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**ASSOCIATION OF PRE-PREGNANCY BODY MASS INDEX AND THE DEVELOPMENT OF GESTATIONAL DIABETES MELLITUS AND RELATED COMPLICATIONS IN THE CENTRAL REGION OF SAUDI ARABIA**

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**ABSTRACT**

**Background:** Gestational diabetes mellitus (GDM) during pregnancy can lead to significant health consequences for mothers and children in the short and long term. However, many countries, including Saudi Arabia, lack comprehensive epidemiological data to inform effective responses. This study aims to investigate the association between pre-pregnancy body mass index (BMI) and the development of GDM and related complications in the central region of Saudi Arabia.

**Materials and Methods:** This cross-sectional study enrolled 55 pregnant women who visited the Diabetes and Endocrinology Center in Buraydah, Qassim region, and voluntarily participated by completing a written questionnaire. Associations between various exposures and outcomes were evaluated using Statistical Packages for Software Sciences (SPSS) version 26, Armonk, New York, IBM Corporation, and 95% confidence intervals (CIs) were estimated.

**Results:** Our data suggested that GDM seemed to have a higher impact on women with normal BMI (65.5%) and those who were underweight (1.8%); however, the overall results did not reach statistical significance ( $p=0.361$ ). Additionally, we found that being a housewife and taking medications influenced pre-pregnancy BMI.

**Conclusion:** In our study, there was no statistically significant relationship between prepregnancy BMI and GDM but normal and underweight women seemed to be more affected by GDM. Also, our study showed some factors to influence prepregnancy BMI, such as being housewife and taking medications.

**Keywords:** Gestational diabetes mellites; Pregnancy outcomes; Body mass index; Obesity; Saudi Arabia

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## INTRODUCTION

Gestational diabetes mellitus (GDM) refers to glucose intolerance first recognized after 20 weeks of pregnancy [1]. Its prevalence varies globally, with rates reported as 7% in North America, 11.2% in South America, and 15% in South-East Asia [2]. The Middle East and North Africa show the highest GDM prevalence, ranging between 8.4% and 24.5% [2]. In Saudi Arabia, various regions report prevalence rates, such as 19.6% in Jeddah, 16.2% in Medina, and 24.2% in Riyadh [3–5]. Despite often being asymptomatic, GDM poses significant risks during pregnancy and delivery, including preeclampsia, cesarean section, preterm delivery, fetal macrosomia, respiratory distress syndrome, neonatal jaundice, and neonatal ICU admission [6-7]. Moreover, women with a history of GDM face a higher risk of developing type 2 diabetes mellitus (T2DM) [8] and cardiovascular diseases [9].

Various risk factors contribute to GDM, including advanced maternal age, non-white ethnicity, previous GDM history, family history of T2DM, and smoking [10–12]. However, the most significant risk factor is being overweight or obese (pre-pregnancy BMI  $\geq 25$  kg/m<sup>2</sup>) [13]. Hence, maintaining a BMI below 25 kg/m<sup>2</sup>, adopting a healthy diet, engaging in regular exercise, and avoiding smoking before and during pregnancy are recommended preventive measures [14].

Obesity and overweight BMI prevalence among women of childbearing age have been rising globally [15]. Recent studies reveal that over 1.9 billion adults are overweight and 650 million are obese worldwide [16]. In Saudi Arabia, the prevalence of obesity surpasses the global average [17]. Besides contributing to GDM, overweight and obese women face higher risks of adverse pregnancy outcomes, including preeclampsia, cesarean delivery, labor induction, increased postpartum hemorrhage risk, gestational hypertension, cardiovascular diseases, and sleep apnea [18–20]. Additionally, neonatal complications such as shoulder dystocia, stillbirth, hypoglycemia, neonatal jaundice, and macrosomia are more common among offspring of obese or overweight mothers [21].

