

## Relationship between Pre-pregnancy Weight and Body Mass Index (BMI) with Glycaemic Indices in Pregnancy

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### Abstract

### Original Research Article

**Background:** Diabetes Mellitus encompasses a group of metabolic diseases characterized by defective insulin activity. Gestational Diabetes Mellitus (GDM). It is defined as glucose intolerance with first onset or recognition during pregnancy. It is estimated that 7% of all pregnancies are complicated by Gestational Diabetes resulting in more than 200,000 cases annually. Gestational Diabetes is associated with perinatal and obstetric complications. WHO has recently developed new criteria for screening for Gestational Diabetes Mellitus? The aim of this study is to determine the relationship between OGTT indices (FPG, 1hr and 2hr post glucose load) and anthropometric indices (pre-pregnancy weight and Body Mass Index BMI) **Subjects And Materials:** This was a cross sectional study comprising 132 antenatal clinic attendees. The participants of the study were screened for Gestational diabetes using oral glucose tolerance test (OGTT) after appropriate history had been taken. **Results:** The prevalence of Gestational Diabetes was found to be 15.2%. The mean age of occurrence was 30.45± 4.30. Pre- pregnancy weight and BMI had a strong association with GDM in contrast to those without GDM. There was a positive correlation between OGTT indices and pre- pregnancy weight and BMI implying that the higher the prepregnancy weight and BMI, the higher the OGTT indices. **Conclusion:** The prevalence of Gestational diabetes is increasing and more likely to be found in older mothers. There is need to screen all pregnant women for Gestational Diabetes Mellitus in Africa. Preventive measures of risk factors for GDM should be advocated such as maintenance of a normal pre-pregnancy body weight and BMI, younger age of child bearing <35years and lower parity.

**Keywords:** Gestational, Diabetes, WHO, New, Criteria ,pregnancy BMI.

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## INTRODUCTION

Gestational Diabetes Mellitus is the most common medical and metabolic complication of pregnancy [i]. GDM represents nearly 90% of all pregnancies complicated by diabetes and affects approximately 7% of all pregnancies resulting in > 200,000 cases per year [ii,iii].

According to the international Diabetes Federation (IDF) Atlas in 2013, 21.4 million (16.9 %) out of an estimated 127.1 million live births to women aged 20-49 were affected by hyperglycemia in pregnancy [3]. Approximately 16% of those 21.4 million cases may be caused by diabetes in pregnancy (including previously undiagnosed diabetes detected in pregnancy, and live births in women with known diabetes). About ninety two percent of these cases of hyperglycemia in pregnancy was reported in low- and

middle-income countries like Nigeria, where access to maternal care is often limited[3].

Gestational Diabetes Mellitus is an important risk factor for developing type 2 diabetes, immediately after pregnancy, 5% to 10% of women with gestational diabetes are found to have diabetes, usually type 2[iv]. Women who have had gestational diabetes have a 35% to 60% increase in chance of developing type 2 diabetes in the next 10–20 years[v]. Children whose mothers have gestational diabetes also have an increased risk of developing obesity and type 2 diabetes [vi].

Increase in incidence rates of GDM may result in a greater overall population with obesity and type 2 diabetes[vii]. Type 2 DM is an important risk factor for cardiovascular disease[viii] and its prevalence is increasing at an alarming rate. The public health impact of cardiovascular disease is enormous and is also

increasing worldwide[ix]. The burden of type 2 DM is mostly in low -middle income countries due to the increasing incidence of obesity and sedentary lifestyle and adoption of western lifestyle.

The prevalence of GDM varies considerably by age, race, ethnicity, family history of diabetes, and obesity among other risk factors. In the United States; Native Americans, Asians, Hispanics, and African-American women are at higher risk for GDM than non-Hispanic white women [12]. Recent data show that gestational diabetes mellitus (GDM) prevalence has increased by 10–100% in several ethnic groups during the past 20 years [7].

