Maternal Obesity Influences Birth Weight more than Gestational Diabetes

Eman M Alfadhli (alfadhli2005@yahoo.com)

Research article

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Abstract

BACKGROUND

Maternal obesity and gestational diabetes (GDM) are commonly encountered during pregnancy. Both conditions are independently associated with unfavorable pregnancy consequences. The objective of this study was to compare the effects of obesity and GDM on birth weight, macrosomia, and other adverse pregnancy outcomes.

METHODS

This was a prospective study involving 531 women with a singleton pregnancy attending the Maternity and Children's Hospital, Medina, Saudi Arabia. Participants underwent a 75-g oral glucose tolerance test between 24 and 32 weeks. The International Association of Diabetes and Pregnancy Study Groups criteria were used for GDM diagnosis. BMI was assessed at the first antenatal visit, and obesity was defined as a BMI ≥30.0 kg/m^2. Women were divided into 4 groups: non-GDM nonobese (reference group), GDM nonobese, obese non-GDM, and obese GDM. Clinical characteristics and adverse pregnancy outcomes were compared.

RESULTS

The mean age and BMI of the participants were 30.5 years and 29.3 kg/m^2, respectively. GDM was diagnosed in 50.2% of the participants, and obesity was diagnosed in 47.8% of the participants. Obese women with GDM were the oldest and heaviest among all women. The mean birth weight increased in order among the four groups; it was highest in the infants in the obese GDM group, followed by those in the obese non-GDM, GDM nonobese and reference groups. Obesity and GDM alone or in combination were associated with higher rates of macrosomia and cesarean deliveries than the reference group. Neonatal intensive care unit (NICU) admission was higher in infants in the GDM nonobese and obese GDM groups. The rate of low Apgar score was significantly higher in infants in the obese GDM group than in infants in the reference group.

CONCLUSIONS

Maternal obesity seems to influence birth weight more than GDM, while GDM is associated with a greater risk of admission to the NICU. The combination of both conditions is associated with the greatest risk of adverse pregnancy outcomes.

Background:

Maternal obesity and gestational diabetes (GDM) are common metabolic problems in pregnancy. Both conditions are characterized by increased insulin resistance and hyperinsulinemia and are usually diagnosed simultaneously.

Maternal obesity has increased considerably among women of reproductive age. Likewise, the prevalence of GDM has also increased in parallel to the increase in obesity [1]. In addition, applying the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria for GDM diagnosis has led to a marked increase in GDM prevalence [2]. The IADPSG recommendations are based on the results of the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study, which showed a continuous linear association between glucose levels and undesirable pregnancy consequences [3]. As a result, the IADPSG criteria classify GDM with a lower degree of hyperglycemia and treatment of mild GDM has been shown to reduce the rate of adverse pregnancy outcomes [4], [5]. Although gestational diabetes is routinely screened for and managed throughout pregnancy, obesity is usually overlooked. The latter is attributed to the lack of authorized guidelines that endorse the care of obesity during pregnancy.

Maternal obesity and GDM are independently linked to unfavorable pregnancy outcomes with some variations in the influence of each condition [6–9]. Ricart et al. found obesity to affect macrosomia and cesarean delivery more than GDM [10]. In a study from Finland, the risk of macrosomia and cesarean delivery was higher in obese women with and without GDM than in normal-weight women with and without GDM [7]. The HAPO study found that the risk of cesarean delivery was higher in obese women without GDM than in nonobese women with GDM; however, macrosomia was higher in nonobese women with GDM than in obese women without GDM.

The purpose of this study was to compare the effects of obesity, GDM and their combination on adverse pregnancy outcomes among Saudi women using the IADPSG criteria. The primary outcomes were birth weight and macrosomia. Secondary outcomes were cesarean delivery, low Apgar score, and neonatal intensive care unit (NICU) admission.

Methods:

A total of 531 pregnant women treated in the antenatal clinic at the Maternity and Children’s Hospital, Medina, Saudi Arabia were included. The inclusion criteria included apparently healthy Saudi women with a singleton pregnancy. Women with pre-existing diabetes or chronic diseases or who used any medications that could affect pregnancy outcomes were excluded.

The study was approved by the ethics committees of the Maternity and Children’s Hospital, Medina, Saudi Arabia. Written informed consent was obtained from all participants.

At the first antenatal visit, demographic data, height, and weight were collected. BMI was calculated as weight/height squared (kg/m^2). Obesity was defined as a BMI $\geq$ 30.0 kg/m^2 based on the World Health Organization [1].

