Elevated Body Mass Index in Expectation of Gestational Diabetes Mellitus

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Abstract: Objective: The aim of this study is to assess the risk of elevated body mass index (BMI) in expectation of gestational diabetes mellitus (GDM). **Patients and methods:** This is an observational case-control study which was carried at Ain Shams Maternity Hospital in the period between April 2010 to April 2011. It included 480 patients divided into two groups: Group I included 300 pregnant females with elevated BMI from 25-40 kg/m^2 and group II which included 180 pregnant females as controls with normal BMI from 18.5 to 24.9 kg/m^2. They were pregnant from 25 to 35 weeks gestation. History taking and examination were performed. BMI was calculated for the participants. Blood pressure measurement was performed. They had oral glucose tolerance test OGTT. **Results:** There was a high statistical significant difference between both groups with higher mean age, BMI, fasting sugar, 1,2,3 hours postprandial sugar, systolic blood pressure and diastolic blood pressure. There was a high statistical significant difference between both groups as regards the presence of GDM. ***Conclusion:*** BMI and age were the significant risk factors for GDM.

Ali Farid Mohamed, Noha Hamed Rabei and Samer Samir Lamey. **Elevated Body Mass Index in Expectation of Gestational Diabetes Mellitus.** *J Am Sci* 2013;9(12): 445-451]. (ISSN: 1545-1003).
http://www.jofamericanscience.org. 61

Key words: elevated body mass, (GDM) , OGTT.

1.Introduction

The body mass index (BMI) is a statistical measure which compares a person's weight and height. Though it does not actually measure the percentage of body fat, it is used to estimate a healthy body weight based on a person's height. Due to its ease of measurement and calculation, it is the most widely used diagnostic tool to identify weight problems within a population, usually whether individuals are underweight, overweight or obese. It was invented between 1830 and 1850 by the Belgian polymath Adolphe Quetelet[(1)]. The relationship between maternal obesity and adverse pregnancy outcome has been well characterized in obstetric and public health literature[(2)]. An increase in body fat is generally associated with an increase in risk of metabolic diseases such as type 2 diabetes mellitus, hypertension and dyslipidemia [(3)]. Several population studies have described an association between body mass index (BMI) and mortality as a U-shaped curve, demonstrating increased mortality in the lowest and highest BMI distribution, even when controlling for age, smoking, and history of other co-morbidities[(4,5)]. Obesity is also strongly associated with an increased risk of diabetes[(6)]. The WHO regard a BMI of less than 18.5 as underweight and may indicate malnutrition, and eating disorder, or other health problems, while a BMI greater than 25 is considered overweight and above 30 is considered obese. These ranges of BMI values are valid only as statistical categories when applied to adults. Morbid obesity (BMI 40 or more) was found in 2% of the men and 4% of the women [(7)].

Gestational diabetes mellitus (GDM) is a condition in which women without previously diagnosed diabetes exhibit high blood glucose levels during pregnancy. Gestational diabetes generally has few symptoms and it is most commonly diagnosed by screening during pregnancy. Diagnostic tests detect inappropriately high levels of glucose in blood samples. Gestational diabetes affects 3-10% of pregnancies, depending on the population studied [(8)]. No specific cause has been identified, but it is believed that the hormones produced during pregnancy increase a woman's resistance to insulin, resulting in impaired tolerance. Babies born to mother with gestational diabetes are at increased risk of problems typically such as being large for gestational age (which may lead to delivery complications), low blood sugar and jaundice. Gestational diabetes is a treatable condition and women who have adequate control of glucose levels can effectively decrease these risks. Women with gestational diabetes are at increased risk of developing type 2 diabetes mellitus (or, very rarely, latent autoimmune diabetes or type 1) after pregnancy, while their offspring are prone to developing childhood obesity, with type 2 diabetes later in life. Most patients are treated only with diet modification and moderate exercise but some receive anti-diabetic drugs, including insulin. Gestational diabetes is formally defined as "any degree of glucose

intolerance with onset or first recognition during pregnancy"[9].

Aim of the work: To determine the risk of elevated body mass index (BMI) in expectation of gestational diabetes mellitus.