### Pre-pregnancy body mass Index (BMI) and weight

The most studied factor in the issue of maternal weight and its relation to GDM is the prepregnancy BMI. Jang *et al.* found that the prevalence of GDM increases with rising BMI; 8.8% of the GDM patients were overweight (BMI > 27 kg/m<sup>2</sup>), compared to only 1.1% of controls ( $p < 0.001$ ). Bo *et al.* [x] described the mean BMIs in GDM and normal controls to be  $25.4 \pm 5.3$  and  $23.6 \pm 4.6$  kg/ m<sup>2</sup>, respectively ( $p < 0.02$ ). Solomon *et al.* also found that prepregnancy BMIs 25–30 kg/m<sup>2</sup> and  $\geq 30$  kg/m<sup>2</sup> are associated with an increased risk for GDM.

Pre-pregnancy weight is another risk determinant of GDM. In a study done by Xiong *et al.* found that 15.8% of women with GDM were obese prior to pregnancy (defined as weight  $\geq 91$  kg), compared to only 7.3% of normal controls (OR 2.4, 95% CI 2.06–2.98). Isaacs *et al.* [xii], in a retrospective study from 1994, showed that women weighing over 300 pounds have a significantly higher incidence of GDM versus a non obese control group (mean weight  $160 \pm 21$  pounds)

### Management of Gestational Diabetes

The management of GDM is based on medical nutrition therapy, moderate exercise and drugs.

#### Medical Nutritional Therapy

- Medical nutritional therapy (MNT) is considered an integral part of GDM management with strong evidence supporting dietary modifications and changes in lifestyle for the treatment of GDM [xiii,xiv]. Ideally, all patients with GDM would see a licensed dietitian to discuss their personal MNT plan.
- The aim of MNT is to provide adequate calories and nutrients for pregnancy while achieving desirable glycaemic targets avoiding ketosis or ketonaemia and post prandial hyperglycaemia
- ADA's general recommendations for MNT in GDM is 25-30 kcal/kg and 30-35kcal/ kg of ideal pre pregnancy body weight in the second and third trimesters respectively with an average weight gain of about 12kg throughout the pregnancy

(and a maximum of 7kg for obese GDM patients) [xv].

- For obese patients moderate calorie restriction (not more than 30% to avoid starvation ketosis) has been shown to be beneficial in improving glycaemic control.
- The diet should consist of 38 to 45% of carbohydrates (mostly high fibre, complex), 20 to 30% from protein, and 30 to 40% of mono and poly unsaturated fat of the daily calorie intake.
- It is recommended that women with GDM consume at least 175 g of carbohydrate per day according to the Institute of Medicine Dietary Reference Intakes (DRIs)[xvi] and distributed throughout the day into three small-to moderate meals and two to four snacks is recommended[xvii].
- Some studies have also reported the beneficial effects of using low glycemic index (GI) foods in the management of GDM[xviii,xix,xx,xxi,xxii].

#### Exercise

Exercise is useful in the management of GDM. Myocytes initially use glycogen stores for energy but are soon forced to use serum glucose, thus lowering blood glucose levels in the short term[xxiii]. In addition, exercise has been shown to increase the insulin sensitivity of muscle cells[xxiv] and glucose uptake into muscle cells, regardless of insulin levels[57], resulting in lower blood glucose.

In the long term, exercise reduces the risk of type 2 DM in people in the general population otherwise at high risk of the disease. Since patients who have had a pregnancy with GDM are at an increased risk of type 2 DM, it is reasonable to assume that exercise can reduce their risk as well. The more vigorous the physical activity, the lower the risk of type 2 DM is believed to be[xxv].

