=99) based on DIPSI criteria for diagnosis gestational diabetes mellitus as shown in flowchart 1. Positive DIPSI means pregnant women with 2hr plasma glucose (PGPG) ≥140mg/dl (≥7.8mmol/l) constituted group1 while pregnant women with 2hr plasma glucose (PGPG)<140mg/dl (<7.8mmol/l) constituted group2 as DIPSI negative.

Sub-categorization on the basis of trimester of pregnancy and period of gestation

All pregnant women (198) were sub-categorized in three trimesters on the basis of weeks of pregnancy (1^{st} trimester: conception to ≤12 week of pregnancy, 2^{nd} trimester: >12week – ≤26 week of pregnancy; 3^{rd} trimester: >26 week - until birth). All pregnant participants were also sub-categorized in four groups on the basis of period of gestation (PoG) [I: ≤12 week of pregnancy; II: >12 week - ≤19 week of pregnancy; III: >19 – ≤26 week of pregnancy; IV: >26 week – until birth].

Distribution of GDM and non-GDM pregnant women according to BMI

All pregnant women, GDM and non-GDM pregnant women were categorized into four groups based on the South-Asian Classification of BMI proposed by World Health Organization (WHO) in 2000 as underweight (<18.5 kg/mt^2), normal weight (18.5 – 22.9 kg/mt^2), overweight (23.0 – 24.9 kg/mt^2) and obese (≥25.0 kg/mt^2).

All pregnant women, GDM and non-GDM pregnant women were also categorized into four groups based on the widely used older WHO classification of BMI as underweight (<18.5 kg/mt^2), normal weight (18.5 – 24.9 kg/mt^2), overweight (25.0 – 29.9 kg/mt^2) and obese (≥30.0 kg/mt^2).

Estimation Of Biochemical Parameters

Plasma glucose was estimated by glucose oxidase and peroxidase method on Selectra Biochemistry analyzer ELITECH (Selectra series/Pro-M) and HbA1c by high pressure liquid chromatography (HPLC) on Biorad D-10.

Statistical Analysis

IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. was used for all statistical analysis. Kolmogorov-Smirnov test was used to decide normality of various study parameters. Results were expressed as [mean ± standard deviation (SD)] for normally distributed data or [median {inter-quartile range (IQR)}] for non-normal data. Student t-test/ One way ANOVA and Mann Whitney U test/ Kruskal Wallis test were used for comparison of data distributed normally and non-normally respectively. Pearson's or Spearman's rank correlation was used to assess association of parameters in normal and non-normal data respectively. p-value <0.05 was considered statistically significant.

RESULTS

BMI followed Gaussian distribution and HbA1c didn't. BMI and HbA1c of all pregnant women enrolled in the study (198) and pregnant women when classified into GDM (99) and non-GDM (99) groups based on DIPSI criteria. GDM and non-GDM women were further classified into three groups on the basis of trimester of pregnancy and four groups on the basis of period of gestation (PoG) as summarized in supplementary table-1.

HbA1c levels were significantly lower among GDM women compared to non-GDM. Though GDM women exhibited higher BMI than non-GDM, the difference was not statistically significant. Further no significant difference was observed in BMI and HbA1c levels of GDM and non-GDM pregnant women when sub-categorized according to trimester of pregnancy and PoG as shown in supplementary table-1. Comparison of BMI and HbA1c was done between GDM and non-GDM pregnant women; subcategorizing according to trimester of pregnancy and PoG (Table-1).

Table 1: Trimester Wise And Period Of Gestation Wise Comparison Of BMI (kg/mt^2) and HbA1c (%) in GDM and non-GDM Pregnant Women