The escalating incidence of GDM is, in part, attributed to the increasing prevalence of obesity among childbearing women. Women with class three obesity, for instance, have a 14.6% higher risk of developing GDM compared to those with a normal BMI [20]. However, there is limited evidence on the association between GDM and obesity in the central region of Saudi Arabia. Therefore, this cross-sectional study aims to provide data on the relationship between GDM and pre-pregnancy obesity in the central region of Saudi Arabia.

## MATERIAL AND METHODS

Ethical approval for the study was obtained from the regional research ethics committee, registered at the National Committee of Bioethics & Medical (NCBE) Registration No. H-04-Q-001 on March 01, 2023.

### Study Design and Participants:

This cross-sectional study involved pregnant women (n=55) attending the Diabetes and Endocrinology Center in Buraydah, Qassim region. Participants were recruited based on their willingness to take part in the study and were requested to complete a study-specific written questionnaire during their visit. The questionnaire collected information on sociodemographic characteristics and maternal factors.

### Data Collection Instrument:

We utilized a written questionnaire in the Arabic language for data collection (Items of the questionnaire was taken from multiple studies [22-25]). The questionnaire encompassed the following aspects: (1) Sociodemographic data, such as age, level of education, and employment status; (2) Physical activity, including cardio sports practice like walking and running, along with the frequency of these activities; (3) Pre-pregnancy weight, current weight (in Kg), and height (in cm); (4) Family history of diabetes mellitus (DM) and personal medical history, encompassing conditions like hypertension, DM, liver diseases, or kidney diseases; (5) Details of any previous pregnancies, their follow-up history, and duration of the current pregnancy (in weeks); (6) History of complications during the current pregnancy; and (7) Whether current

blood sugar measurements meet the recommended glycemic targets, which include a fasting glucose level of  $\leq 95$  mg/dL (5.3 mmol/L), a 1-hour postprandial glucose level of  $\leq 140$  mg/dL (7.8 mmol/L), and a 2-hour postprandial glucose level of  $\leq 120$  mg/dL (6.7 mmol/L). Once validated, the questionnaire was distributed to pregnant women attending the Diabetes and Endocrinology Center in Buraydah.

### Statistical Analysis:

Descriptive statistics were used to compute and report frequencies and proportions (%) for categorical variables. The relationship between pre-pregnancy BMI levels and the demographic and clinical characteristics of the patients was analyzed using the Fisher Exact test. Statistical significance was considered at  $p < 0.05$ . Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 26, Armonk, New York, IBM Corporation.

## RESULTS

The study included 55 women, with 47.3% of them aged between 30 to 35 years old, as depicted in Table 1. The majority of participants (83.6%) held a diploma, bachelor's, or higher degree, and approximately 56.4% were employed outside the home. Of the participants, 47.3% reported regular practice of cardio sports, with 57.7% engaging in sports on a weekly basis. Among the women, 60% had a family history of diabetes, with 63.3% of them having type 2 diabetes. Chronic diseases were present in

**Table 1: Socio-demographic characteristics of the women (n=55)**

<b>Study Data</b>	<b>N (%)</b>
<b>Age group</b>	
• 20 – 29 years	15 (27.3%)
• 30 – 35 years	26 (47.3%)
• >35 years	14 (25.5%)
<b>Level of education</b>	
• Middle	01 (01.8%)
• High school	08 (14.5%)
• Diploma/Bachelor or higher	46 (83.6%)
<b>Nature of work</b>	
• Housewife	21 (38.2%)
• Work from home	03 (05.5%)
• Work outside the house	31 (56.4%)
<b>Do you practice Cardio sports (Walking, running)</b>	
• Yes	26 (47.3%)
• No	29 (52.7%)
<b>If your answer is yes to previous question, How much do you practice it? (n=26)</b>	
• Everyday	05 (19.2%)
• 3-6 Days per Week	06 (23.1%)
• Weekly (less than 3 days per week)	15 (57.7%)
<b>Has any of your 1st-degree relatives (parents, siblings) been diagnosed with Diabetes Mellitus?</b>	
• Yes	33 (60.0%)
• No	22 (40.0%)
<b>Please select the type of DM (n=33)</b>	
• DM Type 1	12 (36.4%)
• DM Type 2	21 (63.6%)
<b>Have you been diagnosed with any chronic diseases?</b>	
• Yes	10 (18.2%)
• No	45 (81.8%)
<b>Specific chronic disease (n=10)</b>	
• Hypertension	02 (20.0%)
• DM	03 (30.0%)
• Liver Diseases	
• Diabetes and Hypertension	03 (30.0%)
• Unknown	01 (10.0%)
<b>If you were diagnosed with diabetes in the past, please select the type</b>	
• DM type 1	03 (05.5%)
• DM type 2	03 (05.5%)
• I have not been diagnosed with DM	49 (89.0%)