#### Drug Therapy

Some oral anti-diabetic agents have also been used in GDM but medical nutritional therapy, exercise and insulin are the mainstay of the management of GDM. ADA recommends starting insulin therapy when MNT fails to maintain plasma glucose concentrations at  $\leq 105$  mg/dL (5.8mmol/l) during fasting,  $\leq 155$  mg/dL (8.6mmol/l) one hour after eating, or  $\leq 130$  mg/dL (7.2mmol/l) two hours after eating.xxvi However, the American College of Obstetrics and Gynecology recommend starting insulin therapy at lower blood glucose levels—a fasting plasma glucose concentration of  $>95$  mg/dL(5.3mmol/l) or a two-hour postprandial plasma glucose concentration of  $>120$  mg/dL(6.7mmol/l) after two weeks of MNT. The ADA target for plasma glucose control for the management of GDM is fasting of  $\leq 95$ mg/dl(5.3mmol/l), 1hour  $\leq 140$  mg/dL(7.8mmol) and 2hours of 120mg/dl and HbA1c of  $<6.0\%$ .

**Complications of Gestational Diabetes Mellitus**

Complications arise following persistent hyperglycaemia in both mother and fetus which include increased incidence of abortions, congenital malformations, unexplained intrauterine fetal death, fetal macrosmia and rarely intrauterine fetal growth restriction on the part of the baby and increased incidence of diabetic ketoacidosis, lactic acidosis, genital injuries in labour, increased rate of operative delivery and the future risk of development of Type 2 DM on the part of the mother[xxvii,xxviii].

The degree of perinatal morbidity and mortality seen in GDM is almost the same as those seen in pregestational DM[3] Since GDM is a condition associated with grave fetal and maternal complications, its early detection is important as treatment greatly affects pregnancy outcome.

**AIM OF STUDY**

To determine the relationship between OGTT indices (FPG, 1hr and 2hr post glucose load) and anthropometric indices(pre-pregnancy weight and Body Mass Index BMI)

**SUBJECTS, MATERIALS AND METHODS**

This was a prospective cross-sectional study of 132 consenting consecutive pregnant women attending the antenatal clinics of the University of Port Harcourt teaching Hospital with gestational ages of between 24-28weeks.Those with pre-gestational diabetes mellitus, those on drugs that affect glucose tolerance and those with multiple pregnancies were excluded. Ethical approval for the study was obtained from the Ethical Committee of the University of Port Harcourt Teaching Hospital before commencement of the study. The study was carried out over a period of six months.

Data from the study subjects included biodata, parity, weight, Body Mass Index (BMI), blood pressure.

All study subjects underwent a 75g Oral Glucose Tolerance Test. They were asked to fast for at

least 8hrs before the test and return in the morning (8am) for the test. They were told to take their last meal before 10pm and bring their breakfast to clinic to eat immediately after the test to avoid hypoglycaemia.

They were allowed to rest for 5-10mins before commencement of the test. A fasting plasma sample was collected after which 75g anhydrous glucose dissolved in 250mls of water was given to each subject to drink over five minutes. Time 0 was taken from the time of the first sip.

Venous blood samples were collected at fasting, 1hour and 2hours after glucose consumption. During the test subjects were not allowed to do any physical activity or eat or smoke but water could be taken. Plasma glucose estimation was determined according to the method described by Trinder[xxix] using the glucose oxidase enzyme solution.

The glucose tolerance status for each subject was determined using the new WHO criteria.

The new WHO criteria as stated below are:  
 Fasting .....5.1mmol/l- 6.9mmol/l ( 92-125mg/dl)  
 1hour..... ≥10.0mmol/l (180mg/dl)  
 2hours.....8.5mmol/l-11.0mmol/l (153-199mg/dl)  
 GDM was diagnosed where one or more threshold value is exceeded.

**STATISTICAL ANALYSIS**

Data was analyzed using the statistical package for the social sciences (SPSS) version 20.0 and the level of statistical significance was set at p<0.05

**RESULTS**

A total of 132 women between the gestational ages of 24-28 weeks were recruited into this study. The most common age group was 26-30years and the least common age group was between41-45years as shown in fig table1. The mean age of the subjects was (31.33±4.33) years with a range of 21-42 years