2.Patients and Methods

This was an observational case-control study. The study was carried on 480 ladies 20-40 years old attending the obstetric outpatient clinic at Ain Sham University Maternity Hospital. BMI was calculated by using BMI formula which is: BMI=weight (Kg)/ height (m) x height (m) [10,11] between 25-35 weeks gestation.

Cases were observed and divided into two groups; group (I): 300 pregnant women diagnosed with increased BMI from 25 to 40 kg/m^2 and group (II): 180 pregnant women as a control group who had normal body mass index from 18.5 to 24.9 kg/m^2. Comparison between both groups (pair-wise comparison) for the presence of gestational diabetes mellitus was done.

All patients had glucose tolerance test (GTT) between 25-35 weeks gestation. The OGTT was done in the morning after an overnight fast of 8 to 14 hours. During the three previous days the subject must have an unrestricted diet (containing at least 150 g carbohydrate per day) and unlimited physical activity. The subject remained seated during the test and was not allowed to smoke throughout the test. The test involved drinking a solution containing 100 gram of glucose, and drawing blood to measure glucose levels at the start and on set time interval thereafter. The diagnostic criteria from the National Diabetes which the American Diabetes Association[12] considers to be abnormal during the 100 gram of glucose OGTT:

Fasting blood glucose level ≥95 mg/dl (5.33 mmol/L)
1 hour blood glucose level ≥ 180 mg/dl (10 mmol/L)
2 hours blood glucose level ≥155 mg/dl (8.6 mmol/L)
3 hours blood glucose level ≥140 mg/dl (7.8 mmol/L)

The Inclusion criteria were: female age from 20 to 40 years and duration of pregnancy from 25-35 weeks. The exclusion criteria were: known diabetes in first-degree relatives, history of abnormal glucose tolerance multiple pregnancies, renal diseases, liver diseases, cardiovascular diseases, thyroid diseases, gout and smoking. All the women were subjected to the following: detailed history, general examination: pulse, temperature, blood pressure, abdominal examination, ultrasonography to calculate gestational age, fetal growth, amniotic fluid and to exclude any congenital malformation, and routine investigations: C.B.C., Rh, blood grouping, blood sugar, kidney functions tests, liver enzymes and complete urine analysis. Required sample size was 480 (300 cases and 180 control).

The data were coded, entered and processed on computer using SPSS (version 15). The level $P< 0.05$ was considered the cut-off value for significance. Data were expressed as mean ±SD (range) or as number (%) of cases. Comparison of proportions and means between both groups was made by using the X^2 test and independent t=test, respectively. The Fisher's exact test was used when applicable. Pearson correlation coefficient was calculated to test the relationship between variables. Logistic regression (multivariate analysis) was performed to detect the most significant factors for GDM. Analysis was performed by using the statistical package for the social sciences (SPSS, version 15). The level $P<0.05$ was considered the cut off value for significance.

3.Results

Four hundred and eighty women were enrolled in this study aiming to determine the risk of elevated body mass index (BMI) in expectation the presence of gestational diabetes mellitus. They were divided into to groups: Group (I): The study group which included 300 pregnant women who had elevated BMI from 25 to 40 kg/m^2, and group (II): The control group which included 180 pregnant women with normal body mass index from 18.5 to 24.9 kg/m^2.

Table (1): Our study master sheet data according to the studied parameters.

	Group I (cases) (n=300)				Group II (control) (n=180)			
	Mean	±SD	Range		Mean	±SD	Range	
Age (yr)	29.66	±4.65	20.00	40.00	23.91	±2.85	20.00	34.00
Blood glucose level								
Fasting sugar	83.88	±11.54	64.00	190.00	74.68	±7.03	62.00	111.00
1st hour PPS	168.11	±17.05	140.00	240.00	151.95	±10.52	122.00	200.00
2nd hour PPS	143.53	±16.24	109.00	222.00	2128.16	±10.16	99.00	180.00
3rd hour PPS	118.45	±17.22	26.00	187.00	102.88	±12.14	80.00	163.00
SBP (mmHg)	110.93	±10.36	90.00	150.00	103.54	±9.76	90.00	140.00
DBP (mmHg)	70.92	±7.57	50.00	90.00	64.56	±7.40	50.00	90.00
Height (cm)	163.31	±3.67	152.00	173.00	163.48	±3.96	152.00	176.00
Weight (kg)	77.95	±7.11	63.40	103.00	64.94	±3.47	55.20	74.60
BMI(Kg/m^2)	29.20	±2.20	25.69	38.52	24.29	±0.64	22.02	24.07

PPS: Post prandial sugar; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body mass index

Table (2): Comparison between cases and controls according to the studied parameters.