Participants underwent a 75-g oral glucose tolerance test (OGTT) between 24 and 32 weeks of gestation. According to the IADPSG recommendations, GDM was diagnosed if any one of the cut-off values were met: fasting plasma glucose 5.1 mmol/L (92 mg/dL), 1-h glucose 10.0 mmol/L (180 mg/dL), or 2-h glucose 8.5 mmol/L (153 mg/dL) [2].

Based on the results of the OGTT and BMI, women were divided into 4 groups: group 1: non-GDM nonobese (normal group); group 2: GDM nonobese; group 3: obese non-GDM; and group 4: obese GDM. Group 1 (non-GDM nonobese) was considered the reference group.

All women were followed up by obstetricians until delivery. In addition, women with GDM were followed by a diabetologist, a diabetes educator, and a dietician. Self-monitoring of blood glucose was performed to ensure adequate glycemic control among women with GDM. The recommended glycemic targets for fasting and 1-h and 2-h postprandial glucose levels were 5.2 mmol/L ($\leq$ 95 mg/dL), 7.8 mmol/L ($\leq$ 140 mg/dL) and 6.7 mmol/L ($\leq$ 120 mg/dL), respectively [3]. If the glucose values were consistently greater than the glycemic target, insulin was prescribed. Obese women without GDM were followed as the reference group and not given extra recommendations on diet or exercise. Adverse pregnancy outcomes were collected from the medical records after delivery.

Comparisons were made between the four groups with regard to clinical characteristics and adverse pregnancy outcomes. The main outcomes included birth weight and macrosomia. Secondary outcomes were cesarean delivery, low Apgar score, and NICU admission. Macrosomia was defined as a birth weight of 4000 g or more, and an Apgar score of 7 or less at 5 minutes was considered low.

Statistics:

Statistical analyses were performed using SPSS software (v 20.0; SPSS Inc., Chicago, IL). A chi-square analysis was performed to test for differences in the proportions of categorical variables. One-way ANOVA was used to determine the significance of differences between the means of continuous variables. To assess associations of obesity and GDM with pregnancy outcomes, multiple logistic regression was used. The level $P < 0.05$ was taken as the cut-off value for significance.

Results:

The mean age of the women was 30.5 years, and the mean BMI was 29.3 kg/m^2. GDM was diagnosed in 50.2% of the women, of which 63.7% were obese. Obesity was documented in 47.8% of all women, of whom 66.7% had GDM. Figure 1 shows the distribution percentages of the participants among the four groups.

Compared to the women in the reference group, women in the other three groups, GDM nonobese, obese non-GDM, and obese GDM, were significantly older and heavier. The mean birth weight increased in order among the groups; it was highest in the infants in the obese GDM group, followed by those in the obese non-GDM, obese GDM and reference groups (Fig. 2). However, significance was only reached when the birth weight of infants in the obese GDM group were compared to that of the infants in the reference group, with a 291-gm difference.

The rates of macrosomia and cesarean deliveries were significantly higher in all three groups than in the reference group. Admission to the NICU was higher in all three groups than in the reference group but only reached significance in women with GDM with and without obesity. The rate of low Apgar score was significantly higher in infants in the obese GDM group than in infants of the reference group (Table 1).

Table 1
Baseline characteristics and outcomes of the four groups.

Variable/Group	Mean	P value		
Age (years)				
Non-GDM nonobese*	**28.9**			
GDM nonobese	**31.7**	**0.000**		
Obese non-GDM	**31.3**	**0.001**		
Obese GDM	**33.69**	**0.000**		
BMI (kg/m^2)				
Non-GDM nonobese*	**24.2**			
GDM nonobese	**26.0**	**0.000**		
Obese non-GDM	**34.5**	**0.000**		
Obese GDM	**36.2**	**0.000**		
Birth weight (g)				
Non-GDM nonobese*	**2859**			
GDM nonobese	**2933**	**0.333**		
Obese non-GDM	**3003**	**0.062**		
Obese GDM	**3150**	**0.000**		
Variable	Percentages (%)	P value	Odds ratio (OR)	CI
Macrosomia				
Non-GDM nonobese*	0			
GDM nonobese	3	**0.048**	7.22	0.37-141.52
Obese non-GDM	6.1	**0.013**	14.05	0.78–252.5
Obese GDM	4	**0.022**	9.37	0.5-176.43
Cesarean delivery				
Non-GDM nonobese*	26.4			
GDM nonobese	43.5	**0.014**	2.15	1.16–3.98

All P values and ORs were compared with the reference group (non-GDM and nonobese women). * reference group, g: gram.