**Table-1: Sociodemographic data of study population.**

| Variable                 | Number (percent) n=132 (100%) |
|--------------------------|-------------------------------|
| <b>Age group</b>         |                               |
| 21 – 25                  | 9(6.8)                        |
| 26 – 30                  | 55(41.7)                      |
| 31 – 35                  | 44(33.3)                      |
| 36 – 40                  | 22(16.7)                      |
| 41 – 45                  | 2(1.5)                        |
| <b>Educational level</b> |                               |
| Primary                  | 2(1.5)                        |
| Secondary                | 20(15.2)                      |
| Tertiary                 | 110(83.3)                     |

|                                  |          |
|----------------------------------|----------|
| <b>Occupation</b>                |          |
| Skilled/ professional employment | 32(24.2) |
| Unskilled employment             | 4(10.6)  |
| Public servants                  | 26(19.7) |
| Business(traders)                | 24(18.2) |
| Unemployed                       | 20(15.2) |
| Others                           | 16(12.1) |
| <b>Parity</b>                    |          |
| 0                                | 25(18.9) |
| 1                                | 36(27.3) |
| 1                                | 49(37.1) |
| 2                                | 20(15.1) |
| 3                                | 2(1.5)   |

GDM subjects had significantly higher mean pre-pregnancy weight (78.50 ±12.23) and BMI(30.23± 5.85) than subjects without GDM (p value 0.009 and 0.001) respectively as shown in table 3

More of those without GDM were normal weight compared to those with GDM while GDM subjects were more in the overweight group compared to those without GDM as shown in fig.1.

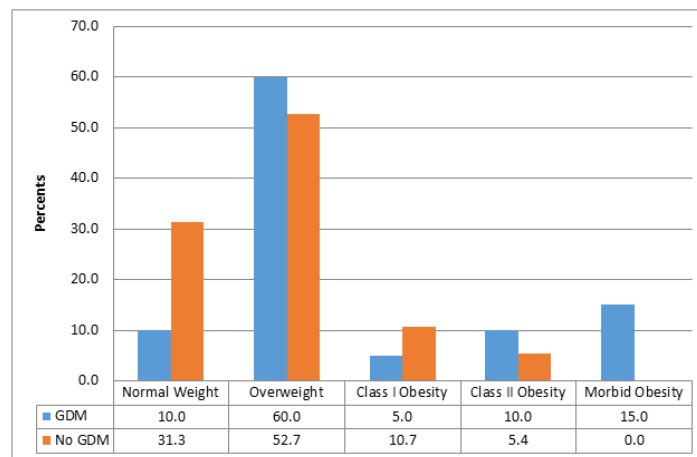


Fig-1: Column chart showing BMI of GDM and No GDM subjects

The mean fasting plasma glucose was significantly higher in those with GDM (5.28± 1.5) than those without GDM (4.34± 0.68) with a pvalue of < 0.001. GDM subjects also had significantly higher

mean one hour (9.20± 2.8) and two hours (7.72±2.52) post 75g glucose load plasma values than subjects without GDM, p value 0.000. These are shown in table 2.

Table-2: Comparison of factors associated with gdm in study population for quantitative variables

| V Variable                 | NoGDM N=112  | GDM N=20      | T Test | P value |
|----------------------------|--------------|---------------|--------|---------|
| AGE (years)                | 31.40 (4.35) | 30.95 (4.30)  | .432   | 0.669   |
| CALCULATED GA (weeks)      | 26.48 (1.79) | 26.50 (1.57)  | -.046  | 0.964   |
| HEIGHT (m)                 | 1.64 (0.06)  | 1.62 (0.06)   | 1.333  | 0.194   |
| PRE-PREGNANCY WEIGHT (kg)  | 71.54 (10.5) | 78.50 (12.23) | -2.668 | 0.009*  |
| PRE-PREGNANCY BMI (kg /m2) | 26.68 (3.83) | 30.23 (5.85)  | -3.491 | 0.001*  |
| FPG (mmol/l)               | 4.34 (0.65)  | 5.28 (1.5)    | -4.646 | 0.000*  |
| 1 HOUR OGTT (mmol/l)       | 7.08 (1.7)   | 9.20 (2.8)    | -4.609 | 0.000*  |
| 2 HOURS OGTT (mmol/l)      | 5.76 (1.4)   | 7.72( 2.52)   | -5.012 | 0.000*  |