	BMI (Students t-test)				HbA1c (MWU)		
	GDM	Non-GDM	p-value		GDM	Non-GDM	p-value
Trimester of pregnancy							
I : ≤12 wk (25 vs 20)	24.75 ± 4.04	23.25 ± 4.34	0.237		4.9 (4.6 – 5.1)	5.05 (4.45 – 5.27)	0.319
II: >12 to ≤26wk (41vs46)	24.95 ± 4.64	23.53 ± 3.55	0.111		4.8 (4.6 – 5.0)	4.9 (4.8 – 5.2)	0.030*
III: >26 wk (33 vs 33)	26.09 ± 4.71	25.08 ± 3.88	0.343		5.0 (4.55 – 5.3)	5.0 (4.8 – 5.2)	0.887
ANOVA/KWH	0.448	0.137	p-value		0.131	0.837	p-value
	0.809	2.032	F		4.059	0.356	KWH
Period of gestation							
I : ≤12 wk (25 vs 20)	24.75 ± 4.04	23.25 ± 4.34	0.237		4.9 (4.6 – 5.1)	5.05 (4.45 – 5.27)	0.319
II: >12 to ≤19 wk (25 vs 25)	24.95 ± 4.91	23.52 ± 3.89	0.259		4.8 (4.6 – 5.0)	5.0 (4.9 – 5.3)	0.017*
III: >19 to ≤26 wk (16 vs 21)	24.95 ± 4.35	23.55 ± 3.18	0.264		4.8(4.625 – 4.975)	4.8 (4.65 – 5.05)	0.639
IV: >26 wk (33 vs 33)	26.09 ± 4.71	25.08 ± 3.88	0.343		5.0 (4.55 – 5.3)	5.0 (4.8 – 5.2)	0.887
ANOVA/KWH	0.534	0.266	p-value		0.255	0.389	p-value
	0.660	1.341	F		4.059	3.014	KWH
MWU: Mann Whitney U test; KWH: Kruskal Wallis test							

Further, GDM and non-GDM women were categorized into underweight, normal weight, overweight and obese based on South-Asian Classification as well as WHO classification of BMI. HbA1c mean, median and range were observed in all pregnant women and in GDM and non-GDM groups (Table-2).

Table 2: HbA1c Median, HbA1c Mean And HbA1c Range Based On South-Asian And WHO Classification Of BMI

		All pregnant women (n=198)	GDM (n=99)	Non-GDM (n=99)	Mann- Whitney U
South-Asian Classification of BMI					
Under weight	Median (IQR)	4.6 (4.5-5.0)	4.5 (4.35-4.6)	5.0 (4.75-5.15)	U
	Mean	4.7	4.48	4.93	2.0
	Range	4.3 – 5.3	4.3 – 4.7	4.5 – 5.3	p-value
	N	11	5	3	0.093
Normal weight	Median (IQR)	4.9 (4.6-5.2)	4.8 (4.6-4.9)	4.9 (4.6-5.2)	U
	Mean	4.831	4.76	4.82	379.5
	Range	3.4 – 5.9	4.2 – 5.3	3.4 – 5.4	p-value
	N	74	24	42	0.095

Over weight	Median (IQR)	4.9 (4.7-5.2)	4.9 (4.7-5.05)	4.9 (4.6-5.25)	U
	Mean	4.933	4.89	4.92	128.5
	Range	4.2 – 5.8	4.3 – 5.3	4.3 – 5.8	p-value
	N	40	21	13	0.775
Obese	Median (IQR)	5.0 (4.8-5.225)	5.0 (4.6-5.2)	5.1 (4.8-5.3)	U
	Mean	5.03	4.96	5.09	831.5
	Range	4.2 – 6.1	4.2 – 6.1	4.4 – 6.1	p-value
	N	94	49	41	0.159
p-value (KW)		0.006** (KWH=12.349)	0.006** (KWH=12.5)	0.209 (KWH=4.54)	
WHO Classification of BMI					
Under Weight	Median (IQR)	4.6 (4.5-5.0)	4.5 (4.35-4.6)	5.0 (4.75-5.15)	U
	Mean	4.7	4.48	4.93	2.0
	Range	4.3 – 5.3	4.3 – 4.7	4.5 – 5.3	p-value
	N	11	5	3	0.093
Normal weight	Median (IQR)	4.9 (4.675-5.2)	4.8 (4.65-5.0)	4.9 (4.6-5.2)	U
	Mean	4.867	4.82	4.85	1089.0
	Range	3.4 – 5.9	4.2 – 5.3	3.4 – 5.8	p-value
	N	114	45	55	0.301
Over weight	Median (IQR)	5.0 (4.8-5.2)	5.0 (4.75-5.2)	5.1 (4.8-5.27)	U
	Mean	5.05	4.98	5.10	443.5
	Range	4.2 – 6.1	4.2 -6.1	4.4 – 6.1	p-value
	N	69	33	32	0.265
Obese	Median (IQR)	4.9 (4.6-5.3)	4.85 (4.6-5.27)	5.1 (4.65-5.4)	U
	Mean	4.97	4.92	5.06	60.0
	Range	4.3 – 6.1	4.3 – 6.1	4.4 – 5.9	p-value
	N	25	16	9	0.495
p-value (KW)		0.005* (KWH=12.936)	0.012* (KWH=11)	0.197 (KWH=4.67)	
KW: Kruskal-Wallis test; *p-value <0.05; **p-value <0.01					

Correlation analysis among post glucose-load plasma glucose (PGPG), BMI and HbA1c in all the pregnant women, GDM and non-GDM women groups was carried out by Spearman Rank correlation analysis (supplementary table-2).