	Group I (cases) (n=300)		Group II (control) (n=180)		T	*P*	Sig.
	Mean	**±SD**	**Mean**	**±SD**			
Age (yr)	29.66	±4.65	23.91	±2.85	15.11	<0.001	HS
Blood glucose level							
Fasting sugar	83.88	±11.54	74.65	±7.03	9.75	<0.001	HS
1st hour PPS	168.11	±17.05	151.95	±10.52	11.56	<0.001	HS
2nd hour PPS	143.53	±16.24	128.16	±10.16	11.52	<0.001	HS
3rd hour PPS	118.45	±17.22	102.88	±12.14	10.75	<0.001	HS
Uric acid (mg/dL)	4.37	±0.90	3.55	±0.73	10.53	<0.001	HS
SBP (mmHg)	110.93	±10.36	103.54	±9.76	7.85	<0.001	HS
DBP (mmHg)	70.92	±7.57	64.56	±7.40	9.11	<0.001	HS
BMI(Kg/m^2)	29.20	±2.20	24.29	±0.64	29.36	<0.001	HS

HS: Highly significant; Student's t test

There was a high statistical significant difference between cases and controls. Cases showed significantly higher mean age, BMI, fasting blood glucose level and after 1, 2, 3, hours postprandial sugar, systolic and diastolic blood pressure $P<0.001$.

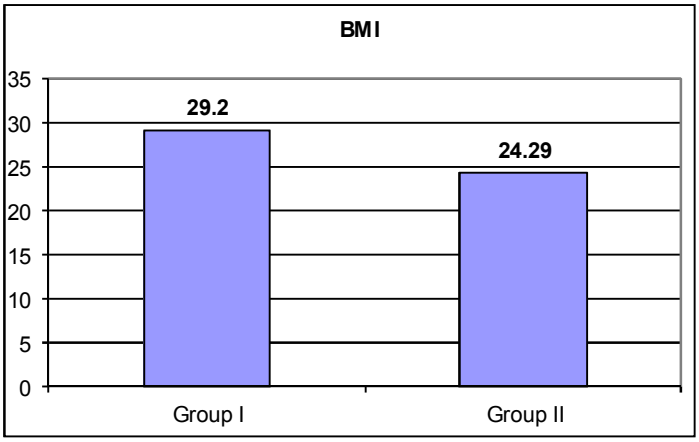

Fig. (1): Comparison between both groups according to the mean values of BMI

There was a highly statistical significant difference between both groups (Group I) showed significantly higher mean BMI.

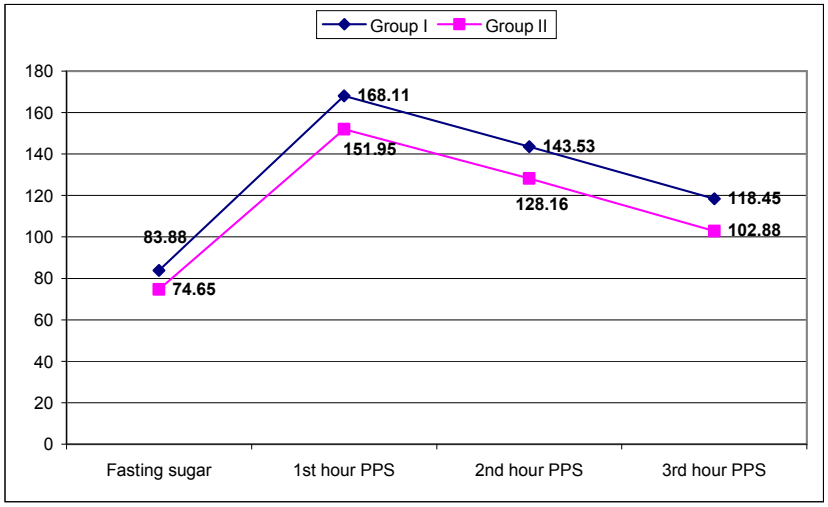

Fig. (2): Comparison between both groups according to mean values of blood glucose level (mg/dl) in fasting, 1st hour, 2nd hour, 3rd hour.