Data are expressed as mean (standard deviation)

\*Significant Student T-test

**Relationship between ogtt indices and Anthropometric indices (pre-pregnancy weight and bmi)**

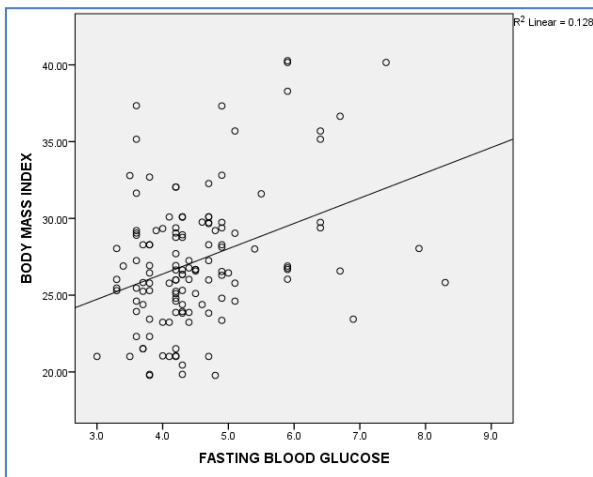
Table 3 and figures 2 ,3,4 & 5 shows the Pearson’s correlation between OGTT indices (FPG, 1hour and 2hours post 75g glucose load),

anthropometric indices ( pre-pregnancy weight &BMI). There was a statistically significant positive correlation between OGTT indices and anthropometric indices, implying that the higher the BMI, pre-pregnancy weight, the higher the OGTT indices.

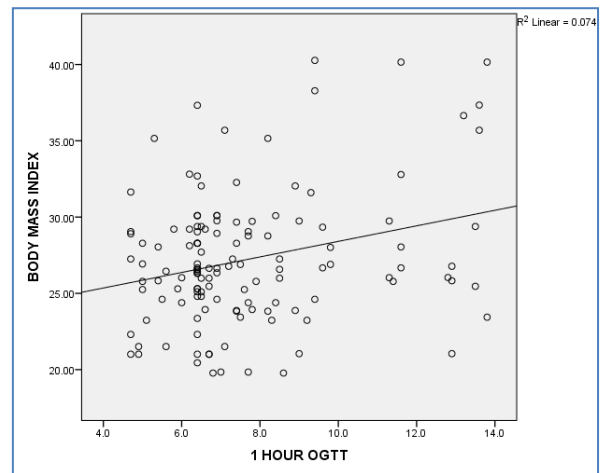
**Table-3: Correlation between ogtt indices and anthropometric indices (pre-pregnancy weight and bmi)**

| VARIABLES                 | FBG   |        | 1 HR OGTT |       | 2 HR OGTT |       |
|---------------------------|-------|--------|-----------|-------|-----------|-------|
|                           | R     | P      | R         | P     | R         | P     |
| BMI (kg/m <sup>2</sup> )  | 0.358 | <0.001 | 0.272     | 0.002 | 0.291     | 0.001 |
| Pre-pregnancy weight (kg) | 0.355 | <0.001 | 0.194     | 0.260 | 0.229     | 0.008 |

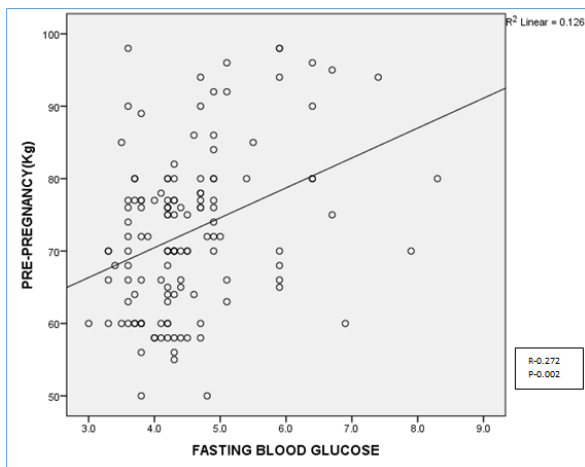
Legend-BMI-body mass index, R-correlation coefficient, P is significant at <0.05