DISCUSSION

BMI and HbA1c level was measured in 198 pregnant women which were further categorized on the basis of trimester of pregnancy and PoG. In our study, though mean BMI was higher among GDM women as compared to non-GDM women, the difference was not statistically significant. Studies are available to identify GDM in Asian population at different BMI threshold and still it is unclear whether lowering of BMI threshold for Asian population will add advantage of predicting GDM on the basis of body weight. In a retrospective study it was observed that at the time of delivery maternal obesity with BMI $\geq 30 kg/mt^2$ (morbid obese) was present in every three out of four women and also found that presence of morbid obesity was lower among Asian women with GDM as compared to women of Caucasians, African-American and Hispanic ethnicity (O'Neil Dudley, Jenner, Mendez-Figueroa, Ellis, & Chauhan, 2017). Another retrospective study used different cut-off for defining overweight and identified only 5% Asians with GDM at cut-off 26.1 – 29.0 kg/mt^2 followed by 24.9% (BMI >25 kg/mt^2) and 68.9% at BMI >21 kg/mt^2 (Shah, Stotland, Cheng, Ramos, & Caughey, 2011). By using different BMI cut-off for overweight (23.0 – 27.4 kg/mt^2) and obese ($\geq$27.5 kg/mt^2) 52.3% South Asian women were identified as GDM when compared to conventional criteria which identified only 34% South Asian women (Nishikawa, Oakley, Seed, Doyle, & Oteng-Ntim, 2017). This study proposed that in Asian women BMI cannot be used as an effective tool to screen GDM women and all Asian women must be screened for GDM as a part of primary care. One study reported that BMI does not serve as an effective risk factor for predicting adverse pregnancy outcome in women of Pakistan origin (Bryant, et. al., 2014). In present study HbA1c level (median) were estimated in all pregnant women, and further when categorized as GDM and non-GDM no statistically was observed. However, when HbA1c median was compared between GDM and non-GDM pregnant women statistically significant difference was observed in 2^{nd} trimester and PoG-II. HbA1c level was found to be significantly lower in 2^{nd} trimester especially in early phase among GDM women. The reason of low HbA1c may be due to low fasting plasma glucose level in early weeks of pregnancy as reported in previous studies so the nascent RBC's are exposed to low glucose concentration (Nielsen et. al., 2004; Lind, & Cheyne, 1979). Also, the half-life of RBC's during pregnancy decreases thereby affecting the HbA1c concentration (Lurie, & Danon, 1992). In a recent study, it was found that HbA1c can undervalue the maternal glycaemia due to low level of hemoglobin in pregnancy (Edelson, et. al., 2020). Diagnostic value of HbA1c in GDM was assessed in a study and found that HbA1c cannot replace OGTT (oral glucose tolerance test) in gestational diabetes (Siricharoenthai, & Phupong, 2019). While contrary to our finding, studies are available in literature with highly significant HbA1c level in GDM women and its diagnostic and clinical utility. A recent study found higher HbA1c level in GDM women as compared to non-GDM women during 1^{st} trimester (Cetin, Gungor, & Yavuz, 2021; Sun, et. al., 2021; Amylidi, et. al., 2016). Another study also observed significantly higher HbA1c level in GDM women enrolled during 1^{st} trimester and found linear association between HbA1c and GDM (Hinkle, Tsai, Rawal, Albert, & Zhang, 2018). Similarly, a retrospective study found that HbA1c level >5.4% in 1^{st} trimester was associated with poor outcome and pregnant women must be closely monitored (Wong, Chong , Mediratta, & Jalaludin, 2017). In our study HbA1c level showed significant difference among GDM women when classified as underweight, normal weight, overweight and obese according to South Asian classification as well as WHO classification however no such difference was observed among non-GDM women. Also due to different cut-off used in both the classifications, more number of women (n=49) were classified as obese by South Asian classification in GDM group as well as in non-GDM group (n=41). A positive correlation between BMI and HbA1c was observed in 2^{nd} trimester as well as in PoG-II (early 2^{nd} trimester) of GDM women. Hence, during early phase of 2^{nd} trimester (>12 weeks to $\leq$19 weeks) linear relationship was observed between BMI and HbA1c i.e., as BMI increases level of HbA1c also increases among GDM women as compared to non-GDM women. No such relationship between BMI and HbA1c was observed in 1^{st} trimester as well as in late 2^{nd} and 3^{rd} trimester GDM women. However, a prospective observational study found that HbA1c positively correlates with BMI (>30 kg/mt^2) among GDM women between 8 – 12 week of pregnancy (Abdelsttar, Omarah, Abdelgaied, & El-Sharkawy, 2019). Positive correlation was found between BMI and plasma glucose in all pregnant women during PoG-II (early 2^{nd} trimester) but when these pregnant women were grouped into GDM and Non-GDM no correlation could be elicited.