There was a high statistical significant difference between cases and controls cases. Cases showed significantly higher fasting blood glucose level and after 1, 2, and 3 hours PPS.

Table (3): Comparison between both groups as regards the presence of gestational diabetes mellitus.

		Group I (cases) (n=300)		Group II (control) (n=180)		OR	*P*	Sig.
		N	%	N	%			
Gestational DM	-ve	265	88.3%	177	98.3%	7.97(2.42-26.20)	<0.001	HS
	+ve	35	11.6%	3	1.6%			

HS: highly significant

There was a high statistical significant difference between both groups as regards the presence of GDM (*P*<0.001).

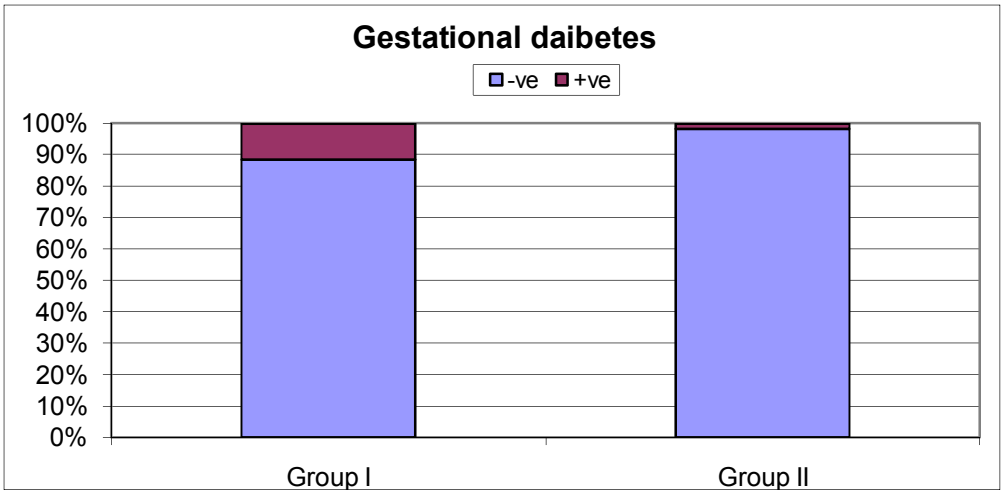

Fig. (3): Comparison between both groups as regard the percentage of GDM

There was a high statistical significant difference between both groups as regards the presence of GDM (*P*<0.001).

Table (4): Correlation between BMI and other measured parameters

	BMI					
	Group I			Group II		
	r	*P*	Sig.	r	*P*	Sig.
Blood glucose test (mg/dL)						
Fasting sugar	0.52	<0.001	HS	0.10	0.20	NS
1st hour PPS	0.48	<0.001	HS	0.17	0.02	S
2nd hour PPS	0.47	<0.001	HS	0.19	0.01	S
3rd hour PPS	0.47	<0.001	HS	0.13	0.07	NS
SBP (mmHg)	0.47	<0.001	HS	0.07	0.34	NS
DBP (mmHg)	0.50	<0.001	HS	0.04	0.56	NS

HS: Highly significant S: Significant NS: Non significant

Pearson correlation coefficient: r value of measures of association: (No association: 0), (mild association ±0.01 to 0.09), moderate association ±0.10 to 0.29) (strong association ±0.30 to 0.99) (strongest association ±1.00).

Among group I: there was a significant correlation between BMI and fasting blood glucose level and after 1, 2, 3, hours (moderate association), systolic and diastolic blood pressure (moderate association) *P*<0.001. Among group II: There was a significant correlation between BMI and blood glucose level and after 1, and 2 hours (mild

association $P<0.05$). There was no significant correlation between BMI and fasting blood glucose level and after 3 hours, systolic and diastolic blood pressure $P> 0.05$.