18.2% of the participants, with diabetes (30%) or combined diabetes and hypertension (30%) being the most common conditions. Moreover, 5.5% had a previous diagnosis of type 2 diabetes.

Table 2 provides additional details on the participants. Around 12.7% were taking medications, and 41.8% were pregnant for the first time. Among those with previous pregnancies, 71.9% had three or fewer pregnancies in the past. The majority of

**Table 2: Maternal characteristics (n=55)**

<b>Variables</b>	<b>N (%)</b>
<b>Are you currently take any medication/drugs?</b>	
• Yes	07 (12.7%)
• No	48 (87.3%)
<b>Is this your first pregnancy?</b>	
• Yes	23 (41.8%)
• No	32 (58.2%)
<b>Number of previous pregnancy (n=32)</b>	
• ≤3	23 (71.9%)
• >3	09 (28.1%)
<b>Duration of current pregnancy</b>	
• ≤22 weeks	24 (43.6%)
• >22 weeks	31 (56.4%)
<b>Are you following with obstetrics physician/gynaecologist</b>	
• Yes	53 (96.4%)
• No	02 (03.6%)
<b>Have you suffered from any complication during current pregnancy?</b>	
• Yes	24 (43.6%)
• No	31 (56.4%)
<b>Type of complication (n=24)</b>	
• Gestational Diabetes Mellitus	18 (75.0%)
• Polyhydramnios	02 (08.3%)
• Oligohydramnios	01 (04.2%)
• Spontaneous Abortion (Miscarriage)	02 (08.3%)
• Other	01 (04.2%)
<b>Last fasting blood sugar measurement (mg/dl)</b>	
• ≤95	34 (61.8%)
• >95	21 (38.2%)
<b>Last 1-hour postprandial blood sugar measurement (mg/dl)</b>	
• ≤140	33 (60.0%)
• >140	22 (40.0%)
<b>Last 2-hour postprandial blood sugar measurement (mg/dl)</b>	
• ≤120	36 (65.5%)
• >120	19 (34.5%)

participants (56.4%) were at 22 weeks of gestation in the current pregnancy, and almost all (96.4%) were under the care of a obstetrician. Maternal complications were reported by 43.6% of the participants, with gestational diabetes being the most common complication (75%). Furthermore, 61.8% had a fasting blood sugar level of 95 mg/dL or less, while 60% had a 1-hour postprandial blood sugar level of 140 mg/dL or less, and

65.5% had a 2-hour postprandial blood sugar level of 120 mg/dL or less.

Figure 1 illustrates changes in BMI during pregnancy. During the current pregnancy, 47.3% of the women became overweight, and the prevalence of obesity increased from 12.7% before pregnancy to 20% during pregnancy.

**Table 3: Relationship between the level of prepregnancy BMI according to the Socio-demographic and clinical characteristics of the women (n=55)**