Asian population residing in Non-Asian countries had been extensively studies but limited studies are available on Indian population residing in India, this study has been designed to find out association of gestational diabetes mellitus with BMI and HbA1c in

North India. Though now-a-days HbA1c [National Glycohemoglobin Standardization Program (NGSP) certified method] is used as both diagnostic and prognostic marker for diabetes mellitus, it cannot detect the gestational diabetes mellitus among Indian population. But HbA1c may be used as an effective tool to differentiate the pre-pregnancy diabetes with gestational diabetes mellitus if carried out timely during early weeks of pregnancy. Most of the people are unaware that they have diabetes and remain undiagnosed for years. HbA1c can detect the pre-pregnancy diabetes and Diabetologist/Endocrinologist/Obstetrics & Gynaecology can appropriately manage the patient during pregnancy, during delivery and in postpartum period.

Our study had some limitations. One of them is non-availability of pre-pregnancy body weight which could have helped in calculating the amount of weight gain during pregnancy. Another limitation of our study is that pregnant women (GDM and non-GDM) were different in all the three trimester. Also, this study was conducted on small sample size in a tertiary care hospital.

As the prevalence of GDM is high in Asian population, a population based multi-centric prospective study is required.

CONCLUSION

Body mass index (BMI) does not show any association with gestational diabetes mellitus (GDM) especially in Indian population, who is at higher risk. Women with higher BMI have the risk of developing diabetes during pregnancy but this does not rule out risk of GDM in women with lower BMI. Similarly, HbA1c level cannot be used as diagnostic marker for GDM because the levels are low during pregnancy and thus women developing diabetes during pregnancy may be missed. It may be used to differentiate pre-pregnancy diabetes from true gestational diabetes. In our study a positive association was observed in early 2nd trimester (>12 to ≤19 week) between BMI and HbA1c among GDM women. Thus, instead of screening for GDM during late 2nd trimester, which is the routine practice; screening during early pregnancy is the need of the hour. As Asian population is at higher risk of developing gestational diabetes, modified criteria categorizes more women as overweight and obese. Early intervention in overweight and obese women may reduce the risk of developing GDM and its associated maternal and fetal complications. In future, more studies are required among Indian population using larger sample size to confirm the relationship between BMI and HbA1c during early phase of pregnancy.

Supplementary Table 1: BMI and HbA1c Levels In Study Groups

Study groups	BMI (kg/mt2) Mean ± SD	HbA1c (%) Median (IQR)
All pregnant women (198)	24.635± 4.24	4.9 (4.7 – 5.2)
GDM (99)	25.28 ± 4.51	4.9 (4.6 – 5.1)
Non-GDM (99)	23.99 ± 3.87	5.0 (4.8 – 5.2)
(T or U)/ (p-value)	[-1.336/0.183] (t-test)	[-1.986/0.047] (MW test)
According to Trimester of pregnancy [All pregnant women (n=198)]		
I : ≤12 wk (45)	24.08 ± 4.20	4.9 (4.6 – 5.2)
II: >12 to ≤ 26 wk (87)	24.20 ± 4.14	4.9 (4.7 – 5.1)
III: >26 wk (66)	25.58 ± 4.31	5.0 (4.775 – 5.225)
p-value (ANOVA/KWtest)	0.083 (F=2.522)	0.150 (KWH=3.788)
GDM (n=99)		
I : ≤12 wk (25)	24.75 ± 4.04	4.9 (4.6 – 5.1)
II: >12 to ≤26 wk (41)	24.95 ± 4.64	4.8 (4.6 – 5.0)
III: >26wk(33)	26.09 ± 4.71	5.0 (4.55 – 5.3)
p-value (ANOVA/KWtest)	0.448 (F=0.809)	0.131 (KWH=4.059)
Non-GDM (n=99)		
I : ≤12 wk (20)	23.25 ± 4.34	5.05 (4.45 – 5.27)
II: >12 to ≤26 wk (46)	23.53 ± 3.55	4.9 (4.8 – 5.2)
III: >26 wk (33)	25.08 ± 3.88	5.0 (4.8 – 5.2)
p-value (ANOVA/KWtest)	0.137 (F=2.032)	0.837 (KWH=0.356)
According to Period of gestation [All pregnant women (n=198)]		
I: ≤12 wk (45)	24.08 ± 4.20	4.9 (4.6 – 5.2)
II: >12 to ≤19 wk (50)	24.24 ± 4.44	4.9 (4.675 – 5.125)
III: >19 to ≤26 wk (37)	24.15 ± 3.74	4.8 (4.65 – 5.00)
IV: >26 wk (66)	25.58 ± 4.31	5.0 (4.775 – 5.225)
p-value (ANOVA/KWtest)	0.174 (F=1.676)	0.176 (KWH=4.937)
GDM (n=99)		
I: ≤12 wk (25)	24.75 ± 4.04	4.9 (4.6 – 5.1)
II: >12 to ≤19 wk (25)	24.95 ± 4.91	4.8 (4.6 – 5.0)
III: >19 to ≤26 wk (16)	24.95 ± 4.35	4.8 (4.625 – 4.975)
IV: >26 wk (33)	26.09 ± 4.71	5.0 (4.55 – 5.3)
p-value (ANOVA/KWtest)	0.534 (F=0.660)	0.255 (KWH=4.059)
Non-GDM (n=99)		
I: ≤12 wk (20)	23.25 ± 4.34	5.05 (4.45 – 5.27)
II: >12 to ≤19 wk (25)	23.52 ± 3.89	5.0 (4.9 – 5.3)
III: >19 to ≤26 wk (21)	23.55 ± 3.18	4.8 (4.65 – 5.05)
IV: >26 wk (33)	25.08 ± 3.88	5.0 (4.8 – 5.2)
p-value (ANOVA/KWtest)	0.266 (F=1.341)	0.389 (KWH=3.014)
MWU: Mann-Whitney U test; KW: Kruskal-Wallis test; ANOVA: Analysis of Variance *p-value <0.05; **p-value <0.01		