Obese non-GDM	56.9	**0.000**	3.69	1.97–6.91
Obese GDM	50.0	**0.000**	2.79	1.653–4.722
NICU Admission				
Non-GDM nonobese*	14			
GDM nonobese	30.3	**0.006**	2.68	1.30–5.52
Obese non-GDM	24.2	0.073	1.97	0.931–4.18
Obese GDM	26.0	**0.016**	2.168	1.143–4.115
Low Apgar Score				
Non-GDM nonobese*	1.6			
GDM nonobese	5.2	0.171	2.82	0.56–14.05
Obese non-GDM	1.6	1.00	1.00	0.09–11.2
Obese GDM	9.7	**0.006**	1.858	1.415–2.440
All P values and ORs were compared with the reference group (non-GDM and nonobese women). * reference group, g: gram.				

Table 2 shows comparisons between the three nonreference groups: GDM nonobese, obese non-GDM, and obese GDM. Maternal age was significantly higher in the obese women with GDM than in the women in the GDM nonobese group and the obese non-GDM group, with no differences between the latter two groups. Obese women with GDM were significantly heavier than the women in the other 2 groups. The mean birth weight increased in order from the GDM nonobese, obese non-GDM, and obese GDM groups but only reached significance when comparing the birth weight of infants in the obese GDM group with that of the infants in the nonobese GDM group, with a 217 gm difference. The difference in the mean birth weight of infants between the obese GDM and obese non-GDM groups was not significant. There were no significant differences in the other studied adverse pregnancy outcomes; macrosomia, cesarean delivery, low Apgar score, and NICU admission, between the three groups.

Table 2
Comparisons between the three nonreference groups: GDM nonobese; obese non-GDM; and obese GDM.

Mean	**Non-GDM Nonobese (group 1)**	**GDM nonobese (group 2)**	**Obese non-GDM (group 3)**	**Obese GDM (group 4)**	**P value**		
					Group 2 Vs. Group 3	**Group 2 Vs. Group 4**	**Group 3 Vs. Group 4**
Age (years)	28.9	31.7	31.3	33.7	0.621	**0.011**	**0.002**
BMI (kg/m^2)	24.2	26.0	34.5	36.2	**0.000**	**0.000**	**0.009**
Birth weight (g)	2859	2933	3003	3150	0.488	**0.006**	0.061

Discussion:

In the current study, we found a high prevalence of maternal obesity and GDM among Saudi women: 47.8% and 50.2%, respectively. This is consistent with a study from Riyadh in which the prevalence of obesity was 44% among Saudi pregnant women. In contrast, the prevalence of GDM was 15% in that study, which is much lower than the rate in this study [9]. The marked difference in GDM prevalence between the two studies is mostly related to the different methods used for GDM diagnosis. While the IADPSG criteria were used in the current study, Wahabi et al. [9] used the Carpenter and Coustan criteria [4]. This finding was demonstrated in our previous study that assessed the prevalence of GDM when applying the IADPSG vs. the Carpenter and Coustan criteria, which revealed a 2.44-fold (144.6%) increase when applying the IADPSG criteria: 41.5% vs. 16.9%, respectively.[5] This is also consistent with the findings from other studies [11], [12].

In the present study, the combination of maternal obesity and GDM affected one-third of women and was associated with older maternal age, higher weight and more adverse pregnancy outcomes than each condition alone. This is in concordance with many previous studies [6]–[9].

The mean birth weight increased in order among the four groups; it was highest in the infants in the obese GDM group, followed by those in the obese non-GDM, GDM nonobese, and reference groups. However, significance was only reached when the infants in the obese GDM group were compared to the infants in the GDM nonobese and reference groups, with 217 and 291 gm differences, respectively. This is consistent with the findings from other studies [6], [7], [9].

The risk of macrosomia and cesarean delivery were significantly increased in all three groups in comparison to that in the reference group. There was a tendency toward a higher risk of macrosomia among infants of obese women with and without GDM than among infants in the nonobese GDM group; however, the result did not reach significance. In the Finnish study, the risk of macrosomia and cesarean delivery were increased in obese women without GDM, and coexistent GDM increased the risk to a greater degree. However, normal-weight women with GDM were similar to normal-weight women without GDM [7]. Similarly, Ricart et al. found that obesity influenced macrosomia and cesarean section rates more than GDM [10]. Although the risk of cesarean delivery was found to be associated more with obesity than GDM in the HAPO study, macrosomia was associated more with GDM than obesity. This contradicting finding is possibly attributed to the lack of medical interventions for mild GDM in that study [8].