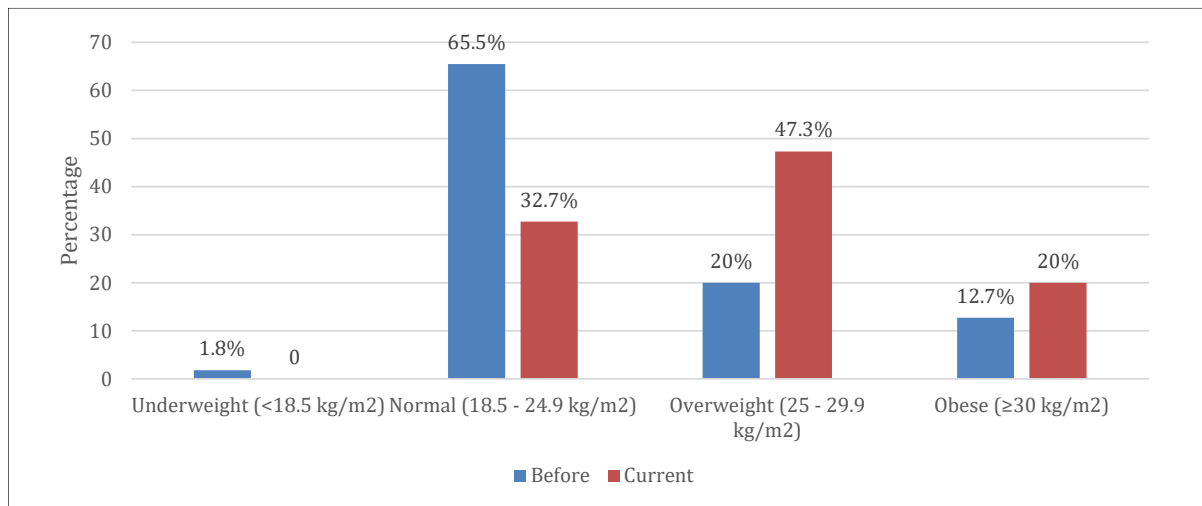
Factor	Overweight or obese N (%) (n=18)	Normal or underweight N (%) (n=37)	P-value §
<b>Age group</b>			
• 20 – 29 years	03 (16.7%)	12 (32.4%)	0.074
• 30 – 35 years	07 (38.9%)	19 (51.4%)	
• >35 years	08 (44.4%)	06 (16.2%)	
<b>Nature of work</b>			
• Housewife	11 (61.1%)	10 (27.0%)	<b>0.020 **</b>
• Working	07 (38.9%)	27 (73.0%)	
<b>Practicing Cardio sports (Walking, running)</b>			
• Yes	09 (50.0%)	17 (45.9%)	1.000
• No	09 (50.0%)	20 (54.1%)	
<b>Family history of DM</b>			
• Yes	13 (72.2%)	20 (54.1%)	0.249
• No	05 (27.8%)	17 (45.9%)	
<b>Associated chronic disease</b>			
• Yes	04 (22.2%)	06 (16.2%)	0.713
• No	14 (77.8%)	31 (83.8%)	
<b>Taking medications/drugs</b>			
• Yes	05 (27.8%)	02 (05.4%)	<b>0.032 **</b>
• No	13 (72.2%)	35 (94.6%)	
<b>First pregnancy</b>			
• Yes	07 (38.9%)	16 (43.2%)	1.000
• No	11 (61.1%)	21 (56.8%)	
<b>Duration of current pregnancy</b>			
• ≤22 weeks	09 (50.0%)	15 (40.5%)	0.570
• >22 weeks	09 (50.0%)	22 (59.5%)	
<b>Complication during pregnancy</b>			
• Yes	07 (38.9%)	17 (45.9%)	0.774
• No	11 (61.1%)	20 (54.1%)	
<b>Last fasting blood sugar measurement</b>			
• ≤95 mg/dl	12 (66.7%)	22 (59.5%)	0.769
• >95 mg/dl	06 (33.3%)	15 (40.5%)	
<b>Last 1-hour postprandial blood sugar measurement</b>			
• ≤140 mg/dl	13 (72.2%)	20 (54.1%)	0.249
• >140 mg/dl	05 (27.8%)	17 (45.9%)	
<b>Last 2-hour postprandial blood sugar measurement</b>			
• ≤120 mg/dl	10 (55.6%)	26 (70.3%)	0.368
• >120mg/dl	08 (44.4%)	11 (29.7%)	

§ P-value has been calculated using Fischer Exact test.