Supplementary Table 2: Correlation Between PPBS, BMI and HbA1c In All Pregnant Women, GDM and non-GDM Women

	PGPG & HbA1c		BMI & HbA1c		BMI & PGPG	
	P	p-value	ρ	p-value	ρ	p-value
All subjects (198)	-0.075	0.272	0.192	0.004**	0.206	0.002**
GDM (99)	0.089	0.380	0.227	0.024*	0.121	0.232
Non-GDM (99)	0.168	0.097	0.158	0.117	0.074	0.464
All pregnant women Trimester-wise (n=198)						
I : ≤12wk (45)	-0.083	0.586	0.281	0.061	0.208	0.170

II: >12to≤26wk (87)	-0.112	0.300	0.204	0.058	0.203	0.059
III: >26wk (66)	0.048	0.701	0.081	0.518	0.099	0.428
All pregnant women PoG- wise (n=198)						
I: ≤12 wk (45)	-0.083	0.586	0.281	0.061	0.208	0.170
II: >12to≤19wk (50)	-0.157	0.277	0.238	0.096	0.304	0.032*
III: >19to≤26wk (37)	-0.092	0.588	-0.021	0.901	0.164	0.331
IV: >26wk (66)	0.048	0.701	0.081	0.518	0.099	0.428
GDM Trimester-wise (n=99)						
I : ≤12wk (25)	-0.129	0.540	0.356	0.081	0.048	0.819
II: >12to≤26wk(41)	0.101	0.528	0.359	0.021*	0.196	0.219
III: >26wk (33)	0.309	0.080	0.033	0.855	0.051	0.780
GDM PoG- wise (n=99)						
I: ≤12 wk (25)	-0.129	0.540	0.356	0.081	0.048	0.819
II: >12to≤19wk (25)	0.249	0.229	0.514	0.009**	0.287	0.164
III: >19to≤26wk (16)	-0.187	0.489	-0.008	0.976	0.113	0.678
IV: >26wk (33)	0.309	0.080	0.033	0.855	0.051	0.780
Non-GDM Trimester-wise (n=99)						
I : ≤12wk (20)	0.350	0.131	0.368	0.110	0.077	0.747
II: >12to≤26wk (46)	0.233	0.119	0.095	0.528	0.018	0.908
III: >26wk (33)	-0.069	0.704	0.120	0.505	0.048	0.790
Non-GDM PoG-wise (n=99)						
I: ≤12 wk (20)	0.350	0.131	0.368	0.110	0.077	0.747
II: >12to≤19wk (25)	0.287	0.164	0.249	0.229	-.007	0.975
III: >19to≤26wk (21)	0.032	0.890	-0.099	0.670	0.003	0.989
IV: >26wk (33)	-0.069	0.704	0.120	0.505	0.048	0.790
Spearman's Rank Correlation; *p-value <0.05; **p-value <0.01						

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