The rate of admission to the NICU was higher in infants in all three groups than in those in the reference group but only reached significance in GDM groups with and without obesity. This is in line with the findings from previous studies [7], [9]. The routine monitoring of infants of GDM mothers due to the concern of neonatal hypoglycemia and close observation of the infants' blood sugar may contribute to the increased risk of NICU admission. Nonetheless, in the Finnish study, the risk of NICU admission remained elevated in the infants of mothers with GDM after adjustment for neonatal hypoglycemia [7].

The rate of low Apgar score was significantly higher in the infants of obese GDM women than in the infants of the reference group. In addition, there was a tendency toward a low Apgar score in the GDM nonobese group in comparison to the scores in the obese non-GDM group and the reference groups; however, the findings did not reach significance. This result is consistent with the findings of the Wahabi et al. and Finnish studies [7], [9]. Although Hildeń et al. found that maternal obesity and GDM are major independent risk factors for a low Apgar score, no interaction effect between GDM and obesity was found [6].

From the findings of the current study and others, one can extrapolate that obesity is associated with a higher birth weight and greater risk of macrosomia and cesarean delivery than GDM. On the other hand, GDM is associated with a greater risk of low Apgar score and admission to the NICU. However, the combination of obesity and GDM is associated with the greatest risk of adverse pregnancy outcomes [6], [7], [9].

Although obesity is recognized to adversely affect pregnancy, there are no recommendations from professional organizations that endorse the consideration of obesity during pregnancy. Maternal obesity should indicate a high-risk pregnancy, particularly if combined with GDM. Until professional guidelines become available, lifestyle interventions, including diet and physical activity, should be recommended for obese women during pregnancy. Weight monitoring during pregnancy is required to avoid excessive weight gain. Women of reproductive age with obesity should receive facts and advice about the risks of obesity during pregnancy and be recommended to lose weight before and between pregnancies [13].

Limitations of the present study include the lack of data on prepregnancy maternal weight, which might be a contributing factor to the higher rate of obesity in this cohort of participants. However, we had the chance to measure weight at the first antenatal visit, which should not vary significantly from the prepregnancy weight. Another limitation was that no intervention was provided to the obese non-GDM group, which may contribute to the higher rate of increased birth weight of the infants in this group; however, this is the usual practice. The strength of this study is that it is prospective, so we had the chance to ensure the maintenance of good glycemic control among women with GDM. In addition, an OGTT was performed on all participants, so no woman with GDM was missed.

Conclusion:

Maternal obesity may be associated with a higher birth weight and a greater risk of macrosomia and cesarean delivery than GDM. Conversely, GDM may be associated with a greater risk of low Apgar score and admission to the NICU. However, the combination of obesity and GDM is associated with the greatest risk for all adverse outcomes. Further studies are needed to confirm our results.

Maternal obesity should indicate a high-risk pregnancy, particularly if combined with GDM. To reduce the risk of adverse pregnancy outcomes, weight monitoring and lifestyle modification, including diet and physical activity, should be recommended for obese pregnant women. Future works are needed to study the effect of such modifications on pregnancy outcomes.

Abbreviations:

Gestational diabetes (GDM); oral glucose tolerance test (OGTT); International Association of Diabetes and Pregnancy Study Groups (IADPSG); neonatal intensive care unit (NICU).

Declarations

Ethics approval and consent to participate:

The study was approved by the Ethical Committee of the Maternity and Children's Hospital, Medina, Saudi Arabia. Written informed consent was obtained from all participants.

Consent for publication:

Not applicable.

Availability of data and materials:

Datasets obtained and/or analyzed in this study are available from the corresponding author on reasonable request.

Competing interests:

None.

Funding:

None

Authors' contributions:

Single author by Eman Alfadhli

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Figures

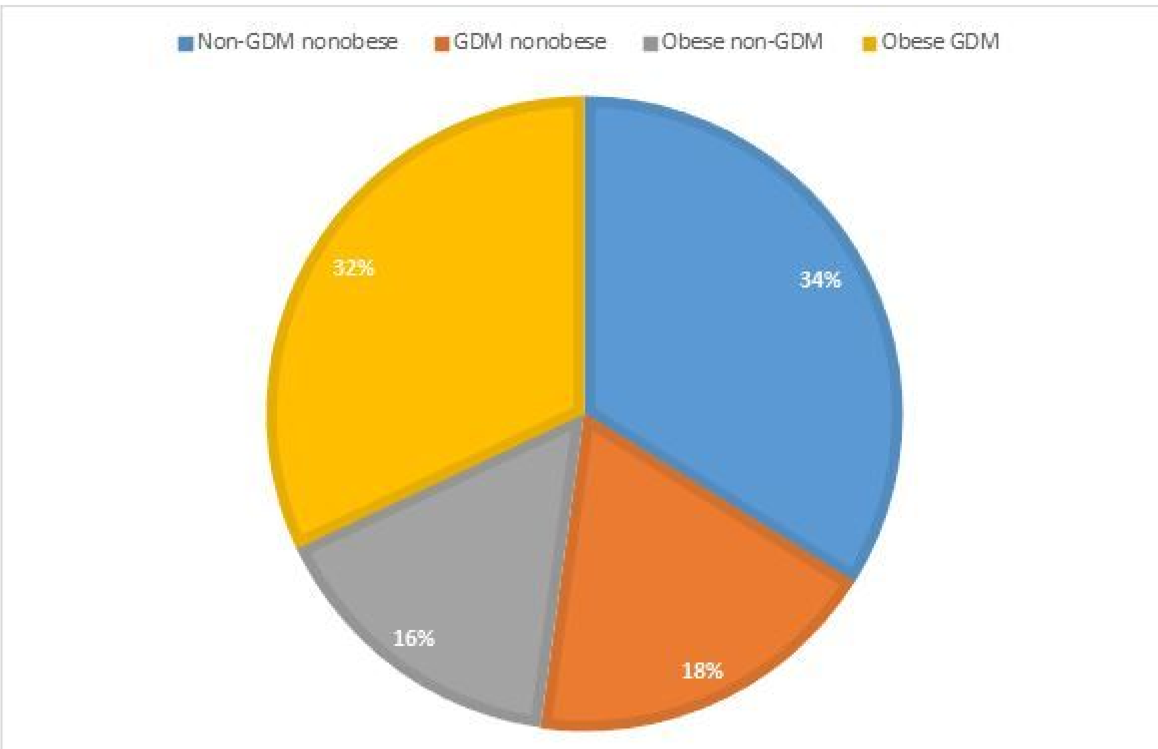

Figure 1

Distribution of the 531 pregnant women among the 4 groups.

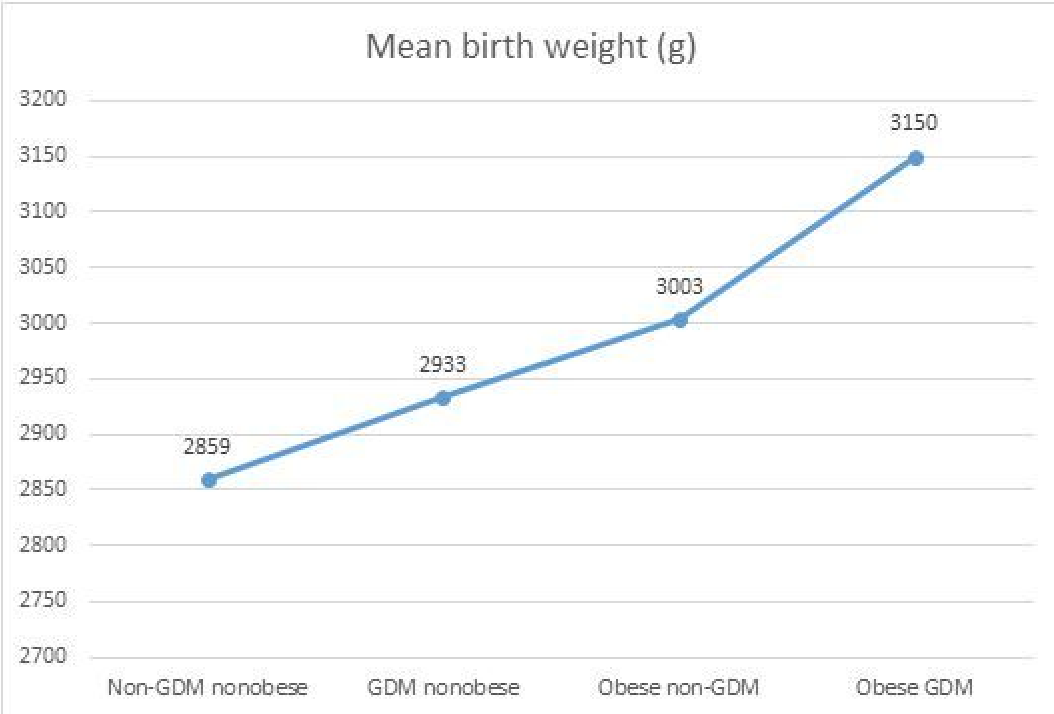

Figure 2

Mean birth weight of the infants in the four groups.