\*\* Significant at p&lt;0.05 level.

Table 3 examines the relationship between pre-pregnancy BMI and demographic and

clinical variables. The prevalence of overweight/obese status before

**Figure 1: Women's current and before BMI**

pregnancy was significantly more common among housewives ( $p=0.020$ ) and those who were taking medication/drugs ( $p=0.032$ ).

## DISCUSSION

This study explored the relationship between pre-pregnancy BMI and the development of gestational diabetes and pregnancy-related complications. Our results showed that 20% of the subjects were overweight before pregnancy, 12.7% were obese, 65.5% had a normal BMI, and 1.8% were underweight. These findings differed from the study by Pirjani et al. [26], where higher levels of obesity (52.5%) and overweight (27.8%) were reported. Similarly, studies conducted in Qassim [23] and Riyadh [24] also demonstrated similar results regarding overweight and obesity, with 63% and 68.1% being overweight or obese, respectively.

Our study identified being a housewife and taking medications/drugs as factors influencing overweight/obesity. It contrasts

with a study conducted in the UAE [15], which found that mothers aged 35 years or older were more likely to be overweight, and obese mothers were more likely to have lower monthly income and deliver via cesarean section. This aligns with a study from Jeddah [3], which documented that women with GDM were more likely to be older and have higher BMI values. This observation was also supported by research from Madinah [4], where older maternal age, elevated BMI, increased blood pressure, previous history of GDM, history of delivering a deformed child, and family history of DM were identified as the main risk factors for GDM. However, in our study, age, family history of DM, and associated chronic diseases showed no significant association with pre-pregnancy BMI, contrary to previous reports.

Approximately 43.6% of our subjects experienced pregnancy complications, with GDM being the most common (75.0%).

Other complications included polyhydramnios (8.3%), spontaneous abortion (8.3%), and oligohydramnios (4.2%). However, our results did not show a direct association between pregnancy complications and pre-pregnancy BMI. In contrast, a study by Sun et al. [27] found several pregnancy complications linked to overweight and obesity, including GDM, gestational hypertension, macrosomia, large gestational age, and low birth weight. Kim et al. [20] also reported an increased risk of gestational hypertensive disorders with increasing BMI. Additionally, a study by Roman et al. [21] linked increasing BMI to adverse maternal and neonatal outcomes, such as stillbirth, shoulder dystocia, macrosomia, hypoglycemia, NICU admission, and neonatal jaundice. Similarly, a cohort study by Wahabi et al. [24] associated obesity with GDM, induction of labor (IOL), failed IOL, hypertensive events in pregnancy, and cesarean delivery.

Regarding blood sugar levels, approximately 61.8% of our subjects had a fasting blood sugar level of 95 mg/dL or less, 60% had a 1-hour postprandial blood sugar level of 140 mg/dL or less, and 65.5% had a 2-hour postprandial blood sugar level of 120 mg/dL or less. However, we found no significant association between fasting blood sugar levels and pre-pregnancy BMI. In contrast, Alfadhli et al. [4] reported that fasting blood glucose was diagnostic in approximately 48% of GDM cases, and 1-hour and 2-hour glucose tolerance tests (OGTT) were added for the remaining GDM cases. Agarwal et al. [28] emphasized the importance of 1-hour and 2-hour glucose concentrations during

OGTT for GDM diagnosis, as they were detected in more than half of the GDM cases.

### **Limitation**

The number of pregnant ladies visiting the GDM clinic was minimal during the data collection period.

### **CONCLUSION**

Our study did not find a statistically significant relationship between pre-pregnancy BMI and GDM development. However, GDM seemed to affect more normal and underweight cases. Being a housewife and taking medications were identified as factors influencing pre-pregnancy BMI. Pregnancy complications observed included changes in amniotic fluid volume and spontaneous abortion. Further research is warranted to investigate the relationship between pre-pregnancy BMI and the development of GDM in the central region (AL-Qassim). Implementing strategic programs to prevent and manage complications associated with pre-pregnancy BMI among women in the Central Region is of paramount importance.

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