Table (5): Comparison between cases of group I with and without GDM

	Gestational diabetes				T	*P*	Sig.
	-ve (GDM) (265)		+ve (GDM) (35)				
	Mean	±SD	Mean	±SD			
Age (yr)	29.11	±4.48	33.79	+3.78	6.15	<0.001	HS
Systolic BP (mmHg)	11014	±10.14	116.84	±10.16	3.82	<0.001	HS
Diastolic BP (mmHg)	70.25	±7.36	75.92	±7.34	4.46	<0.001	HS
BMI(Kg/m^2)	28.81	±1.87	32.15	±2.27	10.08	<0.001	HS

HS: Highly significant
Student's t test

Cases of group I with GDM showed a high significant difference as regards age, BMI, systolic blood pressure and diastolic blood pressure when compared to cases of group I without GDM ($P<0.001$).

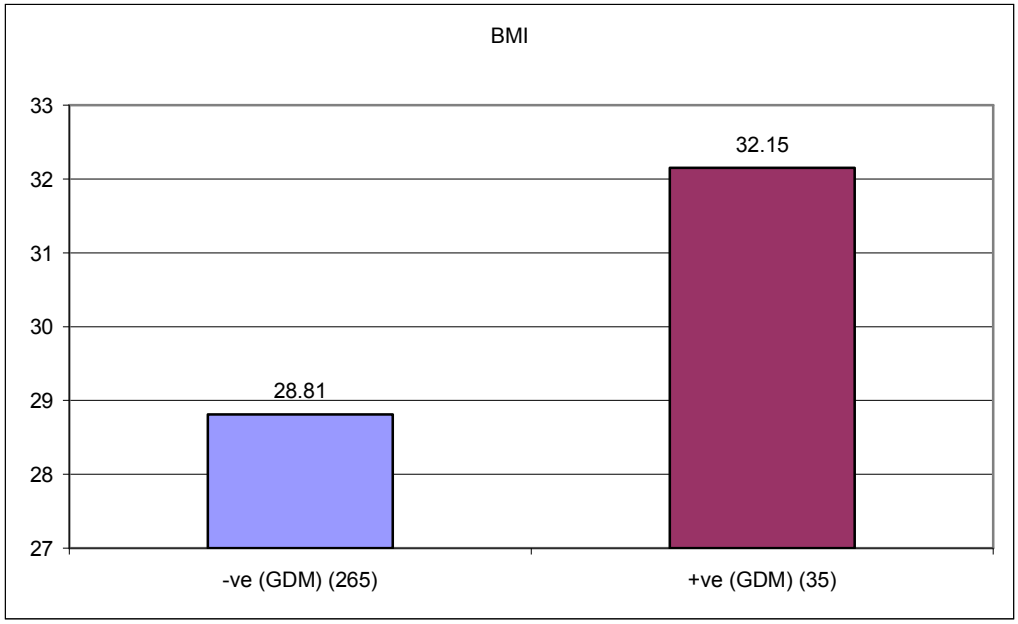

Fig. (4): Comparison between cases (Group I) with and without gestational diabetes according to mean values of BMI.

Cases (group I) with gestational diabetes showed significantly higher mean BMI ($P<0.001$).

Table (6): Multivariate analysis for gestational diabetes.

	Unadjusted		Adjusted		*P*
	OR	95.0% CI	OR	95.0% CI	
BMI (Kg/m2)	1.72	1.49-1.98	1.55	1.31-1.84	<0.001
Age	1.32	1.22-1.43	1.21	1.10-1.33	<0.001
Systolic BP (mmHg)	1.07	1.04-1.11	0.97	0.92-1.03	0.37
Diastolic BP (mmHg)	1.12	1.07-1.17	1.02	0.95-1.11	0.55

OR: odds ratio
95% CI: 95% confidence interval

For every 1 unit increase in BMI, the prevalence of GDM increased by 1.55% (95% CI 1.31 to 1.84). After multivariate analysis BMI and age were the significant risk factor for gestational diabetes (GDM).

4.Discussion

Maternal obesity is a strong risk factor for GDM and for the development of metabolic abnormalities after delivery in women with GDM. Gestational diabetes mellitus (GDM) defined as glucose intolerance with onset or first recognition during pregnancy, represents detection of a chronic metabolic abnormality, manifesting when pregnancy leads to the first evaluation of glucose tolerance in otherwise healthy women. Thus, GDM can be considered an early warning sign of the susceptibility to develop diabetes, metabolic syndrome, and even cardiovascular disease [(13)].