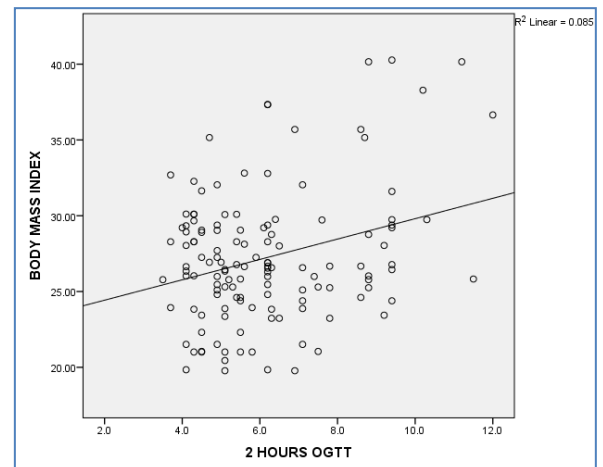
**Fig-2: Scatterplot showing positive correlation between Fasting plasma glucose and body mass index**



**Fig-4: Scatterplot showing positive correlation between body mass index and 1hour post OGTT**



**Fig-3: Scatterplot showing positive correlation between pre-pregnancy weights and fasting blood glucose**



**Fig-5: scatterplot showing positive correlations between body mass index and 2hours OGTT**

**DISCUSSION**

Pre-pregnancy weight and body mass Index (BMI) is one of the most studied factors in the relation to GDM. Jang *et al.* [71] found that the prevalence of GDM increases with rising BMI. Bo *et al.* [7, 6] found that the mean BMIs in GDM and normal controls to be 25.4 ± 5.3 and 23.6 ± 4.6 kg/ m<sup>2</sup>, respectively (p < 0.02). Solomon *et al*<sup>76</sup> also found that pre pregnancy BMIs 25–30 kg/m<sup>2</sup> and ≥30 kg/m<sup>2</sup> are associated with an increased risk for GDM. These were

similar to the findings in this study with the mean pre-pregnancy BMI being  $(30.23 \pm 5.85)$  among those with GDM which was significantly higher compared to a BMI of  $(26.68 \pm 3.83)$  in those without GDM with a pvalue of 0.001. The mean pre-pregnancy weight of those with GDM was also significantly higher than those without GDM which is similar to a study done by Xiong *et al.* that reported that 15% of women with GDM were obese prior to pregnancy compared to 7.3% of normal controls.

There was a significant association between fasting plasma glucose, 1hour and 2hours post glucose load with pre-pregnancy weight and BMI. This association was strong between pre-pregnancy weight and BMI. This is similar to the findings of HAPO study in which there were strong association between the glycaemic indices and pre-pregnancy weight and BMI.

### CONCLUSIONS AND RECOMMENDATIONS

The prevalence of gestational Diabetes like other types of Diabetes is increasing, due to increase in obesity, urbanization and adoption of western lifestyle. This was seen in this study as an increase in the prevalence of GDM done in the University of Port Harcourt Teaching Hospital from 0.3% to 15.2% although it was done using the O'sullivan criteria in the year 2000.

Pre- pregnancy BMI had a strong association with GDM in contrast to those without GDM. There was a positive correlation between OGTT indices and pre- pregnancy weight and BMI.

There is need to screen all pregnant women for GDM due to the high and increasing prevalence of GDM.

This new WHO criteria should be adopted universally to enable a uniform criteria for the diagnosis of GDM which uses lower thresholds to detect mild degrees of hyperglycaemia that predicts adverse maternal and fetal outcomes.

Preventive measures of risk factors for GDM should be advocated such as maintenance of a normal pre-pregnancy body weight and BMI, younger age of child bearing <35years and lower parity.

GDM patients should be followed up and advised on preventive measures against any future development of Type 2 DM.

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