In the current study 480 were enrolled in this study. They were divided into two groups: Group (I): The study group included 300 pregnant women with elevated BMI from 25 to 40 kg/m^2. Group (II): the control group included 180 women with normal BMI 18:5 to 24.9kg/m^2. There was a highly statistical significant difference between both groups as regard the presence of gestational diabetes ($P<$ 0.01). In group I, 35 patients (11.6%) out of 300 had GDM while in group II 3 patients (1.6%) out of 180 patients had GDM. OR (95% CI) is 7.97 (2.42-26.20). For each 1 unit increase in BMI, the prevalence of GDM increased by 1.55% (95% CI 1.31 to 1.84).

Chu *et al.* conducted a metanalysis in 2007 to assess the risk of GDM among women who were overweight on obese. They identified studies from three sources: *1*) a PubMed search of relevant articles published between January 1980 and January 2006, *2*) reference lists of publications selected from the PubMed search, and *3*) reference lists of review articles on obesity and maternal outcomes published between January 2000 and January 2006. They used a Bayesian model to perform the meta-analysis and meta-regression. They included cohort-designed studies that reported obesity measures reflecting pregnancy body mass, that had a normal-weight comparison group, and that presented data allowing a quantitative measurement of risk. Their findings indicated that high maternal weight was associated with a substantially higher risk of GDM. Twenty studies were included in the meta-analysis. The unadjusted ORs of developing GDM were 2.14 (95% CI 1.82–2.53), 3.56 (3.05–4.21), and 8.56 (5.07–16.04) among overweight, obese, and severely obese compared with normal-weight pregnant women, respectively[(14)].

Torloni *et al.* (2009) assessed the risk for GDM according to the prepregnancy maternal BMI. It was a systematic review of observational studies published from (1977 to 2007). Most studies were of high or medium quality. Compared with women with a normal BMI, the unadjusted pooled odds ratio (OR) of an underweight woman developing GDM was 0.75 (95% confidence interval (CI) 0.69 to 0.82). The OR for overweight, moderately obese and morbidly obese women were 1.97 (95% CI 1.77 to 2.19), 3.01 (95% CI 2.34 to 3.87) and 5.55 (95% CI 4.27 to 7.21) respectively. For every 1 kg m^2 increase in BMI, the prevalence of GDM increased by 0.92% (95% CI 0.73 to 1.10). The risk of GDM was positively associated with prepregnancy BMI [(15)].

In the current study there was a high statistical significant difference between both groups as regards blood pressure measurement. The systolic and diastolic blood pressure were higher in group I with elevated BMI. There was a moderate association between BMI and systolic and diastolic blood pressure in group I while in group II there was no significant association. Comparison between cases of group I with and without gestational diabetes according to mean values of systolic and diastolic blood pressure showed significantly higher mean systolic and diastolic blood pressure $P<$ 0.05 in pregnant with GDM.

O'Brien *et al.* in (2003) identified thirteen cohort studies, comprising nearly 1.4 million women. The risk of preeclampsia typically doubled with each 5-7 kg/m^2 increase in pre-pregnancy body mass index. This relation persisted in studies that excluded women with chronic hypertension, diabetes mellitus or multiple gestations or after adjustment for other confounders [(16)].

Bodnar *et al.* (2005) showed that preeclampsia risk rose strikingly from a BMI of 15 to 30 kg/m^2. Compared with women with a BMI of 21, the adjusted risk of preeclampsia doubled at a BMI of 26 (odds ratio 2.1 [95% confidence interval, 1.4-34]), and nearly tripled at a BMI of 30 OR (0.43[0.25-0.76]), and a BMI of 19 was associated with a 33% reduction in risk (0.66 OR [0.50-0.87])[(17)].

In conclusion there is convincing evidence for the association between increasing pregnancy BMI and the risk for GDM. For every one unit increase in BMI, the prevalence of GDM increased by 1.55% (95% CI. 1.31 to 1.84). Pregnancy overweight is an essential risk factor for elevated mean systolic and diastolic blood pressure particularly when combined with GDM.

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11/25/2013